Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
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E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Dachung and Kalu, 2019

EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE EARLY GROWTH OF *Tamarindus indica* L. IN MAKURDI, NIGERIA

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ABSTRACT

Tamarindus indica, commonly known as Tamarind is one of the important multipurpose tropical fruit tree species in the tropical region. To effectively harness the potentials of this species, emphasis must be made for improving their demand as plantation trees, and also their early growth, and speed up their full development rate. The study was conducted to determine the effect of organic and inorganic fertilizers on the early growth of Tamarindus indica in the Forestry Nursery of Federal University of Agriculture Makurdi. Seeds were procured, pre-treated with 50 % sulphuric acid for 60 minutes to break seed dormancy and sown in the poly pots filled with top soil. Two weeks after germination, 10 potted seedlings each were divided into 4 groups of 3 different levels of inorganic and organic fertilizer applications in a Completely Randomized Design (CRD) experiment. Fertilizers were applied using ring method. Data collected for early growth parameters were seedling height, collar diameter and number of leaves produced. The growth parameters were measured at two weeks interval for six weeks. The results showed that application of ~~organic~~ manure at various doses yielded better growth and seedlings quality of Tamarindus indica as compared to NPK (15:15:15) and Urea fertilizer. Urea treatment was toxic to the seedlings at all levels of applications which led to the death of the seedlings. NPK applied at 6 grams and 9 grams were also toxic to the seedlings which also led to high mortality rate after application. From the results obtained in this experiment it was that organic manure (cow dung) should be utilized to make nutrient available for optimal growth of Tamarindus indica seedlings and the application of fertilizers (NPK and Urea) above 3 grams on Tamarindus indica seedlings should be discouraged.

Keywords: *Tamarindus indica*, Cowdung, NPK, Urea, early growth

INTRODUCTION

Tamarindus indica L., commonly known as Tamarind is one of the most important multipurpose fruit tree species in the tropical region. It is a large evergreen tree up to 30 m tall, bole usually 1-2 m, up to 2 m diameter, crown is dense, widely spreading, rounded; bark rough, fissured, grayish-brown (Bhadoriya *et al.* 2011). *Tamarindus indica* has a hard and heavy wood for general carpentry, boat building, firewood, and charcoal production; it is used as shade, amenity, bee forage and windbreak. Pods contain 1-10 seeds, which are irregularly shaped, flattened or rhomboid. Seeds are very hard, shiny, reddish, or purplish brown. They are embedded in the pulp, lined with a tough parchment resembling a membrane, and joined to each other with tough fibres (Kumar and Bhattacharya, 2008).

Tamarindus indica belongs to the family *Fabaceae* and subfamily C*aesalpinioideae*. It is an important source of food in the tropics. It is a multipurpose tree of which almost every part finds at least some use as either nutritional or medicinal (Kumar and Bhattacharya, 2008). Tamarind is indigenous to tropical Africa but it has been introduced and naturalized worldwide in over 50 countries. The major production areas are in the Asian countries, India and Thailand, but also in Bangladesh, Sri Lanka, and Indonesia, while America, Mexico and Costa Rica are the biggest producers. Africa on the whole does not produce tamarind on a commercial scale, though it is widely used by the local people. Minor producing countries in Africa are Senegal, Gambia, Kenya, Tanzania and Zambia (El-Siddig *et al.*, 2006).

Tamarind is valued highly for its fruits, especially the pulp which is used for a wide variety of domestic and industrial purposes (El-Siddig *et al*., 2006), especially for food and beverages (Kotecha and Kadam, 2003). The pulp constitutes 30-50% of the ripe fruit, the shell and fibre account for 11-30% and the seed about 25-40% (El-Siddig *et al.*, 2006).

Tamarind fruit pulp is used for seasoning as a food component, to flavour confections, curries and sauces, and is a main component in juices and certain beverages. Tamarind fruit pulp is eaten fresh and often made into a juice, infusion or brine (El-Siddig *et al*., 1999; El-Siddig *et al*., 2006), and can also be processed into jam and sweets. The refreshing drinks are popular in many countries around the world, though there are many different recipes. In some African countries, the juice obtained from the fruit pulp is mixed with wood ash to neutralize the sour taste of the tartaric acid. However, the most common method is to add sugar to make a pleasantly acid drink. Sometimes pulp is fermented into an alcoholic beverage (El-Siddig *et al*., 2006). There are great differences and variations in fruit size and flavour (Kumar and Bhattacharya, 2008).

Tamarind seed is a by-product of the tamarind pulp industry. The presence of tannins and other dyeing matter in the testa make the whole seed unsuitable for direct consumption. The major industrial product of tamarind seed is the tamarind kernel powder (TKP) which is an important sizing material used in the textile, paper, and jute industries (Kumar and Bhattacharya, 2008). Tamarind seed is also the raw material used in the manufacture of polysaccharide (jellose), adhesive and tannin. In 1942, two Indian scientists observed that decorticated kernels contained 46-48% of a gel-forming substance. This polysaccharide (pectin) with carbohydrate character and gelly forming properties, named 'jellose' (El-Siddig *et al*., 2006), has been recommended for use as a stabiliser in ice cream, mayonnaise and cheese, and as an ingredient or agent in a number of pharmaceutical products (Morton, 1987; El-Siddig *et al*., 2006). Flour from the seed may be made into cake and bread. Roasted seeds are claimed to be superior to groundnuts in flavour (ICRAF, 2007). In view of the overall nutrient and chemical composition, tamarind seeds may be adopted as an inexpensive alternative protein source to alleviate protein malnutrition among traditional people living in developing countries (Siddhuraju *et al.*, 1995).

Tamarind leaves and flowers can be eaten as vegetables and are prepared in a variety of dishes (ICRAF, 2007). They are used to make curries, salads, stews and soups in many countries, especially in times of scarcity (El-Siddig *et al*., 2006).

Tamarind barks and leaves contain tannins. The bark is rich in tannins reaching up to 70%, and as such has found a place for use in the tanning industry. The bark is used for tanning hides and in dyeing (Morton, 1987; El-Siddig *et al*., 2006). In Zambia, bark tannins are used in the preparation of ink and for fixing dyes. The bark is also burnt to make ink in many other African countries. Tamarind twigs are sometimes used as chewing sticks whereas the bark is used as a masticatory, alone or as a substitute of lime in betel nut. The bark yields the alkaloid hordenine (Morton, 1987; El-Siddig *et al*., 2006).

To effectively harness the potentials of this species, emphasis must be made for improving their demand as plantation trees. In this regard, the use of organic and inorganic manure applications becomes essential in forest soil management practice.

In order to regenerate a forest and maintain it, the soil has to be enriched with nutrients. This enrichment could be in form of fertilizer application, which may be organic or inorganic forms, all of which furnish plants with nutrients necessary for their growth (Offiong *et al*., 2010).

Siddhuraju (2007) reported that during the early stages of growth, trees are very well dependent on soil nutrient supply. Failure to manage nursery soil adequately can result in depletion of site quality and a reduction of seedling growth (Hoque *et al.*, 2004). The dilemma for the foresters is how to increase the yield and quality of products for rapidly expanding wood based industries and for use by a rapidly expanding human population and simultaneously maintaining the environmental diversity. However, it is well understood that the loss of diversity may be minimized in a sustainable manner through increasing the number of species used in production forestry through domestication of indigenous timber species (Rafiqul *et al.*, 2004). In view of this multipurpose function and utility of *Tamarindus indica*, it is favoured for plantation programs.

This study was aimed at evaluating the effect of organic and inorganic manure applications on *Tamarindus indica* at early growth stage to ascertain the best means of improving faster seedling growth of the species.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Forestry Nursery of Federal University of Agriculture Makurdi. The Forestry nursery is located beside the University Teaching and Research Farm ($7^o 41^{'}$ N 8^o $37^{'}$ E) Benue state is located in the southern guinea savanna ecological zone of Nigeria with a tropical sub-humid climate. It has two distinct seasons called the dry and wet seasons. The wet season starts from April to October while dry season is from November to March (Odekunle, 2004).

The soils are mainly oxisols and ultisols (tropical ferruginous) which vary over space with respect to texture, drainage, and gravel content. The soil is significantly agronomical because of its ability to produce a perched water table which is an important source of capillary water, which keeps the surface moist long after the end of the rainy season (Fagbami and Akamigbo, 1986).

Seeds Collection and Treatment

The pods of *Tamarindus indica* seeds were purchased from the Railway Market in Makurdi, Benue State and the seeds were extracted from the pods by splitting the pods carefully using mechanical means. Seed dormancy was broken by soaking the seeds in 50 % concentration of H_2SO_4 acid for 60 minutes to rupture the hard coat and to enhance the germination of seeds according to Abubakar and Muhammed (2013).

Experimental Design

The experiment was laid out in a Completely Randomised Design with three treatments (NPK, Cowdung and Urea) replicated four times and a control.

Seeds Sowing

Treated seeds were sown directly into poly pots filled with sterilized river sand. Two seeds were sown per poly pot, approximately 2cm deep into the pots. The seeds were lightly covered with sand and watering was done until germination of the seeds. The seedlings were allowed for two weeks growth before fertilizer application. Tamarind seedlings were transplanted into poly pots filled with a mixture of top soil and river sand in ratio of 4:1 before the fertilizer application. Both organic (cow dung) and inorganic (NPK 15:15:15 and Urea) fertilizers were applied when the seedlings were two weeks old using ring method. Varying levels of 3 g, 6 g and 9 g were administered into the poly pots.

Data collection Procedure

Data were collected for the following early growth parameters: seedling height, collar diameter and number of leaves produced. The growth parameters were measured at two (2) weeks interval for eight (8) weeks. The height of seedling in each poly pot was measured using a graduated meter rule. Vernier caliper was used to measure the collar diameter of seedling. The production of new leaves recorded by visually counting the number of leaves produced. These parameters were measured fortnightly. Data collected were subjected to Analysis of Variance (ANOVA).

RESULTS

Effect of the varying levels of inorganic and organic manure applications on the mean height of *Tamarindus indica* seedlings is shown on Table 1. Highest mean height of 22.73±2.73 cm was observed in the 6 grams dosage of organic manure treatment in the 8th week after application, followed by the NPK treatment with mean height of 19.28±3.49 cm recorded in the 8th week after application. The lowest mean value of 0.00 was observed at all levels of application in Urea treatment.

Table 1: Effect of Varying Levels Organic and Inorganic Fertilizers on the Mean Height (cm) of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	6 g	9 g
		Height (cm)	Height (cm)	Height (cm)
Control	-	12.87±1.50 [b]	8.32±0.02 [a]	8.20±1.14 [a]
NPK	2nd BFA	10.60±2.00 [a]	9.26±1.49 [a]	9.54±1.06 [b]
	4th AFA	11.95±2.08 [a]	10.65±0.21 [b]	8.50±2.12 [a]
	6th AFA	15.08±2.66 [c]	0.00	0.00
	8th AFA	19.28±3.49	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Organic	2nd BFA	9.74±1.37[a]	9.56±0.96 [a]	10.50±1.01 [a]
	4th AFA	10.91±1.58 [a]	11.71±1.44 [a]	11.71±1.44 [a]
	6th AFA	17.05±2.59 [b]	18.91±2.36 [b]	17.63±2.13 [b]
	8th AFA	20.88±3.40 [c]	22.73±2.73 [c]	21.41±2.08. [c]
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Urea	2nd BFA	9.03±1.38	9.39	9.09
	4th AFA	0.00	0.00	0.00
	6th AFA	0.00	0.00	0.00
	8th AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05)
Key: BFA: Before Fertilizer Application; AFA: After Fertilizer Application

Effect of the varying levels of organic and inorganic fertilizers on number of leaves of *Tamarindus indica* seedlings is shown in Table 2. Highest mean number of 19.30±4.03 was observed with 6 grams dosage of organic manure treatment in the 6th week after application, followed by the NPK treatment with mean number of leaves of 14.00±3.68 recorded in the 6th week after application. The least mean value of zero was observed at all levels of application in Urea treatment. Results indicated significant difference in height parameter which showed increase through the study period, with the 6 g level having the highest value. Effect of the varying levels of organic and inorganic fertilizers on the mean girth of *Tamarindus indica* seedlings is shown in Table 3. Highest mean girth of 0.37±0.03cm was observed with 9 g dosage of organic manure treatment in the 6th week after application, followed by the NPK treatment with mean girth of 0.35±0.05cm in 3 g dosage recorded in the 6th week after application. The least mean value of 0.00 was observed at all levels of application in Urea treatment.

Table 2. Effect of Varying Levels Organic and Inorganic fertilizers on the Mean Number of Leaves of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	**6 g**	**9 g**
Control	-	8.20±1.14	8.20±1.14	8.20±1.14
NPK	2^{nd} BFA	5.20±2.20	3.40±0.52	3.80±0.63
	4^{th} AFA	7.30±2.26	6.00±0.00	5.50±0.71
	6^{th} AFA	12.40±2.72	0.00	0.00
	8^{th} AFA	14.00±3.68	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Organic	2^{nd} BFA	3.90±0.32	3.50±0.53	3.70±0.48
	4^{th} AFA	8.00±1.16	7.80±0.92	7.10±1.45
	6^{th} AFA	12.10±2.13	11.50±2.07	11.80±1.40
	8^{th} WAFA	19.30±4.03	19.20±4.49	16.80±4.29
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Urea	2^{nd} BFA	3.30±0.48	3.20±042	3.50±0.53
	4^{th} AFA	0.00	0.00	0.00
	6^{th} AFA	0.00	0.00	0.00
	8^{th} AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05)

Table 3: Effect of Varying Levels of Organic and Inorganic Fertilizers on the Mean Girth (cm) of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	**6 g**	**9 g**
		Girth (cm)	**Girth (cm)**	**Girth (cm)**
Control	-	0.32±0.03 ^{a}	0.32±0.03 ^{a}	0.32±0.03 ^{b}
NPK	2^{nd} BFA	0.32±0.03 ^{a}	0.30±0.02 ^{a}	0.33±0.03 ^{b}
	4^{th} AFA	0.32±0.03 ^{a}	1.67±1.89 ^{b}	0.29±0.01 ^{a}
	6^{th} AFA	0.34±0.04 ^{a}	0.00	0.00
	8^{th} AFA	0.35±0.05 ^{a}	0.00	0.00
	***P*-value**	**0.086**	**<0.001**	**<0.001**
Organic	2^{nd} BFA	0.31±0.03^{a}	0.31±0.03 ^{a}	0.32±0.02 ^{a}
	4^{th} AFA	0.32±0.02 ^{a}	0.31±0.01 ^{a}	0.32±003 ^{a}
	6^{th} AFA	0.36±0.03 ^{a}	0.34±0.03 ^{a}	0.37±0.03 ^{a}
	8^{th} AFA	0.36±0.03 ^{a}	0.36±0.03 ^{a}	0.37±0.03 ^{a}
	***P*-value**	**0.999**	**0.990**	**0.099**
Urea	2^{nd} BFA	0.31±0.31 ^{a}	±0.34 ^{a}	±0.31 ^{a}
	4^{th} AFA	0.00	0.00	0.00
	6^{th} AFA	0.00	0.00	0.00
	8^{th} AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05

DISCUSSION

There were negative responses from Urea treatments and NPK doses on survival of *Tamarindus indica* seedlings Increase in fertilizer dose caused decrease in survival percentage *Tamarindus indica* seedlings. At Urea treatments, there was significantly lower survival rate (higher mortality rate) than NPK, while organic treatment had no significant effect on survival of *Tamarindus indica* seedlings

The greater height at 2 weeks was recorded in the organic fertilizer, followed by NPK fertilizer though not significantly different. However, after 6 weeks of application the response of organic manure was positive and Urea was negative. There was no significant difference (p>0.05) between heights. The performance of organic manure treatment was better than other treatments. When individual dose was examined, responses of organic manure (1:2:3 saw dust, poultry droppings and river sand) were found to be superior in comparison to other doses where various ratios of rice hull and saw dust were combined though the difference was not statistically significant (Ugese, 2010).

The seedlings in this experiment were not significantly different in their initial diameter (at the time of fertilizer application). NPK fertilizer have significant effect on diameter increment of *Tamarindus indica* seedlings and that after 6 weeks of application, there were no significant difference (p<0. 1) on diameter growth among the doses.

There was significant difference (p<0. 1) for leaf area among different treatments. The highest mean leaf number was found with organic manure while the lowest were found with Urea. There were no significant differences in the leaf number between the various doses.
The results of this study show that the application of organic fertilizers yielded better growth and seedlings quality. This is also in agreement with earlier reports of Rafiqul (2004) who recorded high performance in fertilizer application with *Anthocephalus chinensis.* The finding also agrees with the work of Ugese (2010) who obtained higher results in organic manure (poultry droppings) application with *Tamarindus indica* as compared with rice hull and sawdust. Mukhtar (2016) also recorded high performance in organic application with *A. digitata.* Positive effect of fertilization were also reported by Offiong *et al*, (2010) who recorded high performance in both NPK and organic manure with *Tetrapleura tetraptera*. The application of little doses of fertilizer stimulates cell differentiation and multiplication leading to height increments (Afa *et al.,* 2011). Similar results have been reported for *Michelia champaca* L seedlings in which minimal doses of Phosphorus yielded positive effects on height increments (Hoque *et al*., 2004). High doses of phosphorus application may become toxic to seedlings since absorption of this element may affect regular metabolic processes.

CONCLUSION

Application of organic manure at various doses yielded better growth at the early stage of *Tamarindus indica* as compared to NPK and Urea fertilizers. Treatment with urea was toxic to the seedlings at the 3 g, 6 g and 9 g, levels of applications which led to the death of the seedlings. NPK applied at 6 g and 9 g were also toxic to the seedlings which also led to the high mortality rate in the treatment after application.

Recommendation

From the results obtained, it is therefore recommended that:

i. Organic manure (cow-dung) should be utilized for better plant nutrition and faster growth of *Tamarindus indica* seedlings.
ii. The application of inorganic fertilizers (NPK and Urea) above 3 g, can affect the growth of *Tamarindus indica* seedlings negatively hence proper application guidelines should be adhered to.

REFERENCES

Abubakar, Z.A. and Muhammed, A. (2013). Breaking seed dormancy in Tamarind (*Tamarindus indica*). A case study of Gombe Local Government Area. *Journal of*

Applied Sciences and Environmental Management 17(1): 83- 87.

Afa, F.D, Bechem, E., Andrew, E.,Genla, F.A., Ambo,F.B., and Ndah, N.R (2011) Effects of organic and inorganic fertilizers on early growth characteristics of *Khaya ivorensis* Chev (African mahogany) in nursery. *African journal of Plant Science* 5(12), pp. 722 – 729.

Bhadoriya, S. S., Ganeshpurkar, A., Narwaria, J., Rai, G., and Jain, A. P. (2011).*Tamarindus indica*: Extent of explored potential. *Pharmacognosy Reviews*, *5*(9), 73–81. http://doi.org/10.4103/0973-7847.79102.

Doughari J. H. (2006). Antimicrobial activity of *Tamarindus indica* Linn. *Tropical Journal of Pharmaceutical Research* 5: 597-603.

El-Siddig, K., Ebert, G., and Lüdders, P. (1999). Tamarind (*Tamarindus indica* L.): a Review on a Multipurpose Tree with Promising Future in the Sudan. *Journal of Applied Botany* 73, 202-205.

El-Siddig, K., Gunasena, H.P.M., Prasa, B.A., Pushpakumara, D.K.N.G., Ramana, K.V.R., Vijayanand. P., and Williams, J.T. (2006). Tamarind – *Tamarindus indica* L. Fruits for the future 1. Southampton Centre for Underutilized Crops, Southampton, UK, 188p.

Fagbami, A. and Akamigbo F. A. (1986). The Soils Of Benue State and their capabilities. Proceedings of the 14th Annual Conference of the Soil Science Society of Nigeria. 6-17 pp.

Hoque ATMR, Hossian M.K., Mohiuddin M., Hoque, M.M. (2004). Effect of inorganic fertilizers on initial growth performanceof *Michelia champaca* Linn. Seedling in Nursery.*Journal of Biological Sciences* 4: 489-49

ICRAF (2007) .World Agroforestry Centre. ICRAF Agroforestry Tree Database: *Tamarindus indica* L., URL

http://www.worldagroforestrycentre.org

Kotecha, P.M and Kadam, S. (2003). Preparation of Ready –to-serve Beverage, syrup and Concentrate from Tamarind. *Journal of Food Science and Technology* –Mysore- 40(1): 76-79.

Kumar, C.S. and Bhattacharya, S.(2008). Tamarind Seed: Properties, Processing and Utilization. *Critical Reviews in Food Science and Nutrition.* 2008, 48, 1-20.

Morton, J (1987). Tamarind, In: J. F. Morton (ed). Fruits of warm climates. Meanapolis, Florida, 115-121Pp

Mukhtar, R.B (2016) Response of *Adansonia digitata* seedling to organic manure in Aliero area of Kebbi State. *Nigerian Journal of Agriculture, Food and Environment* 12(4): 120- 122.

Odekunle, T.O. (2004). Rainfall and the length of the growing season in Nigeria. *International Journal of Climatology*, 24: 467-479.

Offiong, M. O., Udofia, S. I., Owoh, P. W. and Ekpenyong, G. O. (2010): Effects of fertilizer on the early growth of *Tetrapleura tetraptera* Del. *Nigerian Journal of Agriculture, Food and Environment*, 6(2): 53-59.

Rafiqul, H. M., Hossian, M. K., Mpoinddon, M. and Hoque, M. M. (2004): Effect of inorganic fertilizers on the initial growth performance of *Anthocephalus chinensis* (Lam) seedlings in nursery. *Journal of Applied Science*, 4(1):477-485.

Siddhuraju, P. (2007). Antioxidant activity of polyphenolic compounds extracted from defatted raw and dry heated *Tamarindus indica* seed coat. LWT, 40, 982-990.

Siddhuraju, P., Vijayakumari, K., and Janardhanan, K. (1995). Nutritional and Antinutritional Properties of the Under-exploited Legumes *Cassia laevigata* Willd. and *Tamarindus indica* L. *Journal of Food Composition and Analysis, 8, 351-162.*

Ugese, F. U. (2010): Effect of nursery media on emergence and growth of tamarind (*Tamarindus indica* L.) seedlings. *Journal of Animal and Plant Sciences,* 8(2): 999–1005.

WOOD QUALITY STUDIES OF SOME WOOD SPECIES IN SUDANO-SAHELIAN ENVIRONMENT OF BORNO STATE, NIGERIA

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ABSTRACT

This study investigates wood properties of Azadirachta indica, Eucalyptus camaldulensis, and Khaya senegalensis to determine their potentials for timber in Nigeria. The species were randomly selected from a Forestry and Wildlife Nursery plantation within University of Maiduguri, Borno State in the North-eastern part of Nigeria. Three sampled trees were felled approximately 15cm to the ground and neatly de-branched. From each tree, 3 discs of 6cm height and a billet of 30cm were cut from each bole making a total of 9 discs and 3 billets from each stem, and 27 discs were taken at three height levels: base, middle and top of the merchantable height (MH) to determine their physical properties. Selected wood properties varied considerably among the species (P < 0.05). Wood density, annual ring, bark, sapwood and hardwood proportions decreased from the base to the top while moisture content, bast and pith proportions increased from base to top of the all the species along the sampling heights. The hygroscopicity of the wood shows that longitudinal shrinkage increased from base to top of all the selected species and others do not follow a particular pattern. This results however, when compared with other research results on bark portion shows the juvenility of the sample tress. The shrinkage behaviour of this species are low and indicates that the problems of cracking, splitting, opening of joint and warping in service will be minimal. The average annual ring of the selected species is estimated to be 6 A. indica, 5 in E. camaldulensis and 6 in K. senegalensis, this showed that the trees are still at the juvenile sap stage.

Keywords: *Azadirachta indica, Eucalyptus camaldulensis, Khaya senegalensis* Wood quality, Hygroscopicity

INTRODUCTION

Wood is one of the oldest, best known structural material, and one of the few renewable natural resources. The ubiquitous nature of wood has made it a valuable material in every stage of human development (Fuwape, 2000; Falemara *et al.,* 2012). All wood is composed of cellulose, hemicelluloses, lignin, and minor amount (5% to 10%) of extraneous materials contained in a cellular structure. Variations in the characteristics and volume of these components and differences in cellular structure make wood heavy or light, stiff or flexible, and hard or soft. However, to use wood to its best advantage and most effectively in engineering applications, specific characteristics or physical properties must be considered. Each wood species has unique cellular structure that creates differences in wood properties and ultimately determines the suitability for a particular use (Brian and Peter, 2002).

Wood quality characteristics can be inherent to particular species, but are also influenced by tree growing conditions. This connection to tree growth gives forest managers both an opportunity and an obligation to manage the tree judiciously for value on every site be it only through choice of rotation length, species selection, and initial spacing and stocking control on some sites, to fertilization, thinning and pruning on others. Many wood quality attributes are heritable, and differences in tree-to-tree quality within species can be traced to genetic differences. Forest managers rely on tree improvement programs to ensure that genetics are considered prior to regeneration and planting. Once an appropriate species is selected, its genetic code will govern tree form, tree growth and inherent wood quality. Through stocking control and other silvicultural treatments, however, the forest manager will embark on live crown management, which will determine growth rate, base of live crown, branch size, stem taper, heartwood/sapwood distribution, and juvenile/mature wood content (Josue, 2004).

The ever increasing market demand for 'traditional' high quality timber in Nigeria has resulted in over exploitation of very strong and durable species like *Milicia excelsa*, *Khaya spp.*, *Afzelia africana*, *Nuclea diderrichii*, *Triplochiton scleroxylon*, *Terminalia spp* etc. The resultant effect of this is the scarcity of these species in timber market. This become more pronounced in markets located in the Sudano-sahelian region which hitherto depend on the supply of timber from rainforest and derived savannah zone of the country. This is because the traded timber comes from the rainforest and derived savannah regions, there is very little information on the properties of timber species from sudano-sahelia region, hence their utilization potential is limiting. However, in selecting a tree species for structural and construction works and its inclusion in future large forest plantation programme, information on the wood properties is essential (Sotannde *et al*., 2010). This study was therefore carried out to identify and describe the basic physical properties of *Azadirachta indica*, *Eucalyptus camaldulensis* and *Khaya senegalensis* in Sudano-Sahelian Environment of Borno State, Nigeria to provide wood property information as well as technical information for wood user and proffer possible utilization potentials as an alternative to the economical wood species.

MATERIALS AND METHODS

Study Area

The trees of *A. indica*, *E. camaldulensis* and *K. senegalensis* used for this study were felled from a research plantation of the Department of Forestry and Wildlife within the University of Maiduguri, in the North-eastern part of Nigeria, located on latitude $11^o30''$N and longitude $14^o\,45''$E. The climate is hot and dry for most part of the year. The average annual rainfall is 650mm with a relative humidity of 42-49%. The soil type is generally sandy loam and well drained.

Sampling Technique

Three trees of fairly straight and cylindrical bole with no sign of mechanical damage or attack by fungi and insects were randomly selected from the plantation. The sampled trees were felled approximately 15cm to the ground and neatly de-branched. From each tree, 3 discs of 6cm height and a billet of 30cm were cut from each bole making a total of 9 discs and 3 billets from each stem, and 27 discs were taken at three height levels: base, middle and top of the merchantable height (MH). From the discs obtained, the estimated ages of the trees are 6 years for *A. indica* and *K. senegalensis* while *E. camaldulensis* is 5 years and the following measurements were carried out.

Determination of wood density

The freshly cut sample of 2 cm × 2 cm × 2 cm of about 90 cubes were weighed each with an electronic weighing balance while the volume of each sample were computed based on their dimension. The samples were oven-dried at a temperature of 102 ± 3^oC and weighed at an interval until a constant weight was obtained. Thereafter, the oven dried weight was measured together with the dimension of each cube. Density was then determined using this relationship:

$$P = \frac{W_o}{V_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. 1$$

Where;
P = density (g.cm-^{3})
W_o = oven-dry weight (g)
V_0 = volume (cm^3)

Determination of moisture content of wood

The samples were oven-dried until a constant weight was recorded. The moisture
content determination is shown in equation below:

$$MC = \frac{Wm - Wo}{Wo} \times 100 \ldots\ldots\ldots\ldots 2$$

Where:
MC=Moisture Content
Wm = Weight of the test wood samples before oven-drying (g)
Wo = Weight of the test wood samples after oven-drying (g)

Determination of bark thickness

To obtain the bark thickness of each sampled disc, calibrated ruler was placed on the transverse surface of the disc to measure diameter outside bark of the disc and diameter inside bark which is the xylem (wood). The bark thickness was obtained using the following formula:

BT = DOB – DIB……………… 3

Where:
BT is the bark thickness,
DIB is diameter inside bark (wood),
DOB is diameter outside bark.

Determination of sap and heart wood

There is a visual distinction from sapwood, heartwood to the Pith. The pith is located at the centre of the wood which is darker in colour and well distinct. The heartwood is brownish or yellowish in colour that distinguished from the light colour of sapwood portion.

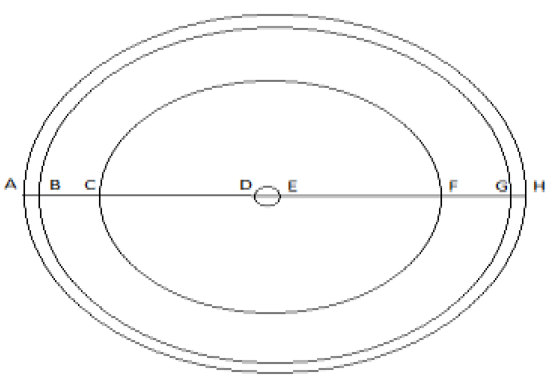

Fig 1: Annotated diagram of a wood cross section
AB and GH represent the bark; BC and FG represent the sapwood; CD and EF represent the heartwood; DE represents the pith.

$$Sapwood = \frac{BC + FG}{2} \dots\dots\dots\dots\dots \; 4$$

$$Heartwood = \frac{CD + EF}{2} \dots\dots\dots\dots \; 5$$

Determination of Growth Ring Number

The variations in age of trees as reflected in the number of growth rings were estimated along the main stem corresponding to the base, middle and top of the tree. This involves smoothing one surface of each disc; identify any false ring and counting the number of actual growth ring with the aid of magnifying hand lens.

Ring width Determination (cm)

The ring width determination was estimated by direct measurement on the transverse surface of each disc from the pith towards the bark using a magnifying hand lens over a calibrated transparent ruler. This involved measuring the distance between the transition zone of the late wood of previous years and the early wood of succeeding year.

Hygroscopicity of wood

This was determined based on shrinkage characteristics of the wood samples. The dimension of the freshly cut samples of 2 cm × 2 cm × 2 cm were taken at maximum moisture content (MMC) in the longitudinal, radial and tangential surface, the samples were oven-dried at temperature of $102 \pm 3^{o}C$ until a constant weight was obtained. The dimensions of the oven-dried samples were also taken in longitudinal, radial and tangential direction. The dimensional shrinkage in longitudinal, radial, and tangential direction was obtained
using the relationships below:

$$Tgs = \frac{Dt - dt}{dt} \times \frac{100}{1} \dots\dots\dots\dots\dots\dots\dots\dots \; 6$$

$$Rgs = \frac{Dr - dr}{dr} \times \frac{100}{1} \dots\dots\dots\dots\dots\dots\dots \; 7$$

$$Lgs = \frac{Dl - dl}{dl} \times \frac{100}{1} \dots\dots\dots\dots\dots\dots\dots\dots \; 8$$

Where:
Tgs =Tangential shrinkage
Rds = Radial shrinkage
Lgs = Longitudinal shrinkage

Dt = Tangential dimension (mm) at MMC
Dr = Radial dimension (mm) at MMC
Dl = Longitudinal dimension (mm) at MMC
dt = Tangential dimension(mm) at oven-dry at MMC
dr = Radial dimension (mm) at oven-dry MMC
dl = Longitudinal dimension (mm) at oven-dry MMC
The volumetric shrinkage (VS) of each sample was computed using the relationship below:

$$VS = 100 - \frac{(100-\mathrm{Lgs})(100-\mathrm{Rds})(100-\mathrm{Tgs})\%}{10^4} \ldots 9$$

RESULTS

Wood Density

The average wood density of the sampled trees stood at 0.88±0.36g/cm^3 for *E. camaldulensis* been the highest followed by 0.63±0.03g/cm^3 in *K. senegalensis* and the least was found in *A. indica* with a mean of 0.54±0.04g/cm^3. *A. indica* decreased from 0.57±0.03 g/cm^3 at the base to 0.50±0.01g/cm3at the top while *E. camaldulensis* decreased from 0.91±0.02 g/cm^3 at the base to 0.85±0.02 g/cm^3 at the top and *K. senegalensis* followed pattern as it decreased from 0.65±0.04 g/cm^3 to 0.61±0.03 g/cm^3 at the base and top accordingly. (Table 2). Table 1 shows that there is significant differences among the species and sampling heights at (P <0.05).

Moisture Content

Table 2 showed that the mean moisture contents for *K. senegalensis*, *A. indica* and *E. camaldulensis* were 86.96±7.32, 57.30±15.46 and 43.21±3.99% respectively (Table 2). There is significant differences among the species and their interactions at (P <0.05) and the all the sampled trees increase in moisture content from base to top except for *A. indica* which decreased from 73.57±2.96% at the base to 39.51±4.98 at the top (Table 2).

Table 1: Anova results of Wood Density and Moisture content among Tree Species and Sampling Height

Source of variation	Df	Density	Moisture Content
Species (S)	2	0.28*	4489.14*
Sampling height (SH)	2	0.01*	59.63 ^{ns}
S*SH	4	0.00^{ns}	512.31*
Error	18	0.00	16.66
Total	26		

* = Significant (P < 0.05), ns = not significant (P $\geq$ 0.05), df = Degree of freedom

Table 2: Mean Density and Moisture Content of the sampled tree Species

Species	Wood portion	Density (g/cm^3)	Moisture Content (%)
A. indica	Base	0.57±0.03	73.57±2.96
	Middle	0.54±.031	58.83±6.87
	Top	0.50±0.01	39.51±4.98
	Mean	**0.54±0.04^a**	**57.30±15.46^a**
E. camaldulensis	Base	0.91±0.02	40.77± 3.83
	Middle	0.86±0.04	42.53±2.15
	Top	0.85±0.02	46.33±4.48
	Mean	**0.88±0.36 ^{b}**	**43.21±3.99 ^{b}**
K. senegalensis	Base	0.65±0.04	78.03±3.33
	Middle	0.64±0.00	90.12±3.87
	Top	0.61±0.03	92.74±1.95
	Mean	**0.63±0.03^c**	**86.96±7.32 ^{c}**
General Variation in Sampling Height and Radial Position of Moisture content and Density			
	Sampling Height		
	Base	0.71±0.16^a	64.13±17.86^a
	Middle	0.68±0.14^b	63.82±21.34^a
	Top	0.65±0.15^b	59.52±25.33^a
	Mean	**0.68±0.15**	**62.49±20.98**

* Means ± Standard error of mean of 3 replicate samples while, values with the same alphabet on the same column and same section are not significantly different at =0.05.

Table 3: Anova results of the variations of the wood proportions along the sampling heights of the selected species

Sources of Variation	DF	BKP (%)	BSTP (%)	SWP (%)	HWP (%)	PTP (%)
Species (S)	2	32.51*	2.86*	5408.13*	4361.23*	33.41 ^{ns}
Sampling Height (SH)	2	3.69 ^{ns}	1.90*	11.76 ^{ns}	16.65 ^{ns}	105.13 ^{ns}
S*SH	4	1.80 ^{ns}	0.20 ^{ns}	36.86 ^{ns}	42.76 ^{ns}	14.37 ^{ns}
Error	18	3.72	0.17	41.86	28.12	11.56
Total	**26**					

* = significant (P < 0.05), ns = not significant (P ≥ 0.05), Df = Degree of freedom.

Wood Properties of the Selected Species

Bark Proportion

As shown in Table 3, the bark proportion varies considerably among the sample species (P < 0.05). The bark proportion decreased from 6.66±0.60% at the base to 6.11±1.02% at the top in *A. indica*, while *E. camaldulensis* decreased from 11.16±3.94% at the base to 9.32±2.29% at the top and *K. senegalensis* followed same pattern by decreasing from 10.02±0.87% at the base to 8.57±2.77 at the top. Averagely bark accounted for 8.67±2.37% of the stem cross section of all the selected species (Table 4). Among the species, *E. camaldulensis* has the highest bark proportion of 10.47±2.45% while *A. indica* had the least with 6.68±1.00% (Table 4).

Bast Proportion (%)

There is a marked effect on the bast proportion of the selected species and sampling heights (P < 0.05) as shown in Table 3. The bast proportion followed the same pattern as it increased from the base to top with 0.99±0.05% and 2.04±0. 42% respectively in *A. indica*, *E. camaldulensis* increased from 2.11±0.29% at the base to 2.19±0.41% at the top while *K. senegalensis* also increased from 2.38±0.59% to 2.90±0.10% at the base and top accordingly (Table 4). Among the species sampled, *K. senegalensis* had the highest bark proportion with a mean value of 2.46±0.49% while *A. indica* had the least with a mean value of 1.33±0. 61% (Table 4).

Sapwood Proportion

There is significant difference in sapwood proportion among the tree samples ($P < 0.05$) (Table 3). The sapwood proportion increased from the base to the top for all species as *E. camaldulensis* increased from 11.91±4.56% at the base to 16.45±8.64% at the top, *K. senegalensis* recorded 42.87±2.65% and 48.10±12.10% for base and top respectively while *A. indica* followed different pattern as in decreased from 64.71±2.75% at to 61.52±1.88% at the top. *A. indica* had the widest sapwood proportion (64.71±2.75%) while *E. camaldulensis* had the least 15.31±6.03% (Table 4).

Heartwood proportion

As shows in Table 3, significant differences existed in the heartwood proportion of the sampled Species ($P < 0.05$). The heartwood proportion increased from 27.64±2.70% at the base to 30.32±1.26% at the top in *A. indica* and decreased from 44.99±0.64% to 40.15±10.73 at base and top of *E. camaldulensis* accordingly while *K. senegalensis* followed same pattern as its decreased from 74.83±1.38% at the base to 69.13±4.65% at the top. Overall, heartwood proportion accounted for 48.06±19.05% of the stem (Table 4). Among trees, *K. senegalensis* had the largest heartwood averaged 71.54±4.03 % while *A. indica* had the least averaged 27.89±2.30% of the total stem (Table 4).

Pith proportion

Sapwood proportion of the pith also increased from the base of the stem to the top with average values of 4.48±0.50% obtained at the base and 13.98±6.80 % at the top of the stem height of *A. indica*, *E. camaldulensis* increased from 4.53±0.61% at the base to 6.48±0.70% at the top and *K. senegalensis* also adopted same pattern as it increased from 5.28±0.68 to 14.09±7.35% of the base and top respectively. Averagely, pith proportion accounted for 7.84±4.57% of the total stem (Table 4). Meanwhile, among trees, *K. senegalensis* had the largest pith with mean value of 9.06±5.41% while *A. indica* had the least, 8.84±5.38 % (Table 4). There is no marked effect among the species and sampling heights ($P > 0.05$) as shown in Table 3.

Table 4: Mean Variations in wood properties of the selected species along the Sampling Heights

Species	BKP (%)	BSTP (%)	SWP (%)	HWP (%)	PTP (%)
A. indica					
Base	6.66±0.60	0.99±0.05	64.71±2.75	27.64±2.70	4.48±0.50
Middle	7.26±1.28	0.97±0.40	66.06±3.31	25.713.29	8.07±0.60
Top	6.11±1.02	2.04±0. 42	61.52±1.88	30.32±1.26	13.98±6.80
Mean	**6.68±1.00**^{a}	**1.33±0. 61** ^{a}	**64.10±3.10**^{a}	**27.89±2.30** ^{a}	**8.84±5.38** ^{a}
E. camaldulensis					
Base	11.16±3.94	2.11±0.29	11.91±4.56	44.99±0.64	4.53±0.61
Middle	10.92±1.00	1.33±0.68	17.58±4.82	49.08±8.88	5.84±1.10
Top	9.32±2.29	2.19±0.41	16.45±8.64	40.15±10.73	6.48±0.70
Mean	**10.47±2.45**^{b}	**1.87±0.59** ^{b}	**15.31±6.03**^{b}	**44.74±7.98** ^{a}	**5.62±1.12** ^{a}
K. senegalensis					
Base	10.02±0.87	2.38±0.59	42.87±2.65	74.83±1.38	5.28±0.68
Middle	7.98±1.03	2.09±0.35	40.83±7.76	70.66±3.91	7.80±0.80
Top	8.57±2.77	2.90±0.10	48.10±12.10	69.13±4.65	14.09±7.35
Mean	**8.86±1.79bc**	**2.46±0.49c**	**43.91±8.34**^{c}	**71.54±4.03**^{a}	**9.06±5.41**^{a}
General Variations in Sampling Height of wood properties					
Sampling Height					
Base	9.28±2.87 ^{a}	1.83±0.72 ^{a}	39.83 ^{a}	49.15±20.73 ^{a}	4.76±0.65 ^{a}
Middle	8.72±1.89 ^{a}	1.46±0.70 ^{a}	41.49 ^{a}	48.48±20.13 ^{a}	7.24±1.29 ^{a}
Top	8.00±2.37 ^{a}	2.38±0.50 ^{b}	42.02 ^{a}	46.53±18.44 ^{a}	11.52±6.28 ^{a}
Mean	**8.67±2.37**	**1.89±0.72**	**41.11**	**48.06±19.05** ^{a}	**7.84±4.57** ^{a}

*Means ± Standard error of 3 replicate samples. **Note:** BKP = Bark proportion, BSTP = Bast proportion, SW P= sapwood proportion, HWP = Heartwood proportion, PTP = Pith proportion.

Hygroscopic Properties of the Wood Samples

Longitudinal shrinkage

Longitudinally, the shrinkage decreased from 2.20±0.41% at the base to 0. 45±0.08% at the top of *A. indica*, *E. camaldulensis* reduced from 1.30±0.46 to 0.81±0.55% at the base and top respectively while *K. senegalensis* increased from 0.61±0.30% at the base to 0.64±0.13% at the top. Overall, shrinkage in longitudinal direction accounted for 0.890.65% of the volumetric shrinkage of the wood samples (Table 6). Among the Trees, *A. indica* had the highest longitudinal shrinkage with a mean of 1.30±0.82% while *K. senegalensis* had the least with a mean of 0.55±0.27% (Table 6). There is also a marked effect among the species (P <0.05) as presented in Table 5.

Radial Shrinkage

Radially, shrinkage accounted for 3.99±1.06% of the total shrinkage of the wood. It decreased from the base to with 3.99±1.77% to 3.94±1.34% at the top in *A. indica*, *E. camaldulensis* also decreased from 3.82±0.30 to 3.21±1.19% at the base and top accordingly but *K. senegalensis* followed different pattern by increasing from 4.39±0.83% at the base to 5.23±0.42% at the top. Among the trees, *K. senegalensis* had the highest radial shrinkage with average value of 4.56±0.79 % while *A. indica* had the least with 3.66±1.24% (Table 8). The result presented in Table 5, shows that there is no significant difference among tree species (P > 0.05).

Tangential shrinkage

There are marked effects in the tangential shrinkage of the selected species (P < 0.05). *A. indica* increased from the base to the top with a mean value of 6.91±2.34% obtained at the base and 8.13±2.64% at the top, similarly it increased from 6.09±1.21 to 6.85±1.78% at the base and top in *E.*
.
camaldulensis respectively while *K. senegalensis* increased from 12.73±1.50% at the base to 16.01±1.65% at the top. Averagely the tangential shrinkage accounted for 7.58±2.18% of the total volumetric shrinkage (Table 6). Among the tree samples, *K. senegalensis* had the highest tangential shrinkage of 13.75±2.28% while *A. indica* had the least with 6.74±2.23% (Table 6).

Volumetric shrinkage

The volumetric shrinkage is the total shrinkage in wood volume and it amounted to 12.03±2.10% of the stem wood volume of the all selected species. *A. indica* increased from 11.67±2.57% at the base to 13.00±5.13% at top, of the stem height in *A. indica*, *E. camaldulensis* also increased from 10.85±1.05 at the base to 9.89±3.25% at top while *K. senegalensis* increased from 12.73±1.50 to 13.75±2.28% respectively following the same pattern. *K. senegalensis* had the highest volumetric shrinkage with a mean value of 13.75±2.28% and the least with a mean value of 11.05±2.70% in *E. camaldulensis* (Table 6). There are no significant differences both among species and sampling heights of the selected species (P > 0.05) seen in Table 5.

Ring Width (RGW)

The result in Table 5 showed that there are marked differences among the tree species and interaction of the selected species (P < 0.05). The highest ring width was found in *K. senegalensis* with averaged value of 0.67±0.42cm followed by 0.63±0.42cm in A. *indica* while *G. sepium* had the least with 0.54±0.20cm (Table 6). The sampled species all followed a particular pattern as they all decreased from base to top.

Table 5: ANOVA results of the variations in shrinkage properties and Ring Width of the selected species

Sources of Variation	Df	Lgs	Rds	Tgs	Vs	Df	RGW
Species (S)	2	1.29 *	2.19 ns	16.56 *	20.16 ns	2	0.19*
Sampling Height (SH)	2	1.80 ns	0.30 ns	5.89 ns	6.13 ns	2	0.74 ns
S*SH	4	0.60 ns	1.23 ns	4.80 ns	10.61 ns	4	0.16*
Error	18	0.14	1.09	3.33	7.59 ns	139	0.12
Total	**26**					**147**	

* = significant ($P < 0.05$), ns = not significant ($P \geq 0.05$), Df = Degree of freedom

Table 6: Mean Variations in Wood shrinkage properties and Ring Width

Species	Lgs	Rds	Tgs	Vs	RGW
A. indica					
Base	2.20±0.41	3.99±1.77	6.91±2.34	11.67±2.57	0. .86±0.49
Middle	1.24±0.50	3.05±0.60	5.18±0.92	9.20±1.35	0.54±0.39
Top	0. 45±0.08	3.94±1.34	8.13±2.64	13.00±5.13	0.47±0.22
Mean	**1.30±0.82 a**	**3.66±1.24 a**	**6.74±2.23a**	**11.28±3.38a**	**0.63±0.42 a**
E. camaldulensis					
Base	1.30±0.46	3.82±0.30	6.09±1.21	10.85±1.05	1.00±0.23
Middle	0.75±0.57	4.25±1.27	7.87±2.03	12.42±3.57	0.52±0.17
Top	0.38±0.12	3.21±1.19	6.58±2.06	9.89±3.25	0.51±0.21
Mean	**0.81±0.55 b**	**3.76±0.99 a**	**6.85±1.78a**	**11.05±2.70a**	**0.54±0.20b**
K. senegalensis					
Base	0.61±0.30	4.39±0.83	8.16±1.04	12.73±1.50	0.76±0.53
Middle	0.40±0.37	4.06±0.72	8.45±1.90	12.51±2.10	0.72±0.38
Top	0.64±0.13	5.23±0.42	10.81±1.48	16.01±1.65	0.50±0.26
Mean	**0.55±0.27**	**4.56±0.79 a**	**9.14±1.48 b**	**13.75±2.28a**	**0.67±0.42c**
General Variations in Sampling Height of wood Shrinkage properties and Ring Width					
Sampling Height					
Base	1.370.77 a	4.07±1.02 a	7.05±1.68 a	11.75±1.77a	0.74±0.44 a
Middle	0.790.56 a	3.79±1.00 a	7.17±2.10 a	11.38±2.72 a	0.58±0.32 a
Top	0.490.15 a	4.13±1.28 a	8.51±2.60 a	12.96±4.11 a	1.00±0.23 a
Mean	**0.890.65**	**3.99±1.06 a**	**7.58±2.18a**	**12.03±2.10 a**	**0.61±0.36**

*Means ± Standard error of 3 replicate samples. **Note:** Lgs = Longitudinal shrinkage, Rds = Radial Shrinkage, Tgs = Tangential Shrinkage, Vs = Volumetric shrinkage and RGW = Ring Width.

DISCUSSION

Wood density

Wood density is widely regarded as one of the most influential properties affecting the strength and several wood characteristics. Savidge (2003), opined that basic wood density is the prime wood quality consideration for industry as higher wood values yield stronger and more pulp wood density has been the focus of many researchers in the past and has traditionally been the factor on which the utilization potential of timber species are based (Oyagade and Fabiyi, 2002; Akpan, 2007; Poku *et al.*, 2001; Oluwadare and Somorin, 2007). This could be attributed to the fact that density has been very good indication of wood strength, stiffness and stability (Josue, 2004). The average value of 0.63±0.03g/cm^3 in *K. senegalensis* was lower than the previous finding by Sotannde *et al.,* (2015), which reported the density to be 0.732±0.12g/cm^3 but followed same trend for the species along the sampling height as it decreased from base to top (Sotannde *et al*., 2010; Sotannde *et al*., 2015).

Moisture content

Moisture content is the ratio of oven-dry weight of a given volume of wood to the weight of an equal volume of water (Baker *et al.,* 2009) is considered to be a good indicator of wood quality. The moisture content of 86.96±7.32% was obtained in *K. senegalensis,* 57.30±15.46% in *A. indica* and 43.21±3.99% was found in *E. camaldulensis* along the sampling heights were all high. This is an indication that moisture is one of the major components of wood.

In this study, the axial pattern of variation of moisture content increased from base to the top following a similar trend as reported by Sotannde *et al.,* (2015) except for *A. indica* which decreased from base to top. The mean value of all the woods studied is greater than 12% often reported in literature for most hardwood species (Ogunsanwo, 2000). The high moisture content could be as a result of wood anatomy, tree age and specie hence, the need to dry wood before use for efficient handling, transportation and storage.

Bark Proportion (%)

Wood bark protects wood from extreme temperature, drought, provides mechanical protection to the softer inner bark and also help to limit evaporative water loss (Raven *et al.,* 1999). It is rich in chemical substances such as tannin and dyes derived plant metabolism. In all the sampled species, bark thickness decreased from the base to the top and accounted for an average 8.67±2.37% of the stem cross section of the selected species. This perhaps explains the juvenility of the sampled trees. Being dry zone species, it is expected that wood bark values could be higher as an adaptive feature of the species to cope with water stress and high temperature (Sotannde *et al.,* 2015).

Bast Proportion (%)

Bast Proportion is important in that bast fibre as found in many non-wood fibre sources is an additional source of fibre. Averagely, bark accounted for 1.89±0.72% of the stem cross section of the selected species. Depending on the quality of the fibre, it could furnish additional fibre material in addition to the woody portion, this need further investigation because the total bast might be an indication of relative growth rate of the tree because bast is made of mostly cambium cell. Bast fibre, could furnish additional fibre material in addition to the woody portion (Oluwadare and Egbewole, 2008).

Sapwood Proportion (%)

Sapwood is the outer portion of a wood stems, trunk or log usually distinguishable from the core or heartwood by its lighter colour. In the living tree, the sapwood is responsible not only for the conduction of sap, but also for the storage and synthesis of biochemicals. Starch grains are stored in the parenchyma cells, and can be easily seen using a microscope. The starch content of sapwood can have important ramifications in the wood industry (Wiedenhoeft and Miller, 2005). To wood workers, the most significant aspect of sapwood is the colour which ranges from whitish to yellowish or light (Hoadley, 2000).

Heartwood Proportion (%)

Heartwood is the area of extractive-impregnated dead cells at the centre of the tree. Heartwood functions in the long-term storage of biochemicals of many varieties depending on the species. These chemicals are known collectively as extractives. In the past it was thought that the heartwood was a disposal site for harmful by-products of cellular metabolism, the so-called secondary metabolites (Wiedenhoeft and Miller, 2005).

Pith proportion (%)

Pith is the central core of the wood. It is formed by epical meristem of the growing tip which is found in the stems and sometimes in the root. The shape and diameter help in the identification of plant species producing the wood. Usually it does not increase in diameter it decreases in its diameter. It contains water in some species, although it believed to be functionless. The pith proportion increases from the base to the top along the sampling height in all the selected species. This shows that more mature wood at the base had lower proportion of pith and juvenile wood at the top had greater proportion.

Longitudinal shrinkage

Longitudinal shrinkage occurs in the direction of the growth. Longitudinal shrinkage is the defect that is most frequently associated with juvenile wood (Philip *et al.*, 2001). This values fall between 0.1% - 1.5% and further confirmed that longitudinal shrinkage of the wood usually very small and less than one Akpan (1999). The mean value of 0.55±0.27% gotten in *K. senegalensis* is higher than the value reported by Sotannde *et al.*, (2015) and this may be due to age differences in the sampled species. This shows that lumber from this specie can exhibit minimum dimensional changes after drying. This might be an advantage for the stability of the wood for structural work.

Radial shrinkage

The radial shrinkage runs from the pith to bark direction, provides lateral support for biochemical and in many cases performs a fraction in the storage of function in wood (Wiedenhoeft and Miller, 2005). Along the sampling height of all the sampled trees, radial shrinkage increased from the base to the top of the stem. The observed trends in the relationship between sampling heights might be due to the decreased wood content with height (Oyagade and Fasulu, 2005).

Tangential shrinkage

On tangential shrinkage, growth rings appear as a series of cones, one within the other and with the apices of the cone point toward the top of the tree. The tangential planes are at right angle to the radial planes. The tangential plane of section does not provide any information about features that vary in the radial direction, but it does not provide information about the tangential dimension of feature (Wiedenhoeft and Miller, 2005). Generally shrinkage along the principal direction slightly increased with increase in sampling height (Oyagade and Fasulu, 2005).

Volumetric shrinkage

In all the samples, volumetric shrinkage increased from the base to the top which is inconsonance with the report of Sotannde *et al.*, (2015) The high radial and tangential shrinkage might be due to the alignment of wood cells in those axes (Josue, 2004).

Ring Width (RGW)

The width of the growth ring indicates the rate of growth of tree. When there is fast growth, wider growth rings will be produced than when there is slow growth. In many woods in the tropics growth rings are not evident. However, continuing research in this area has uncovered several characteristics whereby growth rings can be correlated with seasonality changes (Callado *et al.*, 2001). Along the sampling height there is a general reduction in ring width from the base to the top. The common trend in most wood whether hardwood or softwood has being gradually decreased from pith to bark (Osadare, 2001: Sotannde *et al.*, 2015).

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on this study the following conclusions were made.

The thickness of the bark of the selected species are small (6.68±1.00 - 10.47±2.45%), probably due to the young ages of the trees. The high values of bast proportion of *E. camaldulensis (*1.87±0.59%*) and K. senegalensis* (2.46±0.49%) shows that they can be used as an additional fibre material in pulp and paper industry. The sapwood formed about 64% in *A. indica*, *E. camaldulensis* 15% and 43% *K. senegalensis* of the total stem cross section while the heartwood of *A. indica* constituted only 27% almost disappeared towards the top of the stem. The average annual ring of the selected species is estimated to be 6 *A. indica*, 5 in *E. camaldulensis* and 6 in *K. senegalensis*, this showed that the trees are still at the juvenile sap stage. The density of the wood species shows that strength of a timber depends on its species as it varies from specie to specie and hence different wood species have different strength characteristics. The results obtained in this study have provided quantitative information on the density of selected wood species which can be used as alternative to the economical wood species for construction and structural purposes. The high moisture content could be as a result of wood anatomy, tree age and specie hence, the need to dry wood before use for efficient handling, transportation and storage. The shrinkage behaviour of the selected species is low and indicates that the problems of cracking, splitting, opening of joint and warping in service will be minimal.

Recommendations

Silvicultural practices are needed to increase the merchantable height of the stem, likewise more details are required for the strength characterization of the wood since their densities shows that they can be used as alternative to the economical wood species. Closer sampling should be carried out along the stem height to understand the uniformity of wood properties. There would be need to investigate the chemical properties of the wood and how this relate to strength properties.

REFERENCES

Akpan, M. (1999). Dimensional changes of wood in service; potential of *Eribroma oblanga* for interior decoration. *Journal of technology and development*, 7: 6-11.

Akpan, M., (2007): Hygroscopic properties of neem (*Azadirachta indica*): An experimental determination of the shrinkage characteristics. *Global nest Journal*, 9(2): 152-158.

Brain Bond and Peter Hammer (1998): Wood identification for hardwood and softwood species native to Tennessee. Research Associate Department of Forestry, Wildlife and Fisheries, The University of Tennessee, Tennessee, USA: pp 16.

Falemara, B. C., Owoyemi, J.M., and Olufemi B. (2012): Physical Properties of Ten Selected Indigenous Wood Species in Akure, Ondo State, Nigeria. *Journal of Sustainable Environmental Management* (JSEM) 4:16 – 23.

Fuwape, J. A (2000): Wood utilization: From cradle to the grave. Inaugural lecture delivered at Federal University of Technology, Akure. Nigeria. 1-33pp.

Hoadley, R. B. (2000): Understanding Wood: A Craftman s Guide to Wood Technology.

John. P (2004):Tree growth, foresting and their implications for wood quality. PMW 576 September 2004. A pacific NorthWest Extension Publication Oregan State University, Washington DC.

Josue, J. 2004. Some wood properties of *Xylia xylocarpa* planted in Sabah. *Sepilok Bulletin* 1: 1-15.

Ogunsanwo, O. Y. 2000. Effects of pulp blending and beating on selected strength properties of Pine- *Gmelina* hand sheets in Nigeria. *Journal of Tropical Forest Resources,*16 (58 – 65).

Oluwadare, A. O. and Somorin, O. A. (2007): Preliminary report on utilization potential of *Gliricidia sepium* (Jacg.). steud for timber. *Research journal of forestry*, (2): 80-85.

Oluwadare, A. O. and Egbewole, Z. T. 2008. Wood quality studies in plantation-grown Sterculia (*Sterculia setigera* Del.) in the Guinea savanna, Nigeria. *Research Journal of Forestry*, 2 (1): 22-23.

Osadare, A. O. (2001): Basic wood and pulp properties of Nigeria grown Caribbean pine (Pinus Caribbean) and their relationship with tree growth indics. Ph.D thesis, University of Ibadan, Ibadan.

Oyagade, A. O. and Fasulu, S. A. (2005): Physical and Mechanical properties of *Trilepisiummadaga scariensis* and *Funtumia elastica* wood. *Journal.of Tropical Forestry Science* 7(2):258-264.

Oyagade, A. O. and Fabiyi, J. S. 2002. Density variation in plantation grown *Nauclea diderrichii*. J. Trop. For. Resources., 18(1): 26-34.

Philip, R. L., David, E.K., Alexander, C. and Isebrand, J. G (2001): Formation and properties of juvenile wood in sourthern pines. Pp 245.

Poku, K., Qinglin, W. and Vlosky, R. (2001): Wood properties and their variations within tree stem of lesser-used species of tropical hardwood from Ghana. *Wood and Fiber Science,* 33 (2): 284-291.

Raven, P., Evert, R., and Eichhorn, S. (1999): Biology of plants (6thed.). W.H. Freeman, New York.Rijkaert,

Savidge, R. A. (2003): Tree Growth and Wood Quality. Wood Quality and its Biological Basis. Author: Jeronimidis JR and Barnett G. Blackwell Publishing, CRC Press. Pp. 226.

Sotannde, O. A., Oluyege, A. O., Adeogun P. F. and Maina S. B. (2010): Determination in wood Density, Grain Orientation and Anisotropic Shrinkage of Plantation Grown *Azadirachta indica*. *Journal of Applied Sciences Research,* 6(11): 1855-1861.

Sotannde A. O., Anguruwa, G. T. and Ishaya, D. (2015): Wood Quality Study of 9-Year Old Plantation Grown *Khaya senegalensis* in Sudano-Sahelian Environment of Borno State Nigeria. *Journal of Forestry Research and Management*. 12, 95-112.

Wiedenhoeft, A. C. and Miller, R. B. (2005): USDA, Forest Service, Forest Products Laboratory, Madison, WI.Pp 12.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Mustafa and Adetunji, 2019

ASSESSMENT OF DEMOGRAPHIC CHARACTERISTICS OF STAKEHOLDERS OF MARKETED WILDLIFE SPECIES ALONG FIVE HIGHWAYS IN SOUTH-WEST NIGERIA

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ABSTRACT

Wildlife is an important aspect of biodiversity but human civilization continues to impact negatively on it because hundreds of millions of animals are harvested from the wild and sold for man's use each year. Therefore, there is need to update the existing knowledge of wildlife stakeholders in marketed wildlife species especially in the Southwest Nigeria, has become imperative. A total of twenty-three (23) games markets along five Roads in South-west Nigeria (Road 1:Ibadan-Ife-Ado-Ekiti, Road 2:Ibadan-Ife-Akure, Road 3: Ibadan-Oyo-Ogbomosho, Road 4: Lagos-Ibadan-Shagamu Interchange and Road 5: Sagamu-Ore or IIA, IID, IIO, LSO and ISI respectively) were visited monthly for two seasons to document the wildlife stakeholders' details. Two hundred and fifty (250) copies of a structured questionnaire were administered using systematic random sampling (odd) method to obtain demographic information of the respondents including traders, hunters, herbalists, food vendors and artisans. Data generated were subjected to continuous statistics of bar charts for analysis and interpretation. Results revealed that all classes of people were represented in the trade but Road 5 (LSI) had the highest number of females with the people whose ages ranged between 16 and 25 years (6). Road 2 (Ibadan-Ife-Akure, IIA) had the highest number of people with age between 56 years and above. Generally, age-group in this study was ranked in years as 46-55 >36-45 > 26-35 > 56 plus> 16-25. It was recommended that formulation of laws and Regulations to protect wildlife poaching be enacted. Government should also establish more reserves for wildlife conservation and protection of endangered species to stop them from going into extinction through different governmental programmes and policies.

Key words: Game markets, biodiversity, wildlife, conservation, endangered.

INTRODUCTION

Demography is the study of population size, geographic distribution, structure and composition as well as factors affecting these characteristics (Demographic Resources Research Centre, 2019). It is also the study of a population based on factors such as age, status, income levels, education, tribal race and sex; government and non-government organisations use demographics studies to learn more about a population for development and economic market research (Kenton, 2018). Wildlife trade deals with commerce of products that are derived from non-domesticated animals or plants usually extracted from their natural environment or raised under controlled conditions (Gideon, 2014).

Wildlife marketing makes favourite animals seem common as they slide towards extinction (Kilvert, 2018). Illegal trade in wildlife and products has caused decline of many species in Nigeria and it has affected the economy and ecosystem (NCF, 2016).Road transportation received a boost in Western Nigeria because the then Colonial Government pursued its objectives through road transportation to export agricultural products. This aided internal trade during the pre-Second World-war period when substantial quantities of *garri* and other agricultural products were transported from Ijebu towns to markets in Ibadan, Lagos, Ilorin and other towns in Western Nigeria (Okuseinde,1988).

Also, people of Northern Nigeria consumed kola nut as a good substitute for alcoholic drinks and cigarette and this situation enhanced kolanut transportation from the West to the North (Olubomehin, 2012). He also reported that farmers of Western Nigeria also started replacing old cocoa trees with kola nut seedlings, the latter therefore became one of the most important commodities transported by road from Ijebu, Ekiti and Ondo Provinces to Northern Nigerian markets. These Lorries on return carried commodities such as onions and beans which were not only sold in Ekiti towns but also Oyo, Ile-Ife, Ilesha and Ibadan (Olubomehin, 2012). This study assesses the demographic characteristics of stakeholders of marketed wildlife species along five highways in south-west Nigeria.

MATERIALS AND METHODS

Study Area

The study area is the catchments of five highways within Southwest Nigeria: Ibadan-Ife-Ado Ekiti road named Road 1or (IIA) (264 km), Ibadan-Ife-Akure road tagged Road 2 or (IID) (204 km), Ibadan-Oyo-Ogbomoso road or Road 3 or (IOO)(120 km), Lagos-Benin road (from Sagamu Interchange to Ore Junction in Ondo State (153 km) or (LSO) labeled Road 4 and Lagos – Ibadan (from Sagamu Interchange to old Ibadan Toll Gate) or Road 5 or (LSI)that covers (62km) (Figure 1). Wildlife markets within 100 metres off the road on both sides of the expressways were demarcated /mapped and used for the study. Materials used were field notes, pens and pencils, structured questionnaires and Global Positioning System (GPS) equipment: Trimble Juno SD indicated the markets' geographical locations. The markets are listed in Table 1.

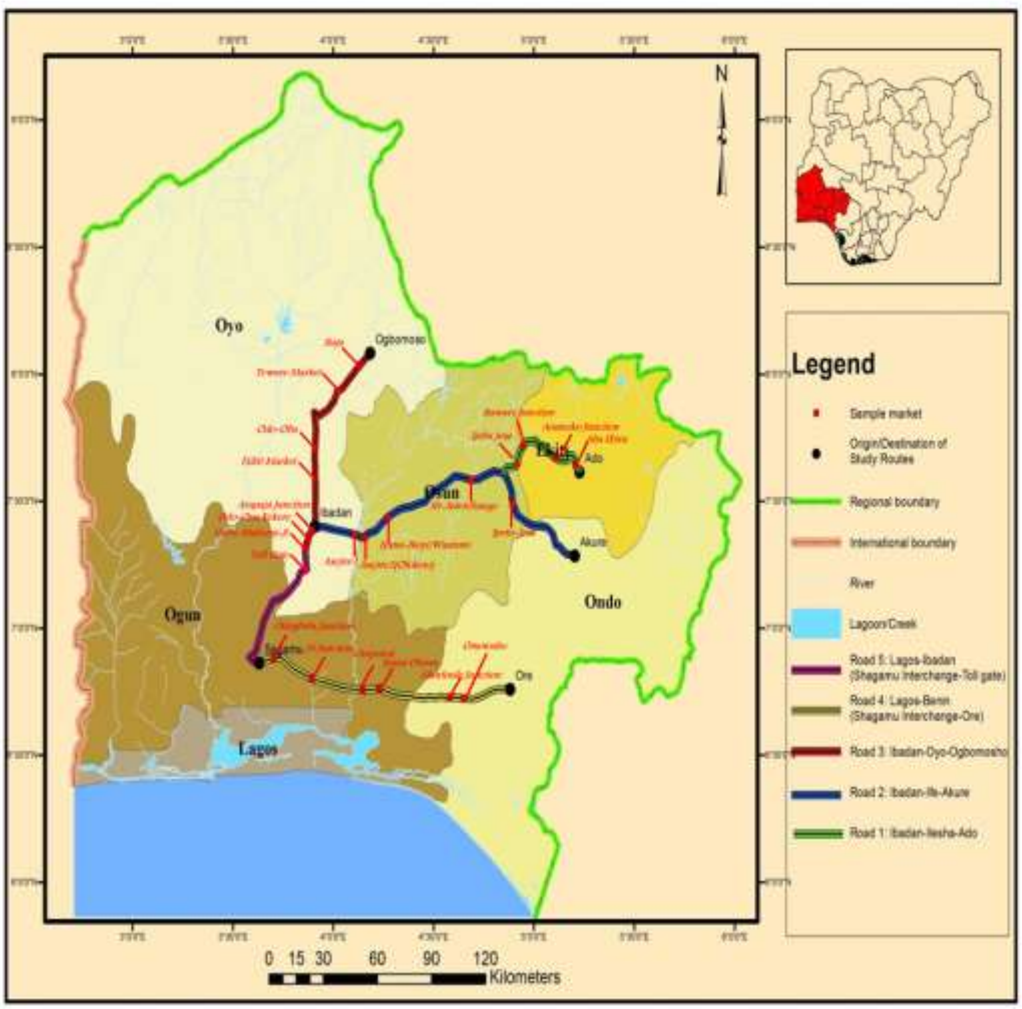


Figure 1: The Study area showing the roads and major neighbouring settlements

Table 1: Market Locations along the Study Roads

Market Roads	Locations	Km	Markets and the Coordinates of Latitude, Longitude and Altitude	States Covered
1	Ibadan-Ife-Ilesa-Ado-Ekiti Road	264	Ijebu Jesa,$7^{0}41^{1}$N$4^{o}49^{1}$E, +223m; Itawure Junction $7^{o}44^{1}$N, $4^{o}57^{1}$E,+265m; Aramoko Junction $7^{o}43^{1}$N, $5^{o}3^{1}$E,+300m; Aba Ebira (Ado-Iyin Road) $5^{o}34^{1}$N, $4^{o}12^{1}$E, +313m **Total: 4 Markets**	Oyo, Osun and Ekiti
2	Ibadan-Ife-Akure Road.	204	Asejire 1: $7^{o}20^{1}$N, $5^{o}3^{1}$E, +137m Asejire2(Olokere) $7^{o}22^{1}$N,$4^{o}7^{1}$E, +145m Iyana-Ikoyi/Wasinmi $7^{o}24^{1}$N, $4^{o}13^{1}$E, +213m Ife-Interchange: $7^{o}30^{1}$N, $4^{o}28^{1}$E, +275m. Ipetu-Jesa $7^{o}41^{1}$E, $4^{o}49^{1}$E +294m **Total : 5 Markets**	Oyo, Osun and Ondo
3	Ibadan-Oyo-Ogbomosho Road	120	Fiditi Market,$7^{o}39^{1}$N, l $4^{o}41^{1}$E, +302m Odo-Oba:$7^{o}27^{1}$N; $4^{o}45^{1}$E, +306m Tewure Market $7^{o}25^{1}$N; $4^{o}34^{1}$E,+277m Iluju: $7^{o}27^{1}$E; $4^{o}46^{1}$E, +299m **Total: 4 Markets**	Oyo
4	(Sagamu– Ore road)	153	Odogbolu Junction $6^{o}51^{1}$N; $4^{o}33^{1}$E, +63m J4 Junction $6^{o}44^{1}$N; $4^{o}19^{1}$E, +72m Onipetesi 6^{o} 44^{1}N; $4^{o}33^{1}$E, +98m IyanaOluwa: $6^{o}44^{1}$N; $4^{o}33^{1}$E, +99m Akinfosile Junction: $6^{o}52^{1}$N; $3^{o}59^{1}$E,+101m Omotosho: $6^{o}53^{1}$N; $4^{o}7^{1}$E. +259m **Total: 6 Markets**	Ogun, Ondo
5	Lagos-Ibadan-Sagamu Interchange	62	Toll Gate 7^{o} 20^{1}N; 3^{o} 56^{1}E, +233m Guru-Maharaj-Ji: $7^{o}22^{1}$N; $3^{o}56^{1}$E, +189m Odo-Ona Kekere:$7^{o}14^{1}$N; $3^{o}52^{1}$E, +165m Arapaja Junction: $7^{o}18^{1}$N, $3^{o}52^{1}$E, +183m. **Total: 4 Markets**	Oyo, Ogun

Experimental Design

Reconnaissance Survey was conducted along the five highways to locate wildlife markets. Thisaided the work in documenting the communities within the catchments of the five highways. A pre-test of 50 (retrieved) structured questionnaires administration was carried out for one month using systematic random sampling (odd numbers) method in all the 23 markets to collate the list of animals found in the surrounding forests and markets from time immemorial through farmers, traders and hunters around the markets.

Market Survey

Visits to all the 23 wildlife markets identified (Table1) viz: Ijebu-Jesa, Itawure Junction, Aramoko Junction and Aba-Ebira (4 markets); along Market Road . Asejire 1, Asejire 2, IyanaIkoyi/Wasinmi, Ife Interchange, and Ipetu-Ijesa (5 markets) for Market Road 2; Fiditi, Odo-Oba, Tewure and Iluju (3 markets) for Market Road 3; Odogbolu, J4, Onipetesi, IyanaOluwa, Akinfosile and Omotosho (6 markets) for Market Road 4 with Toll-Gate, Guru Maharaji, Odo-OnaKekere and Arapaja Junction (4 markets for Market Road) were done monthly for two years.

RESULTS

The socio economic and demographic characteristics of the respondents encountered during the data collection exercise were assessed. On the basis of sex distribution of respondents, the order of female population was Road 5> Road 4 > Road>1Road > Road 2 Male respondents were arranged as Road 2 > Road 3 > Road 1> Road 4 > Road 5 (18%).On the overall consideration, more females (141 or 56.4%) were encountered in this trade (Fig.2).

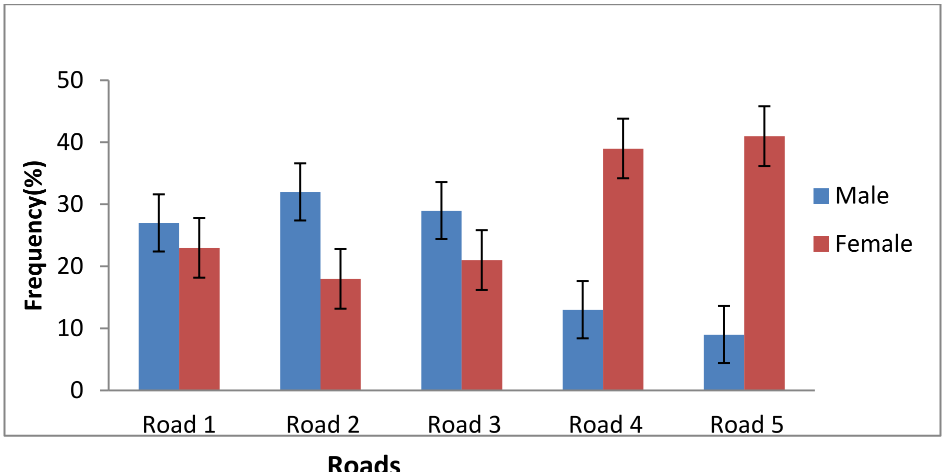
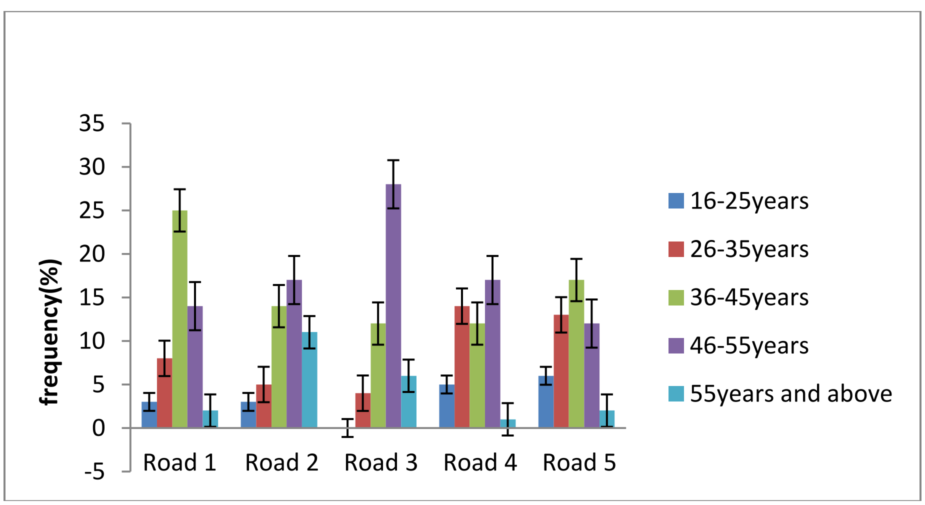


Figure 2: Sex Distribution of Respondents

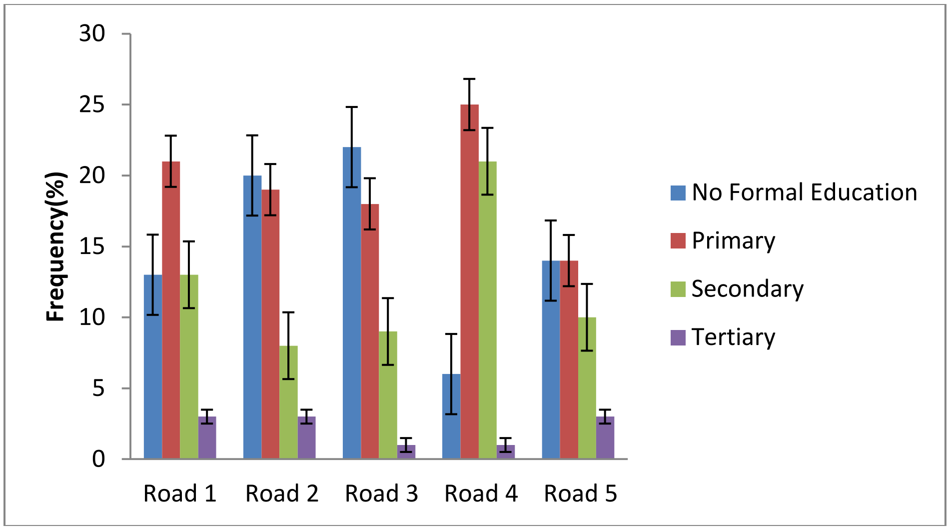
Assessment of age distribution of respondents showed age group 16 – 25 years as highest on Road 5(12%) and absent on Road 3. Respondents belonging to 26 – 35 years of age were arranged as Road 4> Road 5> Road 1> Road 2 > Road 3(8.0%). 36to 45 years of age respondents were in this order: Road 1> Road 2 > Road 5>, Road 4>Road. 46 to 55 years of age were in the order: Road 3>Road 2>Road 4 >Road 1> Road 5. Old people (56 years and above) were most arranged as Road 2> Road 3 >Road 5> Road 1> Road 4 (Figure 3).



Road

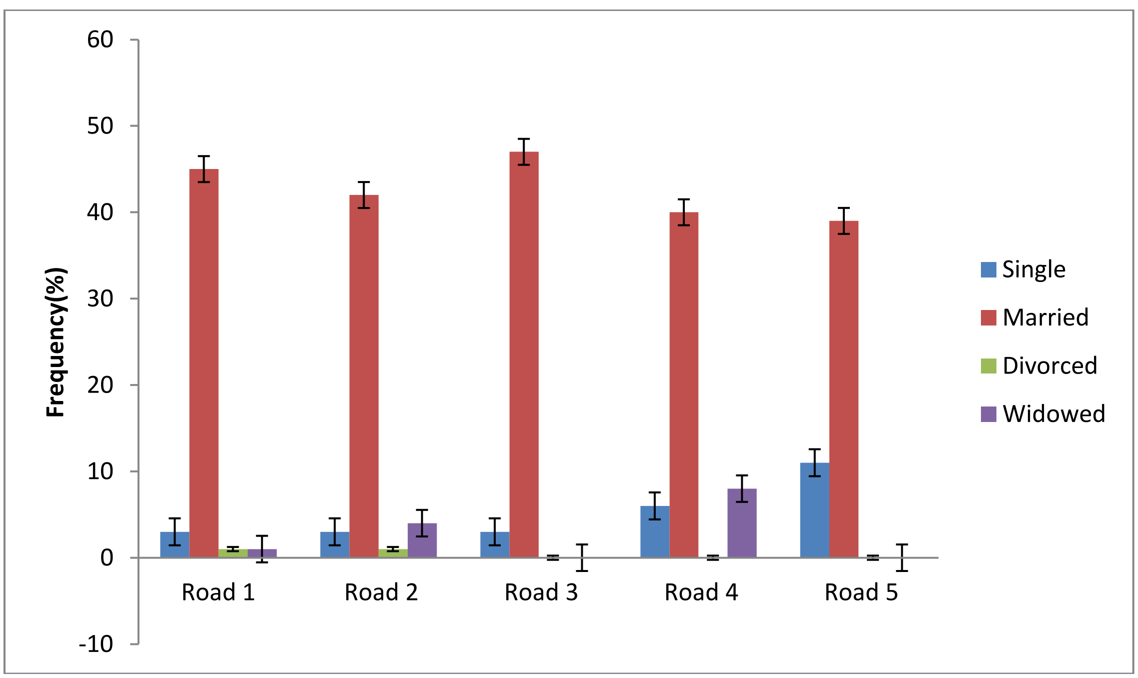
Figure 3: Age Distribution of Respondents

Considering the educational profile of respondents, non-formally educated ones was ranked as Road 3 (44%)> Road 2 > Road 5 > Road 1> Road 4. Primary school certificate holders were in the order: Road 4> Road 1> Road 2 > Road 3 >Road 5. Secondary school leavers were distributed as follows: Road 4 > Road5> Road >Road 3>. Tertiary education certificates holders were distributed as follows: Road 1=Road 2 > Road 5> Road >4 Road 3 (Figure 4).



Road
Figure 4: Educational Profile of Respondents

Assessment of marital status revealed singles as Road 3>Road 5> Road 4>Road 2= Road 1. Married people were distributed as Road 3> Road 1> Road 2 >Road 4 > Road 5 (78%). Divorced people were only found along Road 4 (8%) and Road 2 (2%). Widowed were found along Road 1= Road 2= Road 1 but absent along Road 3 and Road 5 (Figure 5).



Road
Figure 5: Marital Status of Respondents

DISCUSSION

The Stakeholders of marketed wildlife and the products within the study area are predominately females. This agrees with Lameed and Sanni(2011) that grasscutter sellers in Asejire were mainly married females (probably due to the tedious nature of roasting and hawking/selling). The trade cuts across all working class ages along all roads in the study area. Road 2 had the highest number of people with age 56 years and above, while Road 5 had the highest number of people between 16 and 25 years. On overall account, age-group in this study was ranked as 46-55 >36-45 > 26-35 > 56 plus> 16-25. It also agrees with Dedeke *et al.* (2006) that respondents in ethnozoological trade in southwest Nigeria were mostly females, Primary School leavers and between the ages of 36-45 years. This situation implies that the trade is more convenient for matured people. The business cuts across all categories of literacy levels because Primary and secondary school certificate holders were the highest, while tertiary education recipients were the least. This observation suggests that education can be used to assess the stake holders although it is not a pre-requisite for the job because some respondents are not formally educated while all categories of educational attainments were represented. On the marital status, 85.2% among the total respondents were married people, to suggest that the business is highly sustaining because these people are able to take care of their families conveniently through the trade. This assertion was similar to observations of Soewu (2008) that the wildlife trading cuts across all age groups, but the majority fell between ages of 36 and 55. It also agrees with the findings of Soewu*et al.*(2012) that female folk dominated the trade (90%), and that majority of the dealers (64%) were aged between 40 and 60 years. Also that most of the dealers (53%) had post primary education. This work also agreed with the observations of Lameed and Sanni (2011) that grasscutter marketers were ranked on this basis of age in years as 30-39>40-49>20-29>below 20 years>50 years and above. Furthermore, those females were more than males, and the Primary School leavers were the most abundant, while married people were more than singles in the business.

CONCLUSION

Marketed wildlife business and the allied jobs/hobbies/vocations are not only common in Nigeria but also sustaining jobs because the substantial proportions are married people who hail from almost all parts of the Western and many parts of Eastern Nigeria. Also division of labour exists in the business as men were involved in the farming and hunting aspect. This is probably due to the tedium attached to it and women on the other hand are predominantly found among the sellers probably due to their nature of cooking. Furthermore, observations indicated that the jobs attached to wild animals are passed down along generations of people, implying that there is strong attachment between wildlife resources and rural people's income; income pattern of people play significant roles in the distribution and diversity of marketed wildlife This was observed along Ekiti and Oyo-Ogbomoso axis of the study area where villages outnumbered urban areas and where people depended on peasant and farming for livelihood.

Recommendations

It is recommended that:

1. Formulation of laws and Regulations to protect wildlife poaching be enacted.
2. Government to establish more reserves for wildlife conservation and protection of endangered species from going into extinction through different governmental programmes and policies.
3. Traditional medical practitioners and hunters should be educated from time to time about wild animals and their population problems in a bid to discouraging them from indiscriminate harvesting of wildlife.

REFERENCES

Dedeke G.A., Soewu, D.A., Lawal, O.A. and Ola, M. (2006).Pilot Survey of Ethnozoological Utilisation of Vertebrates in Southwestern Nigeria,Indilinga. *Afr. J. Indigenous Knowl. Syst.* 5(1): 87-96.

Demographic Resources Research Centre, DRRC (2019).Demographic Population Studies. Available on-line at *https://wwwsociosite.net>topics>popu*... Retrieved 7-2-19 at 3.11pm.

Gideon, P.K. (2014). Evaluation of Wildlife Hunting and Species of Mammals Marketed as Bushmeat in Dakka Bali Local Government Area of Taraba State, Nigeria.*Journal of Research in Forestry, Wildlife and Environment.* 6(2): 37-39

Kenton, W. (2018).Demographics. Available on-line at Investopedia *https://www.investopedia.com* Retrieved on7-2-19 at 3.14 pm.

Kilvert,N. (2018). ABC Science.Available on-line at *www.abc.net.au>news>science.* Retrieved 7-2-19

Lameed, G.A. and Sanni, D.M. (2011). Marketing and Consumption Rate of Grasscutters(*Thryonomysswinderianus*) in Asejire, Egbeda Local Government Area, Oyo State. In: Proceedings of 34th Annual Conference of Forestry Association of Nigeria (FAN), Osogbo, Osun State of Nigeria. LabodePopoola*et al.* (*eds*).418-430pp.

National Conservation Fund NCF (2016). Why Nigerians should Shun Wildlife Trade. Available on-line at *www.ncfnigeria.org>careers>item>16* Retrieved 7-2-19 at 3.42 pm.

Okusehinde, M. (1988).*Garri* Production in Ijebu-Remo: A study of Growth and Development in Local Economy 1900-1950. M.A. Dissertation, Department of Economics University of Ibadan. 58pp.

Olubomehin, O.O.(2012). Road Transportation as Life Line of the Economy in Western Nigeria 1920-1952.*African Journal of History and Culture*, 4 (3) 37-45.

Soewu, D.A.(2008). Wild Animals in ethnozoological Practices among the Yorubas of South-western Nigeria and the Implications for Biodiversity Conservation. *African Journal of Agricultural Research*, 6(3), 421-427.

Soewu, D.A., Dedeke, G.A., Ojo, V.A. and Soewu, O.K. (2012). Trade in Non-mammalian Wild animals for Traditional African Medicine in Ogus State, Nigeria. *Global Journal of Medical Research (GJMR)*, 16(1): 7-16.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Mustafa, 2019

COMPARATIVE ASSESSMENT OF HEAVY METAL CONTENTS IN ORGANS AND FLESH OF MARKETED CANE RAT (*Thryonomys swinderianus* Temminck, 1827) ALONG FIVE HIGHWAYS IN SOUTH-WESTERN NIGERIA

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ABSTRACT

Comparative heavy metal pollution in organs and flesh of marketed cane rat along five highways in southwestern Nigeria was studied. Twenty-three wildlife markets were visited and there, samples were taken randomly on quarterly basis. Visceral organs of raw kidney, liver, lung, flesh and roasted flesh of Thryonomys swinderianus (cane rat) as the most sourced wild animal were taken and screened using Wet Digestion Method for heavy metals including lead, cadmium, chromium, astatine, copper, manganese and cobalt. Results showed that lung had the least contamination, followed by kidney, then liver; raw flesh and lastly roasted meat as the highest. Chromium and Astatine were significantly different in distribution (0.017 and 0.049 respectively) at P> 0.05.Follow-up procedures showed that at P>0.05, for Astatine, the descending order was concentration was Roads,5 4, 2, 3 and1 . For chromium the distribution order was Roads 5, 4, 3, 2 and 1 also in descending order. Average values in all the samples pooled together showed lead falling within the permissible range of 0.5mg/kg for offals and 0.1 mg/kg for meat, Copper exceeded the values of 0.01 mg/kg flat along all market Roads for both categories, chromium was within the safe limit of 1.00mg/kg for both meat and offals; cadmium was within the safe range of 0.5 mg/kg for both offals and meat throughout the study areas. Cobalt exceeded the value of 0.08mg/kg for offals and 0.03 mg/kg for meat along Road 3 only. Manganese and astatine fell within safe range of 0.5 mg/kg for both samples classes limit. Expansion of environmental conservation strategies was recommended. It was concluded that the marketed wildlife in the study area are partially safe for consumption.

Key Words: analysis, contamination, Heavy Metal, highways, markets, Wildlife.

INTRODUCTION

Roads in Nigeria constitute major means of transportation, the failure of the railway system has contributed immensely to the proliferation of haulage trucks on Nigerian highways and these trucks have been the cause of many road crashes especially along the Lagos-Benin expressway; road construction leads to expansion of farmsteads into villages and later into markets where people settle down for different commercial activities at junctions where foot paths develop into motorable roads (Nnadi, 2011).

Marketed wild animals are substantial components of traditional diets and ethno-medicine among many subsistence communities in the tropics; rodents are a generally accepted food in western and southern Africa especially in rural communities where larger animals are limited in supply but the pouched or cane rat (*Thryonomys swinderianus*) and other rodents are readily accessible at roadsides and local markets (FAO, 2010). The meat of wild animals is widely cherished by the populace in both rural and urban communities of West Africa because of the taste and medicinal purposes, among these animals, the family of rodents contributes the highest percentage of meat protein; the big rodents include the grasscutter/cane rat (*Thryonomys swinderianus*), porcupine (*Hystrix cristata*), giant rat *Cricetomys* *emini* and ground squirrel *Xerus erythropus* (Imran *et al*., 2013).

Social acceptance studies among different ethnic groups of West Africa as reported by Imran *et al*. (2013) have shown in all instances that the meat of grasscutter is acceptable to all social classes of people both in the urban and rural areas. The acceptability cuts across either religion or cultural beliefs. According to them, the meat is particularly favoured among other wild animals because of its good taste, low fat and high dressing percentage. The demand for the grasscutter meat is so high that it is vigorously hunted, in West Africa. This observation was supported by Opara (2010) that grasscutter continues to lead the wildlife trade

While most game meats are produced from healthy animals, some are produced from sick animals, this situation has raised public health concerns because the meat may harbor infectious agents that are not destroyed by smoking, salting nor brining preparations and as a result, could cause human diseases (Klein, 2005).

In man's efforts to increase food production, raise standard of living and boost agricultural and industrial activities, atmospheric pollution from release of oxides of carbon, sulphur and Nitrogen, results; other ways involve the release of pollutants such as, hydrocarbons and chlorofluorocarbons into the ecosystem, resulting in air, water, land and thermal pollution. (Ramalingan, 2012). Heavy metal pollution is common in areas where vehicular traffic is persistent, these metals include Zinc, Lead, Mercury, Cadmium and copper; smog and particulates (Jerrie, 2005). Afolarin (2006) reported that vegetables grown in areas that are subjected to pollution from vehicles and industrial emissions are prone to absorption of contaminants such as heavy metals and move along tropic levels either in simple ways (food chain) or complex (food web) manners. This paper assesses heavy metal accumulation in kidneys, lungs, livers and flesh of marketed cane rat along the above highways as indicators of health status of the animal because it is integral part of human diet.

MATERIALS AND METHODS

Study Area

The study area is the catchments of five highways within South Western Nigeria: Ibadan-Ife-Ado Ekiti road named Road 1 (264km), Ibadan-Ife-Akure road tagged Road 2 (204 km), Ibadan-Oyo-Ogbomoso road or Road 3 (120 km), Lagos-Benin road (from Sagamu Interchange to Ore Junction in Ondo State (153 km) labeled Road 4 and Lagos – Ibadan (from Sagamu Interchange to old Ibadan Toll Gate) or Road 5 that covers (62km) (Figure 1).

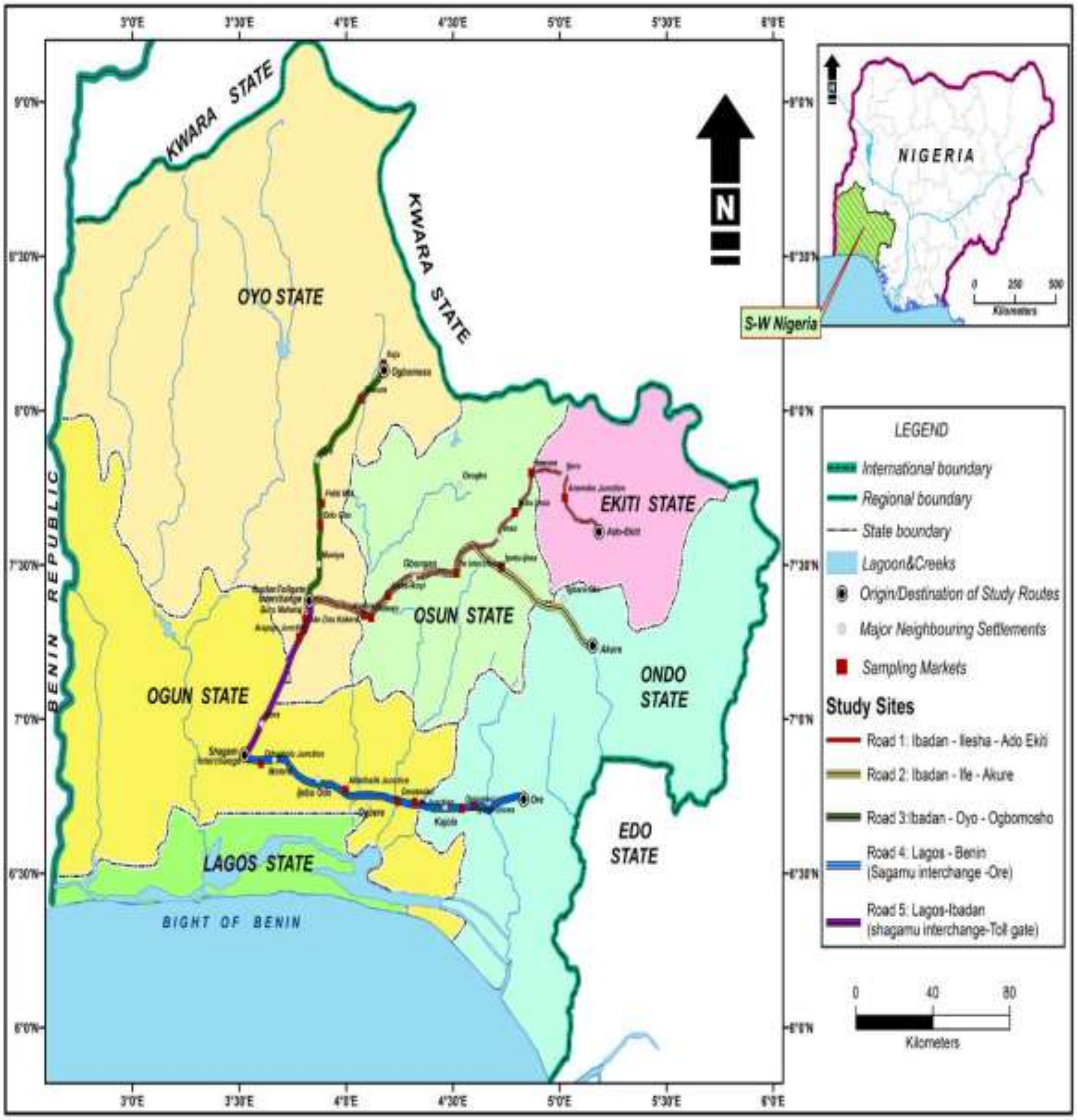

Figure 1: The Study area showing the roads and major neighbouring settlements
Source: Balogun, (2008).

Wildlife markets within 100 metres off the road on both sides of the expressways were used for the study. The markets were selected using systematic random sampling (odd numbers) method. Materials used were structured questionnaires and Global Positioning System (GPS) equipment: Trimble Juno SD indicated the markets' geographical locations. The markets were 23 in number: Ijebu-jesa, Itawure Junction, Aramoko Junction and Aba-Ebira (4 markets); along Road 1. Asejire 1, Asejire 2 (Olokere), Iyana Ikoyi/Wasinmi, Ife Interchange, and Ipetu-Ijesa (5 markets) for Road 2; Fiditi, Odo-Oba, Tewure and Iluju (3 markets) for Road 3; Odogbolu Junction, J4 Junction, Onipetesi, Iyana Oluwa, Akinfosile and Omotosho (6 markets) for Road 4 with Toll-Gate, Guru Maharaji, Odo-Ona Kekere and Arapaja Junction (4 markets) for Road5 .

All the markets were visited for two years on monthly basis; samples of raw lung, liver, kidney, liver with raw and roasted flesh were taken randomly from marketed wildlife displayed for sale. The organs and flesh were from cane rat (*Thryonomys swinderianus*) as the most sourced wild animal and were tested for heavy metal contents. Heavy metal analysis was carried out in

Laboratory Technology Unit, Institute of Agricultural Research and Training (IAR&T), Moore Plantation, Ibadan using Wet Digestion method (Preer and Rosen,1999): The prepared samples were placed in tubes and kept, placed in digestion equipment and slowly digested until complete digestion (appearance of colourless solution) occurred. The digest was washed into 100ml volume flask and made up with distilled water to 100ml level. The washed sample was then read from Atomic Absorption Spectrophotometer (AAS) Model Buck 200 using their respective lamp and wavelength. Calculation of the heavy metal values was done using the formula

Heavy metal value = Meter reading × Slope × Dilution factor.

Slope for the each of the seven heavy metals assessed was 1 ppm (Parts per million). Dilution Factor was calculated as volume of the flask used (or extractant volume of 100ml) divided by weight of the sample used (2g).The metals assessed were Lead (Pb),Cadmium (Cd), Cromium (Cr), Astantine (As), Copper (Cu), Manganese (Mn) and Cobbalt (Co).

RESULTS

Generally, among organs, considering the average contamination level of all metals put together, that of lung (0.67mg/kg) was the lowest, next was that of kidney (0.77mg/kg); this was followed closely by that of liver (0.79 mg/kg) probably because the two organs work hand in hand; next was raw meat and the highest contamination of heavy metals put together was in roasted meat (0.79 and 1.29 mg/kg respectively) (Table 1). The metals might have also been due to the water, land and air pollution. It might also be brought about by vehicular traffic.

Table 1: Comparison of Organs being Contaminated by heavy metals (mg/kg)

Organs	Pb	Cd	Cr	As	Cu	Mn	Co	Sum	Mean
Kidney	0.79	0.61	0.06	0.45	1.77	1.63	0.06	5.37	0.77
Liver	0.72	0.51	1.18	0.04	1.43	0.93	1.40	6.21	0.89
Lung	0.81	0.90	0.42	0.00	1.71	0.82	0.00	4.66	0.67
Flesh	0.67	0.85	0.50	0.27	1.47	1.66	0.13	5.55	0.79
Roasted flesh	1.55	1.66	0.87	0.44	2.29	1.82	0.37	9.00	1.29

Along roads, the highest value of lead was found in kidney being sold at Market Road 5 with value of 0.22mg/kg while the lowest value was obtained in kidney sourced at market Road 2 with value of 0.02mg/kg. For cadmium, the highest value was found in Market Road 4 lung (0.24mg/kg) and the lowest value was in Market Road 4 Liver (0.03 mg/kg). Considering chromium, the highest value was found in Market Road 5 roasted flesh (0.32mg/kg) while the lowest value was Market Road 3 kidney, liver and lung (0.00mg/kg). On the basis of Astatine, Market Road 5 raw Kidney had the highest value (0.44mg/kg) and the lowest value was in Market Road 1 to 4 raw lung(0.00 mg/kg). For copper, the highest value was found in Market Road 4 (0.55mg/kg) and the lowest value was Market Road 4 raw liver (0.00mg/kg). Manganese had the highest distribution in Market Road 5 raw kidney (0.39mg/kg) but the lowest value was in Market Road 1raw liver and raw lung (0.11mg/kg). The highest value of cobalt was found in Market Road 1 raw liver (0.49 mg/kg) while its lowest value was in Market Roads 1 to 4 raw lung as 0.00mg/kg, results on the pattern of variation of individual heavy metals among the market roads showed that Roasted flesh had the highest values of all heavy metals along all market roads. The metal with the highest value in roasted flesh was Copper with an average of 0.46mg/kg. The leading Road Market in this respect was along Road was Road 1 with value of 0.58mg/kg (Table 2). The pattern of distribution of other metals in the market Roads are shown in Table 3 to Table 9.

Table 2: Lead Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Pb	Pb	Pb	Pb	Pb		
Raw Kidney	0.17	0.02	0.19	0.19	0.22	0.79	0.16
Raw Liver	0.17	0.19	0.10	0.22	0.04	0.72	0.14
Raw Lung	0.10	0.14	0.20	0.19	0.18	0.81	0.16
Raw Flesh	0.06	0.20	0.12	0.14	0.15	0.67	0.13
Roasted Flesh	0.22	0.33	0.33	0.27	0.29	1.55	0.29

Key: MR=Market Road

Table 3: Cadmium Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Cd	Cd	Cd	Cd	Cd		
Raw Kidney	0.22	0.15	0.04	0.18	0.02	0.61	0.12
Raw Liver	0.22	0.22	0.02	0.03	0.02	0.51	0 10
Raw Lung	0.12	0.21	0.11	0.24	0.22	0.90	0.18
Raw Flesh	0.08	0.31	0.11	0.33	0.02	0.85	0.17
Roasted Flesh	0.37	0.34	0.23	0.38	0.34	1.66	0.33

Key: MR=Market Road

Table 4: Chromium Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Cr	Cr	Cr	Cr	Cr		
Raw Kidney	0.00	0.00	0.03	0.03	0.00	0.06	0.01
Raw Liver	0.00	0.00	0.03	0.11	0.04	0.18	0.04
Raw Lung	0.00	0.01	0.13	0.13	0.15	0.42	0.08
Raw Flesh	0.00	0.00	0.13	0.14	0.23	0.50	0.10
Roasted Flesh	0.02	0.01	0.22	0.32	0.30	0.87	0.17

Key: MR=Market Road

Table 5: Astatine Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	As	As	As	As	As		
Raw Kidney	0.00	0.01	0.00	0.00	0.44	0.45	0.09
Raw Liver	0.00	0.00	0.00	0.04	0.00	0.04	0.01
Raw Lung	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raw Flesh	0.00	0.00	0.00	0.11	0.16	0.27	0.05
Roasted Flesh	0.01	0.07	0.03	0.14	0.19	0.44	0.09

Key: MR=Market Road

Table 6: Copper Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Cu	Cu	Cu	Cu	Cu		
Raw Kidney	0.49	0.27	0.01	0.55	0.45	1.77	0.34
Raw Liver	0.49	0.39	0.22	0.00	0.33	1.43	0.29
Raw Lung	0.22	0.60	0.23	0.33	0.33	1.71	0.34
Raw Flesh	0.42	0.40	0.00	0.32	0.33	1.47	0.29
Roasted Flesh	0.58	0.41	0.50	0.41	0.39	2.29	0.46

Key: MR=Market Road

Table 7: Manganese Distribution along Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Mn	Mn	Mn	Mn	Mn		
Raw Kidney	0.28	0.20	0.41	0.35	0.39	1.63	0.33
Raw Liver	0.11	0.24	0.13	0.22	0.23	0.93	0.19
Raw Lung	0.11	0.20	0.14	0.18	0.19	0.82	0.16
Raw Flesh	0.45	0.39	0.39	0.03	0.40	1.66	0.33
Roasted Flesh	0.45	0.39	0.39	0.12	0.47	1.82	0.36

Key: MR=Market Road

Table 8: Cobalt Distribution along the Market Road Samples (mg/kg)

Metals	MR1	MR2	MR3	MR4	MR5	Sum	Mean
	Co	Co	Co	Co	Co		
Raw Kidney	0.00	0.01	0.03	0.01	0.01	0.06	0.01
Raw Liver	0.49	0.39	0.22	0.00	0.30	1.40	0.28
Raw Lung	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raw Flesh	0.00	0.00	0.13	0.00	0.00	0.13	0.03
Roasted Flesh	0.02	0.04	0.31	0.00	0.00	0.37	0.07

Key: MR=Market Road

Among the variables tested, Chromium (Cr) and Astatine (As) were found significant ($P \leq 0.05$) while others were not significant at 95% probability (Table 9).

Table 9: One-Way Analysis of Variance for Heavy metals in the Assessed Organs in the Study Area

Element	Variation	Sums of Squares	Df	Mean Square	F-value	Sig. test (F- value)
1. Pb	Variable	0.130	4	0.003	0.479	0.751(NS)
	Error	0.134	20	0.007		
	Total	0.264	24			
2.Cd	Variable	0.084	4	0.021	1.579	0.218(NS)
	Error	0.265	20	0.013		
	Total	0.349	24			
3. Cr	Variable	0.104	4	0.026	3.884	0.017(Sig).
	Error	0.134	20	0.007		
	Total	0.239	24			
4. As	Variable	0.086	4	0.022	2.876	0.049 (Sig.)
	Error	0.150	20	0.007		
	Total	0.236	24			
5.Cu	Variable	0.190	4	0.047	2.004	0.133(NS)
	Error	0.473	20	0.024		
	Total	0.663	24			
6. Mn	Variable	0.067	4	0.017	1.036	0.413(NS)
	Error	0.325	20	0.016		
	Total	0.393	24			
7.Co	Variable	0.033	4	0.008	2.382	0.086(NS)
	Error	0.069	20	0.003		
	Total	0.102	24			

The follow-up procedure using Duncan Multiple Range Test (DMRT) for chromium revealed significant difference in distribution among the five market roads. The highest distribution was detected along Market Road 5 followed by Road 4, 3, 2 and 1 with values of 0.1442+/-0.556^{a}, 0.1460 +/-0.047^{a}, 0.1060+/-0.035^{c}, 0.0040+/-0.002^{c} and 0.0036+/-0.002^{c} respectively (Table 7). The follow-up procedure using Duncan Multiple Range Test (DMRT) for Astatine revealed significant difference across the five Roads at p≥ 0.05(Table 10). The highest concentration was found along Road 5 followed by Roads 4, 2, 3 and 1 in with values of 0.1588, 0.9584, 0.0164, 0.0064 and0.002 respectively.

Table 10: DMRT for Chromium to Separate the Mean Differences

Market Roads	Mean ± SE
1	0.0036±0.002^{c}
2	0.0040±0.002^{c}
3	0.1080±0.035^{b}
4	0.1460±0.047^{a}
5	0.1442±0.056^{a}

Table 11: DMRT for Astatine to separate the mean differences DMRT for chromium to separate mean differences

Roads	Mean ± SE
1	0.002±0.001^{c}
2	0.0164±0.001^{c}
3	0.0064±0.002^{b}
4	0.0584±0.002^{b}
5	0.1588±0.0062^{a}

**Means carrying the same letter subscripts are not significant from each other (P≤ 0.05)*

Generally among organs, considering the average contamination level of all metals put together, that of lung was the lowest, next was that of kidney; this was followed closely by that of liver probably because the two organs work hand in hand; next was raw meat and the highest contamination of heavy metals put together was roasted meat (Table 10)

DISCUSSION

The samples (raw organs of lung, liver, kidney raw with roasted flesh) of cane rat (*Thryonomys* *swinderianus*) revealed different levels of heavy metal contamination. The lung was least contaminated probably because the animals move away from traffic to far places where the air is less polluted. Kidney and liver had close contamination values probably because the two organs work hand in hand. Furthermore, the liver is known to detoxify contaminants and kidney is ultra filtration organ, so this accounted for the high accumulation of heavy metals in them This assertion agrees partially with Soewu *et al*., (2014) that heavy metal accumulation is higher in liver and kidney than lung of cane rat in all the metals lead, copper, zinc, cadmium and chromium but for iron.

There was most heavy metal pollution in the roasted flesh sampled probably due to the use of hydrocarbon used in support of firewood for roasting especially when firewood got wet. Chromium and Astatine were significantly different in distribution but showed very high concentrations among the Road 5 at $P \geq 0.05$ probably due to the heavy traffic attached to these roads as inter-regional links within the country. This result however agrees with previous study of Tanee and Albert (2013) that plants and soils become polluted by heavy metals from traffic. Average values in all the samples pooled together showed lead falling within the permissible range of 0.5mg/kg for offals and 0.1 mg/kg for meat, Copper exceeded the values of 0.01 mg/kg flat along all market Roads for both categories, Chromium was within the safe limit of 1.00mg/kg for both meat and offals; Cadmium was within the safe range of 0.5 mg/kg for both offals and meat throughout the study area, all in comparison with FAO, (2010) recommendation. Cobalt exceeded the value of 0.08mg/kg for offals and 0.03 mg/kg for meat (Agency for Toxic Substances and Disease Registry ASTDR, 2014) along Road 3 only. Manganese and Astatine fell within safe range of 0.5 mg/kg for both samples classes according to European Food Safety Authority EFSA, (2014) limit. These findings concluded that most of the wildlife terrestrial animals in the study areas were partially contaminated and at variance with the different roads each is found. The heavy metal analysis aspect suggests that wildlife in the study area is partially safe for consumption.

Recommendations

1. Hydrocarbon pollution from vehicles and other automobiles should be controlled through enactment of laws by governments with stiff penalties meted to offenders. Caution should therefore be exhibited in consuming wildlife parts and organs.
2. Environmental conservation should be as subjects in primary and secondary schools Basic Science and senior secondary classes' Biology, Geography and Agricultural science curricula.

REFERENCES

Afolarin, T.A. (2006). Lead Content of commonly consumed Vegetables sold in Out-door Markets of Ibadan Metropolis. Unpublished B.Sc. Project, Department of Environmental Management and Toxicology, University of Agriculture, Abeokuta, Nigeria. 49 pp..Agency for Toxic Substances and Disease Registry. ATSDR (2014). Available on line at www.atsdr.cdc.gov/tfacts33.htm. retrieved 11th December, 2015.

Balogun,O.Y. (2008). *Senior Secondary Atlas* .Second Edition, Longman Nigeria Plc, Ikeja- Lagos. 160pp.

European Food Safety Authority EFSA (2014). Dietary Exposure to Inorganic Arsenic in the European Population. *Journal of Food Safety* 12: (3):3597

Food and Agricultural Organization FAO (2010). Utilization of marketed Wild Animal Products in Rural Communities of Western and Southern Africa. Available at http://www.books.google.com.ng/books?id. Retrieved on 15th May, 2012.

Imran, G.T., Alarape, A.A. and Ogundun, N.J. (2013). Wildlife Domestication as a Panacea to Sustainable Forest Conservation in Nigeria. In: Proceedings of 36th annual Conference of Forestry Association of Nigeria (FAN), Labode Popoola *et al*. (eds). Uyo, Akwa Ibom State, Nigeria. 4th - 9th November, 2013. 51-56 pp.

Klein, P.N. (2005). Game meat: A Complex Food Safety and Animal Health Issue. *Conservation Ec*ology (5) 1-23

Nnadi, J. (2011). Nigerian News Service on Lagos Ibadan Expressway available at http://www.nigeriannewsservice.com retrieved 4th October, 2011.

Opara, M.N. (2010). Grasscutter: The Haematology and Major Parasites: *Research Journal of Parasitology* 5, 214-233

Ramalingan, T. (2012). *Modern Biology for Senior Secondary Schools*. Africana Pep Publishers Limited 3rd Edition 570pp.

Preer, J.R. and Rosen, W.G .(1999). Lead and Cadmium Content of Urban Garden Vegetable. *Tiance subs Environmental Health*, 11, 399-405.

Soewu, D.A., Agbolade, O.M., Oladunjoye, R.Y and Ayodele, I.A. (2014). Bioaccumulation of Heavy Metals in Cane Rat (*Thryonomys swinderianus*) in Ogun State, Nigeria. *Journal of Toxicity and Environmental Sciences*, Vol. 6 (8), 154-160. Available

Tanee, F.B.G. and Albert, E. (2013). Contamination of Roadside Soil and Plants along Three Major Roads in River State, Nigeria.. *Journal of Biological Sciences*, 13: 264-272.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ogundimu, 2019

COMPARATIVE ASSESSMENT OF MORPHOMETRIC PARAMETERS OF SOME COMMON LIZARDS

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ABSTRACT

The aim of this study was to examine the differences in the major external features and body weight of some common lizards from two locations. Ten samples each of the male and female rainbow lizard (Agama agama africana) and wall gecko (Hemidactylus frenatus) were purchased from Itoku market in Abeokuta, Ogun state as well as Bode market in Ibadan, Oyo state. Morphometric parameters such as the forelimb length, hindlimb length, tail length, head length, body length and total length were measured. It was observed that the body lengths of both male and female Agama lizards showed significant difference at ($P\leq 0.05$) in terms of location- the male and female Agama lizards in Abeokuta was longer in body length than those from Ibadan. In wall geckos, it was observed that the length of the forelimb was significantly different at ($P\leq 0.05$) while the hindlimb length, head length and body length showed significant difference at ($P\leq 0.01$) in terms of location. However, there was no significant difference in the body weights of the male Agama, female Agama and wall gecko from the different locations at both ($P\leq 0.01$) and ($P\leq 0.05$) significant levels although mean values showed that the weights of the male and female Agama lizards in Abeokuta was more than that of Ibadan while the mean values of the wall gecko from both locations was the same.

Keywords: Morphometrics, Lizards, Comparative assessment, Ibadan, Abeokuta.

INTRODUCTION

Lizard, any of a group of scaly reptiles related to snakes. Lizards are the most abundant of all reptiles and are found throughout the world in tropical and temperate areas. There are about 3000 species of living lizards, including such well known types as geckos, chameleons, Gila monsters, iguanas and skinks. Lizards far exceed snakes – the next most numerous reptiles – in number of individual. Except under special circumstances, snakes are something of a rarity even when one looks at them; lizards, on the other hand, seem to be everywhere in many of the warmer parts of the world (Coborn, 1987). Like snakes, some lizards are legless. Others resemble snakes but have legs. Many large lizards look much like crocodiles.

Lizards vary in size, shape and colour. They have many different ways of moving about and defending themselves. In parts of the United States, many people mistake lizards for salamander. The salamanders are commonly called "spring lizards" or "wood lizards". Salamanders and lizards look much alike but they are not related although both are cold-blooded animals. These animals cannot keep their bodies much warmer or cooler than their surroundings. But lizards have dry, scaly skin and clawed toes. Salamanders are amphibians related to frogs, and have moist skin and no scales or claws. Lizards love to stay in the sun but salamanders usually avoid sunlight (The World Book Encyclopedia, 2003).

The skin of many large lizards, such as iguanas, chuckwallas and monitors is used for leather goods such as handbags, wallets and shoes. Lizards are also used for food, especially among impoverished people, and in some agricultural areas they serve an important role in insect control. Some lizards are also kept as pets (Encyclopedia Americana, 2001). Several features reveal the close relationship between lizards and snakes, the most important of which is the possession of two copulatory organs called hemipenes, in the males. Many male vertebrates have no copulatory organs; some have one but only lizards and snakes have two. Lizards and snakes are also alike and distinguishable from all other reptiles, except the tuatara in having a transverse anal opening. No single feature distinguishes lizards from snakes – not even legs, since some lizards lack limbs of any kind.

However, unlike snakes, lizards usually have the following characteristics: a pectoral or shoulder girdle, that is, a skeletal support for attachment of front limbs; movable eyelids; an external ear opening; an eardrum, and a different skull structure with more skull bones (Encyclopedia Americana, 2001). Lizards are also often confused with salamanders, amphibians that they sometimes superficially resemble. Salamanders however, have elongate or round anal opening, smooth rather than scaly skin, and no more than four fingers on the front limb, rather than the lizards usual five. Lizards occur on most land masses insular as well as continental, in temperate and tropical regions. In general, they increase in diversity as well as in abundance towards the tropics (Encyclopedia Americana, 2001).

Lizards lack the in-built body temperature control, many other animals have. So, most lizards live in places where the ground never freezes. Those that live in areas with cold winters must hibernate. Lizards thrive in the tropics and warm parts of the temperate zones. They are the most common reptile found in the desert and other dry regions. When the desert becomes too hot for comfort, lizards lie in the shade or under the sand to escape the sun’s ray (Encyclopedia Americana, 2001). Lizards are extremely varied in form. There are long, slender snake-like racers; earthworm-like burrowers; stumpy-tailed short-bodied rock dwellers; long-tailed varieties capable of running swiftly on sand, earth and the surface of water; lumbering monsters living on land or in trees; spiny pancake-shape species; slick-skinned agile tree climbers and burrowers and still other too varied and numerous to describe.

The smallest lizards are certain geckos (Sphaerodactylus) that are about ¾ inch (1.9cm) long- the smallest of all reptiles. The largest lizards are the Komodo monitors, about 9 or 10feet (2.7-3.0m) long. Most are, however, less than 15inches (37cm) long. In several lizard families, especially the advanced ones, there are no external differences between the sexes. In other types of lizard however, there are some discernible differences between the sexes. Males of certain species for example have a somewhat enlarged head correlated with enlarged jaw muscles, and some have highly developed preanal pores. In most iguanas, males can be distinguished by their somewhat enlarged scales just behind the anus; in anoles, by their well-developed dewlap; and in some geckos, by postanal spurs and sacs. In some lizards, certain, though often minor, differences in colour pattern may occur, with one sex showing a heightening of colour, at least during the breeding season (Encyclopedia Americana, 2001).

The body of a lizard is covered with an epidermal layer of more or less horny keratin in the form of relatively thick keratinized, flexible skin. The scales vary greatly in shape and roughness: primitive lizards generally have small scales, and more advanced lizards have larger plates and larger scales which are sometimes accompanied by bony plates (osteoderms), shaped much like the epidermal elements but lying in the dermis under them. A very few small surfaces of the lizard body lack epidermal scales. For example, the so-called “mite pockets” - where the neck and limbs join the body - are partly bare-skinned. Some lizards have fused transparent eyelids similar to contact lenses (Smith, 1946).

Like other reptiles, lizards have few integumentary or skin glands. Paired scent glands are present at the base of the tail. In addition, many species have “femoral” or “preanal” pores occurring in a row or patches in front of the anus. These pores or glands are well developed only in males, being vestigial or absent in females. In mature males during the breeding season, a horny core grows out from each pore. This core produces a comb-like structure that the male rubs against the female, presumably to stimulate her sexually (Smith, 1946).

The limbs of lizards, especially the fingers and toes, show a wide variety of environmental adaptations. Some climbing species, for example, have broad pads on the feet to help them adhere to smooth surfaces. Most species have claws, but the claws may be long or short, slender or stout, depending on the species' environment and way of life (Smith, 1946). Desert dwelling species generally have long limbs and fingers along the toes to aid them in getting a purchase on shifting sands; some water-dwelling types have the same adaptations. Slow-moving land types, on the other hand, tend to have short fingers and toes and heavy limbs and some borrowing types have only greatly reduced limbs or none at all (Smith, 1946). The tail is as useful to the lizard as one of its limbs. In length, it ranges from a scarcely visible nubbin to a structure several times the length of the body. In structure, it ranges from a flattened leaf-like affair to a whip-like or heavy club-like form complete with rings of heavy spikes (Mattison, 1989).

The tail has many uses. It serves as a balance for the body, especially in lizards that run on their hind legs with the fore part of the body in the air. It is prehensile in some grasping or hooking onto twigs or rough areas as the lizard climbs trees or cliffs. The tail also stores fat for use during winter hibernation and seems capable of absorbing moisture. In some species the tail is brightly coloured, serving as an ornament or aiding in camouflage. Some lizards wave the tail over the head, exposing a brightly coloured underside, as a warning or deceptive device and some, particularly those with spiny tails, use the tail for defense (Smith, 1946).

The most amazing use of the tail is, however, in escape from predators. Most lizards can break the tail at will at any desired point, usually fixed, however, by the point at which a blow is received. The break occurs at a specially adapted fracture plane near the middle of a vertebra. These muscles contract the blood vessels and permit little blood loss. The dismembered tail gyrates conspicuously, attracting the attention of the enemy while the lizard is able to slip away unnoticed. The lizard soon regenerates a new tail, usually shorter than the old one, but one that can again be used for escape if the need arises. The vertebrae are not regenerated, but a cartilaginous rod replaces the lost vertebrae. Species lacking the fracture plane cannot break off their tail and do not regenerate a new tail if theirs is accidentally cut off (Smith, 1946).

The tail serves yet another unusual function. Thingy lizards have been known to break off the tail deliberately and eat it or to return to the site where the tail was lost and eat any remaining parts (Coborn, 1987). Found in most sub-Saharan Africa (Harris, 1964). *Agama agama* is often referred to as the African red-headed agama or common agama in the United States pet trade and popular literature (Frank and Ramus, 1995; Bartlett, 1999), and in specific literature as the African rainbow lizard (Romer, 1953; Daniel, 1960; Chapman, 1964; Harris, 1964; James and Porter, 1979; Cloudsley-Thompson, 1981; Sodeinde and Kuku, 1989). *Agama agama* is found in tropical, sub-Saharan Africa from Senegal east to Ethiopia and south to northern Angola and southern Tanzania. The colouration and pattern of this species varies over its geographic range, and over nine subspecies are currently recognized (EMBL Reptile Database, 2003). The subspecies in Florida is apparently *Agama agama africana*, which is imported for the pet trade from Ghana, Togo and possibly Benin (Foster, 2003). Dominant, reproductive males in the five Florida populations have tri-coloured tails as described for this subspecies by Harris (1964) and are identified to photographs by James and Porter (1979) and Cloudsley-Thompson (1981) of *Agama agama* from Ghana and Nigeria in West Africa.

The house gecko is grayish, pinkish or pale brown with darker flecks. The colour may vary, depending on the surrounding temperature. This tint can be uniform in colour, or more or less distinctly marbled with darker markings. The head is generally variegated with brown. On the side of the head, a more or less defined passes through the eye and in some individuals extends along the side of the body. The eyes are covered by transparent spectacles, pupils vertically elliptical with serrated edges. The lower surface of the animal is whitish. At night, the upper surface is light gray, tan or brown with scattered small spots, overall colour darker during the day (Edgren, 1950).

The nostril is pierced between the rostra, the first labial and three nasals. There are 10-12 upper and 8-10 lower labials. The mental is large, triangular or pentagonal. There are 2 or3 pairs of chin-shields; the median is in contact behind the point of the mental. The abdominal scales are moderate in size, cycloid and imbricate. The male has a series of 30 or 36 femoral pores which are not interrupted on the preanal region.

The tail is rounded, feebly depressed and covered above with very small smooth scales and six longitudinal series of keeled tubercles. The underside has a median series of transverse dilated plates. The tail serves in many species as an energy or fatlike storage which the animal uses under abnormal feeding conditions. They are also used in territorial posturing; male house geckos lift their tails and vibrate it briefly to ward off other males. Though fragile, the tail regenerates to its original shape if detached.

The limbs are relatively short and stout. It has toe pads on each of its toes that have thousands of microscopic, hair-like structures known as setae, project between the lamellae. The setae are forked at the end, enabling the gecko to grip the surface on which it is walking. With these adaptations, the gecko can climb vertical surfaces and run across ceilings (Norman, 2003).

This gecko is active at night, although it may be seen outside on cloudy days. This nocturnal and arboreal species is closely tied to human habitations. During the day, they can be found beneath surface debris and under loose bark of trees, in houses, in sheltered artificial hide a ways, such as electric installations, air condition units, lamps e.t.c. Male house geckos can be unfriendly and mean. This is especially true when there are many of them in one area and plenty of food.

Both sexes vocalize, producing a loud chirp, usually uttered during aggressive interactions. Unlike other lizards, geckos have a distinctly audible voice and utter chirps and click sounds. The male uses the voice to advertise ownership of a particular area and to attract females (Bartlett, 1988).

Geckos are found to have excellent vision and good hearing. They also possess the visual attributes and sound producing mechanisms necessary for complex displays. Display types are categorized according to the display mechanism used. Visual displays are found to utilize colour, pattern, posture and movement. These displays are used in predator threat as well as in intraspecific social contexts such as aggression and courtship. Combined visual-acoustic displays involve colour, pattern, postures, movements and sound. Combined displays are used in predator threat and in intraspecific aggressive encounters. Acoustic displays have little or no visual component and involve sounds that may be single chirps or temporally patterned multiple chirps. The single chirps are associated with distress while the multiple chirps are heard in intraspecific social contexts. The displays of diurnal and nocturnal geckos are compared and it is found that differences are correlated with differences in their diet activity cycles (Bartlett *et al*, 1995).

Morphometrics is a field concerned with studying variations and changes in the form (shape and size) of organisms including measurement of lengths. Morphometric analyses are commonly performed on organisms and are particularly useful in analyzing the fossil record. Morphometrics in a broader sense of the term is also used to precisely locate certain areas of featureless organs and is used it describing the shape of other things (Zelditch *et al*; 2004). Morphometrics adds a quantitative element to descriptions allowing more rigorous fashion and permits numerical comparism between different forms; by reducing shape to a series of numbers. Further, statistical analysis can highlight areas where changes is concentrated, removing the need to explicitly declare an area for investigation before study.

Reptiles are rarely studied in many places because they comprise of species that are generally unloved due to their appearance, nature and activities. At present, not much scientific research have been conducted on Nigerian lizards and as such there are limited knowledge of the potential and values of lizards as environmental indicators especially in the South western region of Nigeria.

MATERIALS AND METHODS

Study Area

Ten unmutilated samples of male and female rainbow lizard (*Agama agama africana)* and wall gecko (*Hemidactylus frenatus*) were purchased from Itoku market in Abeokuta and Bode market in Ibadan. Abeokuta is a city in Ogun State in southwest Nigeria and is situated at 7°9′39″N and 3°20′54″E on the Ogun River; 64 miles north of Lagos by railway, or 81 miles by water. Ibadan (the town at the junction of the savannah and the forest), the capital of Oyo State, is the third largest city in Nigeria by population (after Lagos and Kano), and the largest in geographical area and is situated at 7°23′47″N and 3°55′0″E.

Formalin was sprinkled into a container with lid and the lizards were placed inside till they became inactive. Sensitive weighing scale was used to take the body weights of the lizards while thread and ruler was used to measure forelimb length, hindlimb length, tail length, head length, body length and total length. Pen and note pad was used to document the morphometric parameters measured. Statistical Package for Social Science (SPSS) was used to analyze the data collected using the independent sample t-Test.

RESULTS

Table 1: Comparison of morphometric parameters in Agama Lizards by Location

Parameter (cm)	N	Ibadan (mean)	Abeokuta (mean)	T-Value	Sig P	Remark
Fore limb Length	10	4.34	4.37	0.15	0.88	N.S.
Hind limb Length	10	5.89	5.81	0.51	0.61	N.S.
Tail length (cm)	10	17.19	17.27	0.29	0.78	N.S.
Head Length	10	3.72	3.79	0.83	0.42	N.S.
Body Length	10	6.08	6.38	2.21	0.04**	S
Total Length	10	26.96	27.44	1.09	0.29	N.S.

*** Significant at (P≤0.05); NS = Not Significant, S = Significant*

.

Table 2: Comparison of morphometric parameters in Female Lizards by Location

Parameter (cm)	N	Ibadan (mean)	Abeokuta (mean)	T-Value	Sig P	Remark
Fore limb Length	10	4.09	4.17	0.497	0.62	N. S.
Hind limb Length	10	5.50	5.73	1.902	0.07	N.S.
Tail length	10	16.50	16.81	1.66	0.11	N.S.
Head Length	10	3.12	3.10	0.19	0.85	N.S.
Body Length	10	5.56	5.77	2.31	0.04**	S
Total Length	10	25.18	25.68	1.53	0.14	N.S.

** Significant at (P≤0.05); NS = Not Significant, S = Significant

Table 3: Comparison of morphometric parameters in Wall Geckos by Location

Parameter (cm)	N	Ibadan (mean)	Abeokuta (mean)	T-Value	Sig P	Remark
Fore limb Length	10	2.00	2.21	2.22	0.04**	S
Hind limb Length	10	2.45	3.08	4.56	0.00*	S
Tail length	10	6.20	6.02	0.69	0.50	N.S
Head Length	10	1.66	1.99	2.97	0.01*	S
Body Length	10	4.54	5.09	4.99	0.00*	S
Total Length	10	12.40	13.10	1.61	0.13	N.S

* Significant at (P≤0.01), ** Significant at (P≤0.05); NS = Not Significant, S = Significant

Table 4: Comparison of Body Weight in Agama lizard, Female lizard and wall gecko by location

Species	N	Ibadan (mean)	Abeokuta (mean)	T-Value	Sig P	Remark
Agama agama africana (male)	10	291.30(g)	304.27 (g)	0.26	0.81	N.S
Agama agama africana (female)	10	312.33(g)	317.93(g)	0.14	0.90	N.S
Hemidactylus frenatus	10	130.93(g)	130.93(g)	0.00	1.00	N.S

NS = Not Significant, S = Significant

DISCUSSION

Table 1 show that there were no significant difference in the forelimb, hindlimb, tail, head length and total length(s). However, agama lizards from Abeokuta had longer body length (6.38cm) than agama lizards from Ibadan.

Consequently, Table 2 shows that there were no significant differences in the length of fore limb, hind limb, tail length and total body length of female lizards between the two locations. However, the body length of female lizard in Abeokuta was significantly higher than the body length (5.77cm) of female lizards in Ibadan.

However, Table 3 shows that Wall geckos in Ibadan were significantly shorter ($P \leq 0.05$) in forelimb (2.00cm), hindlimb (2.45cm), head length and body length than wall geckos in Abeokuta with length of 2.21cm, 3.08cm, 1.99cm and 4.54cm for fore limb, hind limb, head, body respectively. However, there were no significant differences in the tail length and total length for wall geckos between the two locations.

The results of the Comparison of the body weight and microbial load by species, sex and locations were presented in Tables 4 shows that there was no significant difference in the body weight of the agama lizards, female lizards and wall geckos collected from Ibadan and Abeokuta.

CONCLUSION AND RECOMMENDATION

This study illustrated that there was no significant difference in the morphometric parameters (forelimb length, hindlimb length, tail length, head length, total length) and body weight of both agama male and female lizard but there was significant difference in the body length in both locations with Abeokuta having longer body than those from Ibadan. Limb length strongly impacts locomotor performance; lizards with longer hindlimbs and shorter forelimbs achieve greater sprint speeds and jump farther (e.g., Bonine & Garland 1999; Toro *et al*. 2004) although there may be additional advantages to longer limbs that are unrelated to locomotor performance (Iraeta *et al*. 2011).

In the wall geckos, there was significant difference in the forelimb length, hindlimb length, head length and body length but no significant difference in the tail length and total length in both locations with Abeokuta having longer forelimb, hindlimb, head length and body length. However, longer limbs may not always be optimal for effective escape from a predator. As discussed above, shorter limbs may be advantageous for maneuvering in confined spaces, such as burrows, because they may achieve faster cycling frequencies and are easier to maneuver around obstructions. Shorter limbs may also be beneficial for stability on narrower surfaces (Enge *et al.*, 2004).

Therefore, further research is required in order to evaluate differential elongation of limb segments and also how it affects locomotor performance.

REFERENCES

Bartlett, R.D. and P.P. Bartlett. (1995). Geckos. Everything about selection, care, nutrition, disease, breeding and behaviour. Hauppauge New York: Barron's Educational Series. Pp 169.

Bartlett, R.D. and P.P. Bartlett. (1999). A Field Guide to Florida Reptiles and Amphibians.Gulf Publishing, Houston, TX. Pp 280.

Bartlett, R.D. (1988). Geckos: In search of Reptiles and Amphibians. New York: E.J. Brill.Pp.204.

Bonine, K. E. and Garland, T., Jr. (1999). Sprint performance of phrynosomatid lizards, measured on a high-speed treadmill, correlates with hindlimb length. *Journal of Zoology*, 248, 255–265.

Chapman, B.M. and R.F Chapman. (1964). Observations on the biology of the lizard *Agama agama* in Ghana. *Proceedings of the Zoological* Society *of London*, 143: 121-132.

Cloudsley-Thompson, J.L., (1981). Bionomics of the rainbow lizard *Agama agama* (L.) in Eastern Nigeria during the dry season. *Journal of Arid Environments,* 235-245.

Coborn, J. 1987. Snakes and Lizards. Ralph Curtis Books. Pp 205-213.

Daniel, P.M. (1960). Growth and cyclic behaviour in the West African Lizard, *Agama agama* Africana. Copeia 1960: 94-97.

Edgren, R.A. (1950). Notes on the Neotropical population of *Hemidactylus frenatus* Schlegel Natural History Miscellanea (55): 1-3.

EMBL Reptile Database. (2003). Available online at: *http//www/emblheidelberg.de/~uetz/Living Reptiles. html.*

Encyclopedia Americana, (2001). Lizards. Pp 621-624.

Enge, K.M., Krysko K.L. and Talley B.L. (2004). Distribution and Ecology of the introduced African Rainbow lizard, *Agama agama Africana* (Sauria: Agamidae), in Florida.

Foster, D.R. (2003). Archer, FL. Pers. Comm. Reviewed on 2007-01-10

Frank, N. and E. Ramus. (1995). A Complete Guide to Scientific and Common Names of Reptiles and Amphibians of the World. N G Publishers, Pottsville, PA. 377pp.

Harris, V.A. 1964. The Life of the Rainbow lizard. Hutchinson Tropical Monographs. 174pp.

Iraeta, P., Monasterio, C., Salvador, A. and Díaz, J. A. (2011). Sexual dimorphism and interpopulation differences in lizard hind limb length: Locomotor performance or chemical signalling? Biological Journal of the Linnean Society, 104, 318–329.

James, F.C. and W.P Porter. (1979). Behaviour-microclimate relationships in the African Rainbow Lizard, *Agama agama*. Copeia 1979: 585-593.

Mattison, C. (1989). Lizards of the World. Facts on file, New York. Pp. 105-118.

Norman, B.R. (2003). A new geographical record for the introduced house gecko, *Hemidactylus frenatus*, at Cabo San Lucas, Baja California, Mexico, with notes on other species observed. Bulletin of the Chicago Herpetological society. 38(5): 98-100.

Romer, J. D. (1953). Reptiles and amphibians collected in the Port Harcourt area of Nigeria. Copeia 1953:121–123.

Smith, H.M. (1946). Handbook of Lizards. Comstock Publishers. Pp. 55-83.

Sodeinde, O. A. and O. A. Kuku. (1989). Aspects of the morphometry, growth-related parameters and reproductive condition of agama lizards in Ago-Iowye, Nigeria. *Journal of Herpetology*, 1:386–392.

The World book Encyclopedia. 2003. Lizards. 12. Pp 399-401.

Toro, E., Herrel, A. and Irschick, D. J. (2004). The evolution of jumping performance in Caribbean Anolis lizards: Solutions to biomechanical trade-offs. American Naturalist, 163, 844–856.

Zelditch, M. *et al*. (2004). Geometrics for biologists. Academic press. Pp. 115. ISBN 012778460.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Awotoye, 2019

STUDY ON THE INFLUENCE OF SELECTED ORGANIC MANURES ON THE EARLY GROWTH OF *Senna fistula* Linn

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ABSTRACT

The study assessed the manuring potentials of Chromolaena odorata and composted kitchen waste on the growth of Senna fistula seedlings. Germination was observed and assessment of growth parameters commenced two weeks after transplanting and was done weekly for 12 weeks. Seedling height, stem diameter, leaf production and leaf area were measured. Data were analyzed using ANOVA at $\alpha_{0.05}$. Results showed that T_8 (80g of composted kitchen waste + 1.5 kg of top soil) had the highest performance in terms of plant height with 8.08 cm while T_4 (80g of Chromolaena odorata leaf powder + 1.5 kg of top soil) had the best performance with mean value 1.44 mm for stem diameter. The highest leaf production was observed on seedlings raised on T_8 (80 g of composted kitchen waste + 1.5kg of top soil) with 17.00. However, for leaf area, T_8 (80g of composted kitchen waste + 1.5kg of top soil) had the best performance with mean value of 8.00 cm^2. The organic manure used for the study had an excellent performance on the growth of Senna fistula seedlings. It is therefore, recommended that composted kitchen waste and Chromoleana odorata leaf powder be adopted for raising seedlings of Senna fistula at the nursery stage.

Keywords: *Chromoleana odorata,* Compost, Growth, Manure, Seedlings, *Senna fistula***,**

INTRODUCTION

Senna fistula is an exotic species that command good market price. This is due to its vast economic uses. It is popularly known as golden shower tree which belong to the family Fabaceae and a high valued species in terms of its aesthetic purposes (Willis 2001). *Senna fistula* is widely grown as an ornamental plant in tropical and sub-tropical areas and it grows well in dry climate with relatively drought tolerant ability. The species produces flowers which are golden yellow and hangs its showers bunch of up to 4cm long hence the name golden shower tree (Murali, 1993). The plant has been used extensively in the folklore medicine for the treatment of variety of diseases such as purgative (Kasuko and Nagayo, 2001), menstrual disorder (Bhaktal *et al*., 2001), skin diseases, leprosy, malaria, rheumatism etc. (Willis, 2001).

Chromolaena odorata (Siam weed) is a perennial shrub forming dense tangled bushes up to 3m in height. Although, it re-sprouts from its stumps immediately after rains, the ability coupled with its fast growth rate enables it to compete well with other plants. It provides a vegetative cover that protects the soil surface against erosive action of rain and wind and when it shed its leaves or when the entire plant dies and decays it adds organic matter to the soil (Nwaokoro and Omolaja, 2000).

Compost on the other hand, are organic materials which have been decomposed and recycled as a fertilizer and soil amendment. It is a key ingredient in organic farming. Compost is added to the soil for several reasons. It improves the physical conditions of the soil. It also keeps up the level of humus in the soil and maintains the best conditions for the activities of soil organisms (Radovich, 2011). In addition, it makes up for the plant nutrients which have been removed by crops or lost by leaching and soil erosion. The compost adds air space to the soil and also alleviate compacted soil conditions. However, in most developing countries, many farmers find it difficult in making use of these materials hence this study aimed at investigating the influence of organic manure on early growth of *Senna fistula*.

MATERIALS AND METHODS

Study Area

The experiment was carried out in Federal College of Forestry, Ibadan. The college is located in Ibadan North West Local Government Area of Oyo state at Latitude $7^0$26'N and Longitude 3^0 36'E of the Greenwich meridian. It has an annual rainfall of about 1400-1500mm and average relative humidity of about 65%. The average temperature is 37.2^{0}C. There are two distinct seasons that are notable in the area which are dry and wet (raining) season (FRIN 2019).

Procedure

Forty five seeds of *Senna fistula* were collected from a mother tree within the premises of Federal College of Forestry, Ibadan. The seeds were soaked in Conc. H_2SO_4 (to break its dormancy) for 5 mins after which they were thoroughly washed under running water to remove all traces of the acid before they were sown into germination box filled with sterilized river sand. Watering was done twice a day. After germination (8days), the 45 seedlings were carefully pricked from the germination basket and then transplanted into the polythene pots containing various treatments. The readings were taken every week for 12 weeks.

Compost preparation

The kitchen waste were collected and put into a perforated bucket with lid and thick black polythene bag. The hole was to allow water to drain out as well as allow the free flow of air while the polythene bag was to help provide adequate heat for decomposition process to take place. The waste was also watered (to keep it moist) and mixed with garden fork twice in a week so that complete decomposition can take place. The decomposition process was achieved after 2 months of preparation.

Green manure preparation

Leaves of *Chromolaena odorata* were collected from the College Premises, these were chopped with a knife and then spread out (to air dry) in a cool dry place for 4 weeks. The dried leaves were then grinded into powder form using a grinding machine.

Treatments

The treatments were: T_1 (1.5kg of top soil + 20g of *Chromolaena odorata* leaf powder), T_2 (1.5kg of top soil + 40g of *Chromolaena odorata* leaf powder), T_3 (1.5kg of top soil + 60g of *Chromolaena odorata* leaf powder), T_4 (1.5kg of top soil + 80g of *Chromolaena odorata* leaf powder), T_5 (1.5kg of top soil + 20g of kitchen waste compost), T_6 (1.5kg of top soil + 40g of kitchen waste compost), T_7 (1.5kg of top soil + 60g of kitchen waste compost), T_8 (1.5kg of top soil + 80g of kitchen waste compost), T_9 (1.5kg of top soil ,control)

Experimental design

The experiment was arranged in a Completely Randomized Design (CRD) with nine (9) treatments and five (5) replicates. Stem diameter (mm), seedlings height (cm), leaf production and leaf area.

Data Analysis

Data were analysed using ANOVA and the means were separated using Duncan multiple range test at 5% level of probability.

RESULT

Chemical analysis of top soil, compost and green manure

The characteristics of soils play a great role in the growth of plants. For plants to grow, the soil must provide a satisfactory environment (basic nutrients) that enable growth. From the result, it was indicated that nitrogen (N), potassium (K) and Phosphorus (P) are 0.19%, 0.46 cmol/kg and 12.40 mg/kg respectively. The pH level of the soil was observed to be closer to neutral level showing that the soil is good for planting and would be able to support plant growth (Table 1).

Table 1: Chemical analysis of top soil, compost and green manure

Parameters	Top soil	Compost	Green manure
Exchangeable Na (cmol/kg)	0.09	-	
Exchangeable Ca (cmol/kg)	1.29	0.28	
Exchangeable K (cmol/kg)	0.46	0.49	35
Exchangeable Mg (cmol/kg)	0.47	0.33	
ECEC	3.15		
% Organic C	0.79	26.78	
% N	0.19	2.28	1.51
% O. M.	-	46.22	
Average P (mg/kg)	12.40	0.33	45.2
pH	6.57		
Cu (mg/kg)	1.41	-	
Zn (mg/kg)	117.6	-	
Pb (ppm)	6.18	11.78	
Fe (mg/kg)	125.9		
Mn (mg/kg)	70.7	31.28	
Sand (%)	70	-	
Silt (%)	13	-	
Clay (%)	17	-	

Effect of different organic manures on seedlings height (cm), diameter (cm), leaf production and leaf area of *Senna fistula*

The effect of different organic manures on seedlings height (cm), diameter (cm), leaf production and leaf area of *Senna fistula* shows in Table 2.

The result on seedling height shows that T_8 (80g of compost + 1.5kg of top soil) had the best performance with 8.08 cm. This was closely followed by T_4 (80g of *Chromolaena odorata* leaf powder + 1.5kg of top soil) with 7.93 cm. However, the least performance (7.22 cm) was recorded in T_5 (20g of compost + 1.5kg of top soil). This is an indication that the presence of organic manure in the soil can enhance better performance of plants height. There was no significant difference among the treatments at p<0.05 (Table 3).

However, the result on stem diameter revealed that T_4 (80g of *Chromolaena odorata* leaf powder + 1.5kg of top soil) had the best performance with mean value 1.44 mm. This was followed by T_5 (20g of compost + 1.5kg of top soil) with 1.41 mm. However, T_7 (60g of compost + 1.5kg of top soil) had the least performance in stem diameter with 1.25 mm. This clearly showed that *Chromolaena odorata* leaf powder and the composted kitchen waste have effect on the stem diameter of the species. There was no significant difference (p<0.05) in stem diameter of the *Senna fistula* grown on varying levels of organic manure (Table 3).

In addition, the results further indicated that T_8 (80g of composted kitchen waste + 1.5kg of top soil) produced the highest number of leaves with 16.55. This was followed by T_4 (80g of *Chromolaena odorata* leaf powder + 1.5g of top soil) with 16.48 while T_5 (20g of compost + 1.5kg of top soil) had the least leaf production with mean value of 14.58 implying that higher quantities of organic manures had effect on the leaf production of *Senna fistula seedlings*. There was significant difference among treatments at p<0.05probability level (Table 3).

Finally, T_8 (80g of composted kitchen waste + 1.5kg of top soil) produced the highest leaf area with 8.00 cm^2. This was followed by T_7 (60g of compost + 1.5kg of top soil) with 7.00 cm^2 while T_9 (1.5kg of top soil only) had the least leaf area with mean value of 3.67 cm^2 implying that higher quantities of organic manures had effect on the leaf area of *Senna fistula* seedlings. However, there was significant difference among treatments at p<0.05 probability level (Table 3).

Table 2: Effect of different organic manures on seedling height, stem diameter, leaf production and leaf area of *Senna fistula* seedlings

Treatments	Seedling height (cm)	Stem diameter (mm)	Leaf production	Leaf area (cm^2)
T_1	7.31a	1.36a	16.38ab	5.08ab
T_2	7.25a	1.27a	14.65a	5.52ab
T_3	7.77a	1.35a	15.15a	5.44ab
T_4	7.93a	1.44a	16.48ab	6.21c
T_5	7.22a	1.41a	14.58a	4.26a
T_6	7.65a	1.34a	15.66ab	5.15ab
T_7	7.64a	1.25a	15.83a	7.00c
T_8	8.08a	1.36a	16.55ab	8.00c
T_9	7.54a	1.40a	15.03a	3.67a

Table 3: Analysis of variance for the effect of different organic manures on seedling height, stem diameter, leaf production and leaf area of *Senna fistula* seedlings

Sources of variation	SS	Df	MS	F	p-value
Seedlings height (cm)					
Treatments	17.13	8	2.14	0.55	0.81ns
Error	140.81	36	3.91		
Total	157.94	44			
Stem diameter (mm)					
Treatments	0.15	8	0.02	0.06	0.74ns
Error	1.08	36	0.03		
Total	1.24	44			
Leaf production					
Treatments	62.40	8	7.80	1.61	0.16*
Error	174.40	36	4.84		
Total	236.80	44			
Leaf area (cm^2)					
Treatments	148.70	8	8.59	1.74	0.12*
Error	385.51	36	0.71		
Total	534.21	44			

Ns= not significant p >0.05; * significant p>0.05

DISCUSSION

The results on seedling height of *Senna fistula* corroborated the findings of Burkill (1997) that organic manure when applied in adequate proportions could be justified by means of increasing the growth and productivity of plants. Meanwhile, Edward (2003) opined that *Chromolaena odorata* leaf powder (green manure) performed best on the stem diameter of *Albizia lebbeck*. The result of leaf production obtained in this study agreed with the findings of Ulysses (1982) who reported that when organic manure are added to the soil, it reflects in an increase in the leaf production of plants. Santharam (1998) likewise reported an increase in the quantity of organic manure in the soil can lead to an increase in leaf area of *Senna fistula* seedlings.

CONCLUSION

The study revealed the manuring potentials of composted kitchen waste and green manure of *Chromolaena odorata* at varying levels as good source of organic manure for the enhancement of the growth of *Senna fistula* most especially in terms of height stem diameter, leaf production and leaf area at the nursery stage. In addition, it was indicated that the rate at which plants grow is highly determined by the application of optimum manure level. The potential of composting waste to wealth makes it an attractive proposition, by enhancing soil fertility thereby increasing plant productivity and hence reducing ecological risks of environmental pollution. Therefore, as a means of improving the growth of *Senna fistula* seedlings, it is recommended that composted kitchen waste and *Chromolaena odorata* be adopted for raising the seedlings.

REFERENCES

Bhaktal, T. Benrjee. S, and Subhashe, W. (2001). Protective activities of *Senna fistuta* leaf extract Phytomedicine, California: University press. Pg. 220- 224.

Burkill, H. M. (1997). *The useful plants of West Africa. 2nd Edition, Vol 4*, Families M-R. Royal Botanical Gardens, Kew, Richmond, United Kingdom. Pp. 969.

Edward, W. P. (2003). Comparism of *Chromolaena odorata* leaf powder and horse dung on the growth of *Senna fistula*: Ibadan. Department of Forest Resources Management, University press. Pp. 84-86.

FRIN (2019). Forestry Research Institute of Nigeria, Metrological Station Report.

Kasuko, I. and Nagayo O. (2001). Effect of vegetable drugs on pathogenic fungi. In *Effect of Anthragione-glycoside containing crude drug upon the growth of pathogenic fungi Bullphram. Resources Institute Japan. Journal vol.* 2: pg. 23- 29.

Murali, K. S. (1993). Differential reproductive success in *Cassia fistula* in different habitats. A case of pollinator limitations in current science. Bangalore: Vol. 65 (3): Pp. 270-272.

Nwaokoro, N. S. and Omolaja, M. O. (2000). The utilisation processing and nutritional value of Cassia fistula. The African locust bean. Nassarawa State: Department of Biological sciences, Nassarawa State University press. Pg. 154-179.

Radovich, T.A. (2011). Compost quality in tea time in the tropics: A handbook for compost tea production, *US College of Tropical Agriculture and Human Resources*. Hawaii: university press

Santharam, V. (1998). The use of compost manure in raising of *Senna fistula* seedlings at nursery stage: forest resources management, university of Ibadan, Nigeria press. Pp 16-27.

Ulysses, O. (1982). Stated approach fertilizer application that increase the productivity of the plant crop. A.B.U.: Synopsis of research proposal for degree of M.Sc. Agronomy. Nairobi, Kenya. Pp 234.

Willis, T.E. (2001). *Phamacognosy 5th Edition.* CBS Publishers and distributor 485 Jain Bhawan, Shahdara Delhi. Pg. 252 -253.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Aluko et al., 2019

PERCEIVED EFFECT OF BUSH BURNING ON HOUSEHOLDS LIVELIHOOD SECURITY IN AGAIE LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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ABSTRACT

This study was to determine the effect of bush burning on household's livelihood security in Agaie Local Government Area of Niger State. Multi-stage sample technique was used to select 130 respondents in the study area. Data was collected through the use of interview scheduled with the aid of well-structured questionnaire and analyzed using descriptive and inferential analysis. The study revealed that the agricultural activity was the major occupation of the respondents in the study area. Also, the level of livelihood security was low with more than half (53.8%) felt the negative effect of bush burning ranging from destruction of wildlife, pollution of environment, destruction of soil texture, respiratory infection and lastly destruction of agricultural products. However, significant relationship existed between livelihood activities and livelihood security. ($r = -0.318$, $p \leq 0.000$). This study therefore recommends that the dwellers should be educated by extension agents on safer cultivation strategies and appropriate farming methods to be used instead of bush burning.

Keywords: Bushing burn, Livelihood and Livelihood Security

INTRODUCTION

Bush burning is one of farming practices commonly used by vast majority of farmers in developing countries where traditional farming system is been operated. This practice could be described as the process of clearing, gathering and burning of forestland for the purpose of preparing the land for crop or livestock production. According to Isah and Adeyeye (2002) in similar study on bush burning, reported that vast majority of area in savanna ecological zones are been burnt and cleared annually for cropping, hunters, and grazing condition for livestock. However, research had shown that the practice had series of environmentally problems contrary to the people believed on the benefit of the practice. Wilkinson *et al.* (2005) reported that fire as a result of bush burning could lead to change soil-microbial composition while Andersson *et al.* (2004) substantiate that fire results in abrupt physical destruction of vegetation and its related ecosystem function. This practice of bush burning invariably results in heating and drying of the soil and destroying the ecosystem of the savannah. Furthermore, bush burning resulted into major air pollutants that are emitted during bushfire and these include Carbon monoxide, Carbon dioxide, oxides of Nitrogen, and oxides of Sulphur, particulates and Hydrocarbon as a result of incomplete combustion of cellulose materials (Hamid *et.al*, 2010).

Furthermore, it has also been observed that the activities of this people sometimes determine the manner in which they engage in bush burning. This action may likely damage assets or means of livelihood of the people in the rural area. All these problems tend to directly affect the household security and have negative effect on the livelihood of the people in such area. Livelihood security has been a fundamental component underpinning the scientific discourse on sustainable development (Frankenberger and McCaston 1999, Lindenberg

2002). Food and Agricultural Organization (FAO, 1996) defined households livelihood security as adequate and sustainable access to income and other resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, time for community participation and social integration). Livelihoods can which range from on-farm and off-farm activities. These activities provide a variety of procurement strategies for food and cash. However, these strategies could be jeopardized in cases of disaster such as fire disaster thus, resulting in destruction of lives and properties, releasing toxic waste to the soil as well as air, if strong measures are not taken to safeguard the livelihood of the people.

The North central zone of Nigeria which is considered as the food basket of the nation is not left out of this menace as rural dwellers and hunters engage in bush fire indiscriminately. In many Local Government Area of Niger state, uncontrolled and indiscriminate bush burning has become a common and yearly practice, particularly during the dry seasons (Adetunji and Onumadu, 2005). These authors also noted that the effect of bushfire on rural livelihoods and on the ecosystem is increasingly becoming extensive and damaging. Thus, suggesting the need for a clearer understanding effect of bushfires to inform policies that will address the undesirable effects with respect to arable agriculture, rangeland and soil conservation.

Although several studies on bush burning activities have been carried out in north central zone of Nigeria, however, most of these studies were centered on the negative effect of bush burning on farmlands and soil condition of the affected area without considering the effect on livelihood as well as the livelihood security of the people. It is therefore germane to critically investigate the perceived effect of damaged caused by bush fires on livelihood security of rural dwellers so as to resolve the problems emanating from these phenomena. It was against this background that the study intended to assess the perceived effect of bush burning activities on change in livelihood security of respondents in the study area as well as identifying the livelihood activities of the respondents in the study area and also ascertain changes in livelihood of respondents as a result of bush burning activities in the study area. The study also ascertained if there is significant relationship between perceived effect of bush burning and livelihood activities of the respondents in the area.

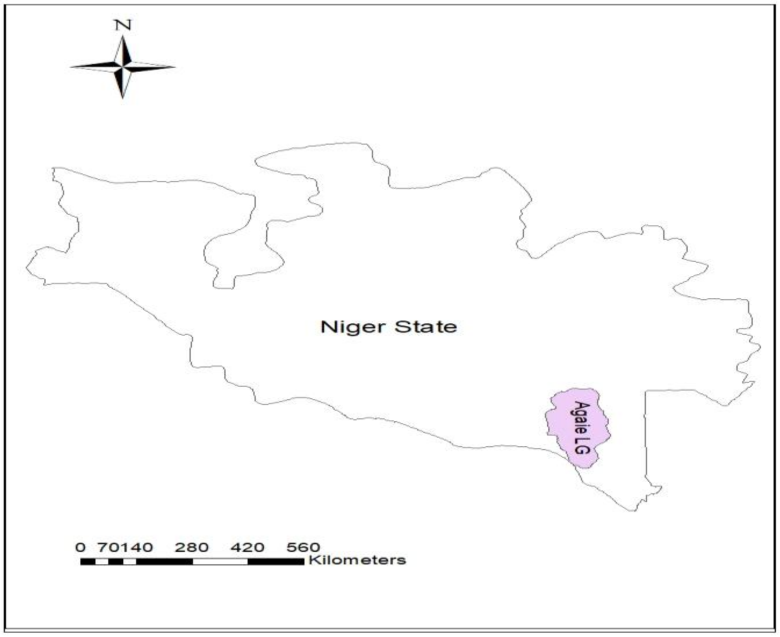
MATERIALS AND METHODS

Study Area

This study was conducted in Agaie Local Government Area of Niger State. Agaie is the headquarter of Agaie LGA and lies between latitude $9^0\,00'\,30.60''$ N and longitude $6^0 19'\,5.56''$ E. Agaie is found in a low basin found by the valleys of one river Gbakogi, the mean annual rainfall of the town is 1227 mm^3 and mean monthly temperature of 31 °C. The predominant tribe is Nupe with an average low representation of other tribes. The indigenous habitants are mostly Muslims. The residents are predominantly farmers and fishermen. The socio-economic status of the town is on the average as most people use pit latrines and the literacy level is averagely low. Infrastructural facilities present in the town include a government owned general hospital, electricity and pipe-borne water that is erratic in its supply like other major parts of the country.

Target Population of the study

The target population was household heads or representatives in farm-households in Agaie Local Government, Niger State.



1: Map of the Niger state showing Agaie LGA

Sampling procedure and Size

Multistage sampling technique was used to carry out the study. Two districts in Agaie Local Government Area of Niger State namely Kintado and Kintifi were considered for the study. There are 64 towns/villages in Kintako and 220 town/ village in Kintifi (NPC, 2006).

First stage: Purposive sampling technique was used to select three (3) farm household settlements in each of the districts. In Kintado, Dekdoza, Ejitigi and Jito-magaji were selected while Kapagi, Tagagi, Wanigi were selected in Kintifi district.

Table 1: Selected Household Settlements in each District

S/No.	**Selected Settlement in each District**	
	Kintado District	**Kintifi District**
1	Dekdoza	Kapayi
2	Ejitigi	Tagagi
3	Jito-magaji	Wanigi

Second stage: There are 72 household in Dekdoza, 41 household in Ejitigi, 60 household in Jito-magaji, 88 household in kapagi, 25 household in Tagagi, and 105 households in wanigi. Systematic sampling technique was used to select 24 from Dekdoza, 14 household from Ejitigi, 20 household from Jito-magaji, 29 household from Kapagi, 8 household from Tgagi, while 35 household from Wanigi to give a total of 130 respondent to be interview from the study.

Table 2: Sample size of Selected Districts in Selected Local Government Area

District	Number of household	Settlement	Number of household	Selected households
Kintado	1	Dekdoza	72	24
	2	Ejitigi	41	14
	3	Jito-magaji	60	20
Kintifi	1	Kapagi	88	29
	2	Tagagi	25	8
	3	Wanigi	105	35
Total = 2	**6**	**6**	**391**	**130**

Total number of households selected is 130

Measurement of variables

Livelihood activities

Livelihood activities were measured using some identified income generating (Agriculture – non Agriculture) activities. Respondents were asked to indicate their activities which was measured on 2 point scale of Yes and No. Scores of each item was summed up to obtain a composite score of livelihood activities. The lowest score was 11 and 22 were the highest score. The mean score was used as benchmark in categorizing into high and low livelihood activities such that respondents with below mean score was assumed to have low activities while those within the mean an above the mean score was categorized as having livelihood activities. The composite score was used in the hypothesis

Change in household livelihood security scales

Change in household livelihood security scale was adapted from CARE, (2001) who considered five main domains which include; economic security, food, health, empowerment and education. This was measured on a four point scale of improving, unchanged, decline and worse off while score of 4, 3, 2, and 1 was assigned respectively. Scores of each item were summed up to obtain a composite score of household livelihood security. The lowest score was 22 and 88 was the highest score. The mean score was used as benchmark in categorizing into high and low household livelihood security such that respondent with below mean score was assumed to have low household livelihood security while those within the mean an above the mean score was categorized as having level of household's livelihood security. The composite score was used in the hypothesis.

Perceived effect bush burning: Respondents were asked to respond to extent of damage caused by bush burning activities which was measured on 3 point scale of often major, minor and none. A score of 3 was assigned to often 3 to Major, 2 minor and 1 to none. 4 questions were asked ensure the high score was 12 while lowest was 4. The composite score was used in the hypothesis. The composite score was used in the hypothesis.

Data collection

Data was obtained using a well-structured questionnaire.

Data analysis

The statistical tools used for this research work are descriptive statistical tools, which include frequency table, simple percentile while the inferential statistical tool was Pearson Product Moment Correlation (PPMC).

RESULT

Tables 3 revealed that majority (99.2%) of the respondents were into crop farming in the study area. It was further revealed that 56.2% of the respondents are into hunting activities while 43.8% of the respondents are not into hunting as an occupation. Furthermore, 68.5% of the respondents never engage in lumbering, while 31.5% of the respondents practice lumbering operation as their livelihood activity. In addition it was further stated that the majority (54.6%) of the respondents never engage in gathering of non-timber forest product. 25.45% of the respondents are fully involved in grazing in the study area while with majority (84.6%) of the respondents never involved in petty cassava processing. It was also revealed that majority (82.3%) of the respondents were not into livestock farming. Trading was viewed as a regular activity in the study area with majority (87.7%) of the respondents engage in petty trading while 12.3% never involved in the activity. Also, it was further reported that 50.8% of the respondents were artisans while 41.5% of the respondents survive on income generate from hired labor job. Lastly, transportation business was reported as livelihood activity engaged by 22.3% of the respondents in the study area.

Table 3: Livelihood Activities of Respondents in Agaie LGA

Variable	Yes (%)	No (%)
Agriculture		
Crop Farming	129(99.2)	1(0.8)
Hunting	73(56.2)	57(43.8)
Lumbering works	41(31.5)	89(68.5)
Gathering of non-timber forest product	59(45.4)	71(54.6)
Grazing	33(25.4)97	97(74.6)
Cassava processing	20(15.4)	110(84.6)
Production of livestock	23(17.7)	107(82.3)
Non Agriculture		
Trading	114(87.7)	16(12.3)
Artisan	66(50.8)	64(49.2)
Hired labour	54(41.5)	76(58.5)
Transporter	29(22.3)	101(77.7)

Source: Field survey, 2018.

From Table 4, 78.5% of the respondents reported that the income derived from their livelihood activities decreased and worse off as a result of burning of farmland. .Furthermore, 71.5% of the respondents affirmed that their housing facilities remain unchanged even in the mist of bush burning activities. In terms of dwellers assets, majority (46.2%) reported that their assets are gradually declining .Also the majority (73.9%) of the respondents recorded that banking savings worse off. 89.2%, 91.5%, and 90.0% respectively of the respondents attested to the fact that household food grain stocked, affordability of food items and access to food items improved. it was revealed that majority (42.3%) of the respondents reported that access to health facility remains unchanged while 45.4% of the respondents affirmed that there is frequent respiratory infection. In addition, it was reported that 43.1%, 47.7%, 57.7%, respectively of the respondents attested that level of other disease/infection, dependency in medication; numbers of days unable to work due to sickness were worsen off in the study area . Furthermore, it was revealed that majority (42.3%) of the respondents reported that access to health facility remains unchanged while 45.4% of the respondents affirmed that there is frequent respiratory infection. In addition, it was reported that 43.1%, 47.7%, 57.7%, respectively of the respondents attested that level of other disease/infection, dependency in medication; numbers of days unable to work due to sickness were worsen off in the study area.

Table 4: Household Livelihood Security of the Respondents in Agaie LGA

Variable	Improved	Unchanged	Declined	Worse-off
Household Livelihood Security				
i Economic Security				
Income derived from livelihood activity	25(19.2)	1(0.8)	2(1.5)	102(78.5)
Current housing facility	34(26.2)	93(71.5)	2(1.5)	1(0.8)
Current value of asset	28(21.5)	40(30.8)	60(46.2)	2(1.5)
Bank saving rate	0(0.0)	26(20.0)	8(6.2)	93(73.9)
ii Food Security				
Household food grain stocked	116(89.2)	11(8.5)	2(1.5)	1(0.8)
Affordability of food items	119(91.5)	9(6.9)	2(1.5)	0(0.0)
Access to food items	117(90.0)	10(7.7)	3(2.3)	0(0.0)
iii Health security				
Access to health facility	8(6.2)	23(17.7)	55(42.3)	44(33.8)
Frequency of respiratory infection	36(27.7)	3(2.3)	32(24.6)	59(45.4)
Level of other diseases/infection	56(43.1)	1(0.8)	25(19.2)	48(36.9)
Dependency in medication	62(47.7)	2(1.5)	23(17.7)	43(33.1)
Number of days unable to work due to sickness	75(57.7)	2(1.5)	20(15.4)	33(25.4)

Percentage in parenthesis

In summary, table 5 shows that the level of household livelihood security was low with more than half proportion of the respondents (53.8%) recorded low level while 46.2% of the respondents recorded high level of household livelihood security.

Table 5: Level of Household Livelihood Security of Respondents in Agaie LGA

Level	Frequency	Percentage
High	60	46.2
Low	70	53.8
Total	130	100.0

.

Table 6 revealed that majority (62.3%) of the respondents accepted the fact that bush burning resulted into destruction of agricultural product and produce. Also. The Table further shows that majority (100%) of the respondents agreed to the statement that bush burning resulted into destruction of soil structure. it was revealed that 61% of the respondents believed that bush burning result to environmental pollution in the study area while100% accepted the fact that bush burning contributed to respiratory diseases in the study area. it was revealed by majority (100%) that bush burning resulted into destruction of wildlife/Non-wild animal in the study area .

Table 6: Perceived Effect of Bush Burning by the Respondents in Agaie LGA

Variable	Major (%)	Minor (%)	None (%)
Destruction of agricultural product	81(62.3)	43(33.1)	6(4.6)
Destruction of soil structure	130(100)	0(0)	0(0)
Pollution of environment	79(61)	51(39)	0(0.0)
Causes respiratory diseases	130(0)	0(0)	0(0)
Destruction of wildlife/ Non-wild animal	130(0)	0(0)	0(0)

Percentage in parenthesis Source

Table 7 revealed a significant relationship between effects of bush burning and livelihood activities. The p-value is ≤ 0.05.

Table 7: Spearman correlation coefficient for relationship between effect of bush burning and livelihood security

Variable	r-value	p-value	Decision
Livelihood activities and Livelihood security	-0.318	0.000	S

DISCUSSION

Majority (99.2%) of the respondents were into crop farming. This implies that majorities are into crop farming operation. This is in line with Kamanga *et al* (2009) who reported that agriculture as a sector is dominated by small holding crop farming families, with most of them residing in rural area. Hunting was another occupation engaged by 56.2% of the respondents in the area. This could be attributed to the fact that more than half engaged in bush burning to drive out animal such as rodents, wild rabbits, cane rat etc. from the wild. This is in agreement with Gnado (2004) who observed that farmers use fire to hunt for games or bush meats despite its widely acclaimed long-term devastating effects on the environments. 25.45% of the respondents are fully involved in grazing in the study area. This implies that few respondents engaging in this activity are doing it on temporary bases.

Household livelihood securities of the respondents were operationalized on three key indices (Economic security, Food Security, Health security). Majority (78.5%) of respondents reported that the income derived from their livelihood activities decreased and worse off. This could be attributed to the fact that bush burning destroyed the nutrients in the soil which could result into low productivity. This is in agreement with the findings of Wilkinson and Boulding, (2003) that estimated net annual bush fire losses for N, P and K in a similar study in northern region of Ghana .Furthermore, 71.5% of the respondents affirmed that their housing facilities remain unchanged even in the mist of bush burning activities. This unchanged could be directly link to the fact that their farmlands are far from their homes, therefore did not have any effect on the facilities. This implies that bush burning do not cause destruction to their buildings. Also the majority (73.9%) of the respondents recorded that banking savings worse off. This could be as a result of longer proximity to the bank from/to the study area. This could be concluded that the respondents in the study area do not use banks. 89.2%, 91.5%, and 90.0% respectively of the respondents attested to the fact that household food grain stocked, affordability of food items and access to food items improved. This implies that their main occupation of the dwellers is farming and there is enough food for consumption in the study area. This is in agreement with Ekong (2010) who reported that rural dweller in Nigeria having farming as their major livelihood activity and also in agreement with Falusi and Adeleye (2002), who reported agriculture has the main occupation of 75% of people in most developing nation. Furthermore, it was revealed that majority (42.3%) of the respondents reported that access to health facility remains unchanged while 45.4% of the respondents affirmed that there is frequent respiratory infection. In addition, it was reported that 43.1%, 47.7%, 57.7%, respectively of the respondents attested that level of other disease/infection, dependency in medication; numbers of days unable to work due to sickness were worsen off in the study area. This could be linked to the fact that bush burning spread air borne diseases easily.

The level of household livelihood security was low with more than half proportion of the respondents (53.8%) recorded low level. This implies that bush burning contributed negative to the household livelihood security most especially in the area of economic activities and their health conditions. Majority (87.7%) of the respondents were traders. This implies that trading was a major non-agricultural activity of the respondents in the study area. This could also be attributed to the fact that the respondents in the study area engaged in trading to sell or dispose their farm produce. Transportation business was reported as livelihood activity engaged

by 22.3% of the respondents in the study area. This is an indication that the few people engaging in this business were assumed to be responsible for movement of farm produce with their vehicles from farm gate to market spots.
The effect of bushing revealed that majority (62.3%) reported that bush burning resulted into destruction of agricultural product and produce. This is in line with Izah *et, al. (2017)* who reported destruction as an adverse impact of bush burning on the un-harvested crops on farmlands. This implies that bush bushing could retarding agricultural production of the nation if not properly manage. All the respondents (100%) believed that bush burning resulted into destruction of soil texture while they also reported that bush burning led to respiratory diseases in the area as reported by all the respondents interviewed in the study area.

It was revealed that 61% of the respondents believed that bush burning result to environmental pollution while majority (100%) reported that bush burning resulted into destruction of wildlife/Non-wild animal in the study area. This is an indication that bush burning is hazardous and could destroy the environment resources if drastic actions are not taken to halt the effect. There is significant relationship between livelihood activities and effect of bush burning. This is an indication that the nature of livelihood activities of the dwellers contributes to the bush burning activities and it effect in the study area.

CONCLUSION

From the result of this study, it shows that larger percentage of the respondents were into agricultural activities than non-agricultural activities. Farming was the major agricultural activities of the respondents while trading is the non-agricultural activities engaged by majorities of the dwellers in the study. The result further revealed that bush bushing contributed negatively to the sources of income of the dwellers as well as their health status. The rate of diseases such as respiratory and other air borne diseases/infections increased in the study area resulting into the dweller depending on constant medication for survival. The livelihood activities were reported to influence the livelihood security of the respondents in the study area.

Recommendation

This following are the recommendation made base on the findings of this study.

i. Agricultural extension agent should be empowered, in other to guide and enlighten the farmer on cultivation strategies that can be best adopt base on the activities of the respondents.
ii. Appropriate and correct farming methods should be made available by the government for land clearing which will reform their attention from bush burning.
iii. Educating farmers on extension service to educate the farmer on effect of bush burning and there environmental health and livelihood activities.

REFERENCES

Adetunji, M. J. A and Onumadu, F. M. (2005). “A survey of fire incidents in the High Forest and Plantation areas of Oyo, Ogun and Ondo States of Nigeria”. Paper presented at the workshop on forest fires: Ecology and Environment at FRIN HQ, Ibadan 10th – 12th October, 2005.

Andersson M, Michelsen A, Jensen M, and Kjoller A (2004), “Tropical savannah woodland: effects of experimental fire on soil microorganisms and soil emissions of carbon dioxide. *Soil Biology & Biochemistry* 36: 849-85

Ekong E. (2010): Rural Development in Nigeria. An introduction to rural sociology. Dove education publisher, Uyo, Akwa Ibom State. 13 (1).

Falusi AO, Adeleye IOA(2002). Agriculture Science for Senior Secondary School. Book 1. Onibonoje Press and book industry Nigeria Limited. Ibadan. PP-1-40

Frankenberger, T., and McCaston, M. (1999): Rapid Food and Livelihood Security Assessment:

A comprehensive approach for diagnosing nutritional security. Overcoming malnutrition in developing countries, Overseas Publishers Association, Amsterdam.

Gnado J. (2004). “GIA/NABIO Agro forestry development organization”.GNADO Report Bolgatanga. Ghana For.Res. 1:21-25.

Hamid, A and Usman, L & Elaigwu, S.E. and Zubair, Marili. (2010). Environmental and health risk of bush burning. *Advances in Environmental Biology*. 4. 241-249.

Isah, A. D. and Adegeye, A. O. (2002). “Effects of burning on soil properties and growth of Gmelina arborea seedlings in a savanna ecosystem”. *Journal of Agriculture and Environment 3(2). Pp 349-357*

Kamanga, P., Vedeld P. and Sjaastad, E. (2009). Forest income and rural livelihood in Chiraszulu District, Malawi. Ecological Economics, 68(3), 613-624

NPC (National Population Commission). (2006). Population Census Data Niger State, Nigeria: "Official Gazette, National and State Provisional Totals Census". Federal Republic of Nigeria. Printed and Published in 2007.

Lindenberg, M. (2002): Measuring Household Livelihood Security at the Family and Community Level in the Developing World. University of Washington, Seattle, WA, USA World Development 30 (2): pp. 301-318

Wilkinson, K. and Boulding, M (2003) “Stand structure, fuel loads, and fire behavior in riparian and upland forests”, Sierra Nevada Mountains, USA; a comparison of current and reconstructed conditions. *Forest Ecology* and *Management*, 262: 215-25.

Wilkinson, M.T., Chappell, J., Humphreys, G.S., Fifield, K., Smith, B. and Hesse, P. (2005). Erratum for soil production in heath and forest, Blue Mountains, Australia: influence of lithology and palaeo climate. Earth Surface Processes and Landforms 30: pp 1683-1685.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adeoye et al., 2019

CONTRIBUTION OF PALM OIL PROCESSING ENTERPRISE TO HOUSEHOLD WELFARE IN ODIGBO LOCAL GOVERNMENT AREA ONDO STATE NIGERIA

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BSRACT

This study was carried out in Odigbo Local Government Area of Ondo state to assess the contribution of palm oil processing enterprise to household welfare. A multistage sampling procedure was used for sample selection with a 30% purposive selection of wards from 11 wards in Odigbo LGA. Random sampling was used to select 50% of palm oil processors from 240 processors from 10 communities in the 3 selected wards respectively making a total of 120 respondents. A well-structured questionnaire was used for data collection and data was analyzed with descriptive and inferential statistics. The findings of the study revealed that most of the respondents (66.7%) were male, majority of respondents (38.3%) within the age range of 31 and 40, and 82.5% were married. Based on the findings, the result revealed that respondents' involvement in palm oil enterprise does not correlate with household welfare (r = 0.390, p>0.05). The result further revealed that other livelihood activities have correlation with household welfare (r = 0.263, p<0.05). In conclusion, most of the respondents diversified into other livelihood activities which are invariably responsible for their household welfare. Also paucity of funds and credit facility were major challenges encountered by the processors. Therefore, the input of extension services is needed to motivate and encourage the palm oil entrepreneurs to visit relevant research institutes for latest innovation on processing methods and they should also be assisted in sourcing credits facility from relevant agencies to improve their production for better welfare system.

Keywords: Contribution, Palm-oil, Enterprise, Household, Welfare

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is a perennial crop believed and accepted to have originated from West Africa (Obahiagbon, 2012). It spreads to South America in the 16th century and to Asia in the 19th century (Olagunju, 2008). In the recent decades, the domestic consumption of palm oil in West Africa has increased rapidly than its production, and has now become a net importer of palm oil (Olagunju, 2008). Oil palm is deemed to be of great economic importance especially when considering household welfare issues. There are many enterprises being derived from oil palm due to involvement of rural dwellers in its production, processing, palm kernel extraction, broom making, palm kernel oil business, palm kernel cake and sales/marketing. However, Nigeria was one of the leading exporters of crude palm oil in the 1960s but has now become a net importer to bridge the increasing domestic demand gap (Yusuf, 2018).Thus Nigeria's expedient goal is to meet the domestic demand, and if possible seeks to become competitive in the export markets. Nigerian palm oil production is potentially competitive in domestic markets to enhance the overall economic development through income and employment effects in rural and urban economics. Palm oil has many uses. It is used as a source of energy in livestock feed, manufacturing of detergents, cosmetics, shoe polish, candle sticks and for other domestic/ nutritive purposes (Abdeltawab and Khattab, 2018). According to Hartley (1998) Nigeria used to produce a large proportion of palm oil for sale in the world market. It was a dominant source of foreign exchange for Nigeria before Indonesia and Malaysia took over (Omoti, 2003). The fortunes of Nigeria plunged as a result of the discovery of crude oil and this has caused a major decline in the processing of palm oil in Nigeria. There are indications that promotion of private sector participation in oil plantation holds the ace in effective revival of the produce business in the country. Despite several research efforts on improved processing methods for palm oil over the years, there are still myriads of challenges like inadequate finance, insufficient oil palm kernel fruits, and lack of effective processing techniques among rural processors (Ajani *et al*., 2012). These challenges encountered among others are major factors that affect production, supply of palm oil and poor welfare of the rural processors. Therefore, this study seeks to evaluate contribution of palm oil processing enterprise to household welfare in Odigbo Local Government Area, Ondo State. The specific objectives were to examine the socio-economic characteristics of respondents, ascertain the extent of involvement of the respondents in palm oil enterprise, identify other livelihood activities of respondents apart from palm oil enterprise, and assess the constraints encountered by respondents in the study area to assess the contribution palm oil business to welfare of the people. The hypotheses for the study are as follows; $H_0 1$: there is no significant relationship between the extent of involvement in palm oil enterprise and household welfare and $H_0 2$: there is no significant relationship between other livelihood activities of respondents and household welfare.

MATERIALS AND METHODS

Study area

The study was carried out in Odigbo Local Government Area, Ondo state. Ondo state is geographically located in the Southwestern Nigeria with 7°5′ N 5°5′E coordinates. The state comprises 18 Local Government Areas of which Odigbo is one. However, the state has the total land area of 15,500 km² and population of about 3,460,877 (NPC, 2010). It falls in the tropical climate and belongs to equatorial rainforest vegetation belt. It has an average rainfall of 1,524 mm annually with the rainy season lasting for 8 months from April to November, and the temperature range between 24 °C and 31 °C with average of 27 °C, and average humidity of 73% annually (Adeleke and Olabode, 2017). Odigbo Local Government selected for the study has land area of about 1,836.878 km² and population of 232,287 (NPC, 2010). There are eleven (11) wards in the study area, which are Ago-Alaye, Oniparaga, Ayesan, Araromi-Obu, Koserun, Ore, Ejija, Agbabu, Odigbo,Ajue, and Onisere. The major occupation of the people in the state is cultivation of permanent crops such as cocoa, kolanut and also practices of agroforestry whereby plantain and oil-palm are interplanted with arable crops.

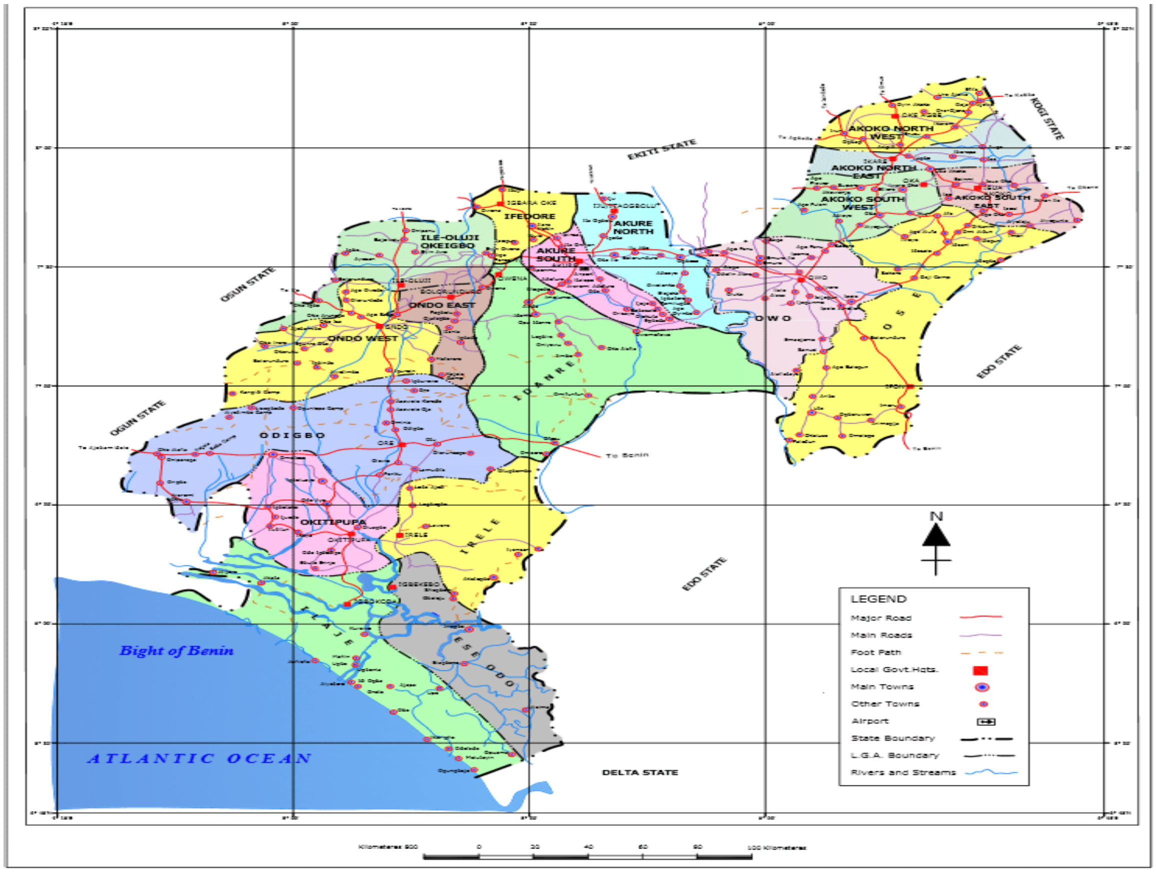

Figure 1: Map of Ondo State Showing Odigbo Local Government Area
Source: Owolabi and Aderinola (2014).

Research Design

A multistage sampling procedure was used for sample size selection. Purposive sampling was used to select 30% of the wards from Odigbo LGA. These were Oniparaga, Ago-Alaye and Araromo-Obu comprising 10 communities notable for palm oil production respectively. A random sampling was used to select 50% of 240 processors from the communities making a total of 120 respondents as sample size. A well-structured questionnaire was used for data collection.

Data Analysis

Data from the study were analyzed with both descriptive (frequencies and percentages) and inferential statistics (Pearson Product Moment Correlation).

RESULTS

Socio-economic characteristics of the Respondents

Table 1 reveals that majority of the respondents (66.7%) were males. The table also shows that majority of the respondents (38.4%) are between the ages of 31-40 years. The table reveals that 82.5% of the respondents are married signifying the majority. The table reveals that 53.3% of the respondents have secondary education. The table further reveals that most of the respondents (43.3%) have farming as the primary occupation. The table shows that the majority (71.7%) of respondents were producing palm oil below 1000 kg.

Table 2 reveals that majority of the respondents (65.0%) were into oil palm plantation while 49.2% of the respondents were involved in harvesting of oil palm fruits from the plantation. Furthermore the table reveals that 53.3% of the respondents were involved in the sales of oil palm products.

Table 3 reveals that majority of the respondents (72.5%) were into trading. The categorization of respondents based on their involvement in other livelihood activities reveals that most of the respondents (66.7%) were highly involved other livelihood activities.

Table 1: Respondents distribution of personal characteristics (N= 120)

Variable	Frequency	Percentage
Gender		
Male	80	66.7
Female	40	33.3
Total	**120**	**100**
Age		
21-30	5	4.2
31-40	46	38.3
41-50	30	25.0
51-60	20	16.7
>60	19	15.8
Total	**120**	**100**
Marital status		
Single	13	10.8
Married	99	82.5
Divorced	4	3.3
Widow(er)	4	3.3
Total	**120**	**100**
Education		
Non-formal	24	20
Primary	18	15
Secondary	64	53.3
Tertiary	14	11.7
Total	**120**	**100**
Primary occupation		
Farming	52	43.3
Artisan	22	18.3
Civil servant	21	17.5
Trading	25	20.9
Total	**120**	**100**
Tonnage capacity (kg)		
≤1000	86	71.7
1001-2500	24	20.0
>2500	10	8.3
Total	**120**	**100**

Source: Field survey, 2015

Table 2: The Extent of involvement of respondents in palm oil enterprise (N= 120)

Statements	**Always Frequency (%)**	**Sometimes Frequency (%)**	**Never Frequency (%)**
Oil palm plantation	65 (54.2)	51 (42.5)	4 (3.3)
Harvesting palm fruits	59 (49.2)	49 (40.8)	12 (10.0)
Sales of oil palm products	64 (53.3)	53 (44.2)	3 (2.5)
Sorting of palm fruits for sales	53 (44.20)	36 (30.0)	31 (25.8)
Farm labour and processing	53 (44.2)	33 (27.5)	34 (28.3)
Possess local processing facility palm oil production	42 (35.0)	37 (30.8)	41 (34.2)

Table 3: Other livelihood activities of the respondents (N= 120)

Other livelihood activities	Yes Frequency (%)	No Frequency (%)
Arable crop farming	82 (68.3)	38 (31.7)
Livestock rearing	48 (40.0)	72 (60.0)
Trading	87 (72.5)	33 (27.5)
Hired labour	30 (25.0)	90 (75.0)
Food vendor	12 (10.0)	108 (90.0)
Civil service	45 (37.5)	75 (62.5)
Transport business	17 (14.2)	103 (85.8)

Note: Percentages in parentheses

Table 4 reveals that 48.3% of the respondents identified inadequate finance as a very severe constraint to the processing of palm oil. The result further showed that54.2% of the respondents signified that inadequate credit facility was a serious challenge in the processing of palm oil in the study area.

Table 4: Constraints associated with palm oil processing enterprise

Constraints	Not severe Frequency (%)	Severe Frequency (%)	Very severe Frequency (%)
Inadequate finance	21(17.5)	41 (34.2)	56 (48.3)
Inadequate credit facility	7 (5.8)	48 (40.0)	65 (54.2)
Shortage of labour	8 (6.7)	50 (41.7)	62 (51.7)
Lack of agricultural inputs	20 (16.7)	26 (21.7)	74 (61.7)
Poor power supply	19 (15.8)	13 (10.8)	88 (73.3)
Poor access to poverty alleviation program	7 (5.8)	31 (25.8)	82 (68.3)
Buyers who buy on credit	24 (20.0)	26 (21.7)	70 (58.3)
Low patronage by buyers	21 (17.5)	43 (35.8)	56 (46.7)

Note: Percentages in parentheses

Table 5 revealed that there is no significant relationship level of involvement in palm oil enterprise and household welfare ($r = 390$, $p>0.05$). Table 6 revealed that there is a significant relationship between other livelihood activities of respondents and their household welfare ($r = 0.263$, $p< 0.05$).

Table 5: Pearson product moment correlation (PPMC) analysis distribution

Variable	r-value	p-value	Decision
Level of involvement in palm oil enterprise Vs Household welfare	0.390	0.254	Not significant
Other livelihood activities Vs Household welfare	0.263	0.004	Significant

DISCUSSION

Socio-Economic Characteristics of the Respondents in the Study Area

The socio-economic characteristics of the respondents indicate that males were more involved in palm oil processing than females in the study area. This result does not corroborate with the submission of Nwankwo (2016) that women are more involved in palm oil processing in South-East Nigeria. This finding also contradicts the submission of Ali *et al*. (2009) that food processing is mostly practiced by women. The high number of respondents within the age bracket of 31 and 40 could be an indication that youth who are active and are in their productive years dominate the business. This finding corroborates with the work of Anzanku *et al*. (2006) that oil palm processors are in the active youthful age. The distribution also shows that majority of the respondents are married. This corroborates with the submission of Atibioke *et al*. (2012) that most rural dwellers are married with high sense of responsibility. The table reveals that majority of respondents have secondary education. This implies that palm oil processing exclusion business of the illiterates but the involvement of educated people could influence their level of production. This is in agreement with the view of Erhabor and Emokaro (2007) that the output of educated processors tends to be higher than if than if they are not educated. The table shows that the majority of respondents were producing palm oil below 1000kg. This implies that majority of the processors lack necessary machines for large volumes of production.

Extent of Involvement of Respondents in Palm Oil Enterprise

The result of the study revealed that respondents were involved in different aspect of oil palm production processes. Some were into oil palm plantation, some were involved in harvesting of fruits from plantation, and others in processing. Furthermore the result reveals that most of the respondents were also involved in the sales of oil palm products. This implies that most respondents were involved in various aspects of oil palm production activities which are profitable in all ramifications. This finding is in line with the submission of Nwalieji and Ojike (2018) that most respondents in Anambra State were involved in different aspects of palm oil production processes.

Other Livelihood Activities of the Respondents

The result in table 3 revealed that majority of the respondents was into trading. This implies that many of the respondents are into other livelihood activities other than palm oil processing business. The study further reveals that most of the respondents were highly involved other livelihood activities such as arable crop farming and trading. This is an indication that the respondents diversified into other means of livelihood due to paucity of funds and poor access to credit facility for the palm oil processing business. This corroborates with the submission of Reardon *et al*. (2001) that occupational diversification is associated with higher and stable income for sustainable welfare throughout the year.

Constraints Associated with Palm Oil Processing Enterprise

The result of the study showed that most of the respondents identified inadequate finance as a very severe constraint to the processing of palm oil. It further revealed that poor power supply, poor access to poverty alleviation program, lack of agricultural input probably have great consequence on processing of palm oil. The distribution also reveals that majority of the respondents signify that they experienced serious challenges in the processing palm oil. This implies that palm oil processing business among the household encountered high severity of constraints. This finding corroborates with the submission of Nwalieji and Ojike (2018) that insufficient funds and poor incentives were severe constraint encountered by the processors in Anambra State.

CONCLUSION

The findings showed that palm oil processing enterprise was dominated by male. The respondents were active and productive middle aged young people with production capacity below 1000kg. They were involved in various aspects of production processes. The respondents also diversified into other livelihood activities like crop farming and trading due to paucity of funds and poor access to credit facility.

Recommendation

The input of extension services is needed to motivate and encourage the palm oil processors to visit relevant research institutes for latest innovation on processing methods and they should also be assisted in sourcing for credit facility from government and other relevant credit agencies to improve their production for sustainable welfare system.

REFERENCES

Abdeltawab, A.M. and Khattab, M.S.A. (2018). Utilization of Palm Kernel Cake as a Ruminant Feed for Animal: A Review. *Asian Journal of Biological Sciences*. 11 (4): 157-164.

Adeleke, E.A. and Olabode, A.O. (2017). Statistical Analysis of Rainfall Trend in Akure, Ondo

State, Nigeria. *Analele University din Oradea Seria Geographie.* 1:114-121

Ajani, E.N., Onwubuya, E.A. and Nwalieji, H.U. (2012). Assessment of Oil Palm Production and Processing among Rural Women in Enugu North Agricultural Zone of Enugu State Nigeria. *International Journal of Agricultural Sciences*. 2 (12): 322-329.

Ali, J., Singh, S.P., and Ekanem, E. (2009). Efficiency and productivity changes in the Indian food processing industry: Dererminants and policy implications. *International Food and AgribusinessManagement Review*.; 12 (1). 43-66

Anzanku, H., Abiniku, O.E., Azayaku, E.O. and Yohana, J.K. (2006). Socioeconomic analysis of small scale of oil palm fruit processors in Nasarawa State. *Proceedings of the* 46^{th} *Annual Conference of Agricultural Society of Nigeria*. 141- 144

Atibioke, O.A., Ogunlade, I., Abiodun, A.A., Ogundele, B.A., and Ade, A.R. (2012). Effects of farmers' demographic factors on adoption of grain storage technologies developed by Nigerian Stored Products Research Institutes: A case study of selected villages in Ilorin West LGA of Kwara state. Journal of Research on Humanities and Social Science. 2 (6). 56-64

Erhabor, P.O. and Emokaro, C.O. (2007). Economic importance of cassava. In cassava the white gold. Erhabor, P.O., Azaiki, S.S. and Ingawet, S.A. (Eds). Initiative Publication Company. Pp 18

Hartley, CW.S. (1998). The Oil palm. The third edition, Harlow, England. Longman.

National Population Commission, NPC (2010). Federal Republic of Nigeria 2006 Population and Housing Census: Population Distribution by Sex, State, Local Government Area and Senatorial Districts. Accessed at URL www.catalog.ihsn.org>download

Nwalieji, H.U. and Ojike, H.U. (2018). Characteristics of Small-scale Palm Oil Production Enterprise in Anambra State. *Journal of Agricultural Extension*. 22 (11): 22-34.

Nwankwo, E.C. (2016). Women in Palm Oil Processing in South-East Nigeria: Challenges and Prospects in Dwindling Economy. *Journal of Development and Agricultural Economics*. 8 (11): 251-259.

Obahiagbon, F.I. (2012). A Review: Aspects of African Oil Palm (*Elaeis guineensis* jacq.) and the Implications of its Bioactives in Human Health. *American Journal of Biochemistry and Molecular Biology*. 2 (3): 106-119.

Olagunju, F.I. (2008). Economics of Palm Oil processing in Southwestern Nigeria. International Journal of Agricultural Research. 1 (2). 69-77

Omoti, U. (2003). The Oil palm in Nigeria. Paper presented to the regional group on Palm Oil sector development. Organized by the United Nations International Development Organization, UNIDO, 16^{th} – 19^{th} December, 2003, Akosombo, Ghana.

Owolabi, T.A. and Aderinola, O.S. (2014). Geotechnical Evaluation of Some LateriticSoils in Akure Southwestern Nigeria. *EJGE Journal*. 19. (2014), Bund. R. 6675-6687

Reardon,T., Berdegue, J., and Escobar, G. (2001). 'Rural non-farm employment and incomes in Latin America: Overview and Policy Implications'. World Development. 29 (3). 395-409

Winters, P., Davies, B., and Corral, L. (2001). Assets, activities, and income generation in rural Mexico: Factoring in social and public capital. Paper prepared for the Food and Agricultural Organization Regional Office for Latin America and Caribbean. Social capital and rural livelihood strategies in Latin America. Accessed at URL ftp://ftp.fao.org.dorcep/fao/007

Yusuf, V.A. (2018). Nigeria's Palm Oil Deficit Worth $800 Million Making Import Inevitable. *Excerpt in Daily Trust Newspaper 2018*. Retrieved July 2019 from *https://www.pressreader.com>nigeria*

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Omokhua et al., 2019

INFLUENCE OF PRE-GERMINATION TREATMENTS ON GERMINATION AND EARLY SEEDLINGS GROWTH OF *Carapa procera*

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ABSTRACT

This study was carried out at the Forest Nursery of the Department of Forest and Wildlife Management, Faculty of Agriculture, University of Port Harcourt Nigeria. It assessed the effect of pre-germination treatments on seed germination and early seedling growth performance of Carapa procera. The experiment was laid out in a completely randomized design involving analysis of variance. Duncan multiple range test (DMRT) at (P<0.05) was used for mean separation. The treatments used were: hot water soaking (5 minutes), mechanical scarification, cold water soaking (24 hours) and the control. A total of 600 seeds were used for germination (i.e. 150 seeds per treatment). Observations on germination were recorded daily for six weeks on germination emergence, duration and percentage. A total of 80 seedlings were used i.e. 20 seedlings of uniform height at two (2) leaves stage for each treatment were transplanted into polypots, Evaluation of early seedling growth was done for four months based on height, collar diameter and leaf number. Highest Germination percentage was observed in mechanically scarified seeds (94%) and lowest in control seeds (56%). Earliest emergence and duration was observed in mechanically scarified seeds (5 and 4 days respectively) and latest in control (21.67 and 29.33 days respectively). A significant effect ($p \leq 0.05$) was observed in all growth parameters at all stages of growth. Mechanically scarified seeds produced the highest performance for all growth parameters studied followed by control when compared to the other pre-treatment methods. It is recommended that seeds of Carapa procera be mechanically scarified before sowing. Although other treatments can be used to enhance germination, they may not be required for seedling growth since seedlings from untreated seeds produced higher growth parameters after scarification treatment.

Keywords: *Carapa procera*, pre-treatments, germination, early seedling growth

INTRODUCTION

Carapa procera DC is a genus of flowering plants in the Mahogany family Meliaceae (Orwa *et al.*, 2009). It is commonly known in Nigeria as Agogo (Yoruba), Irere (Benin), Nkwo (Igbo), crabwood and bastard mahogany (English). (Orwa *et al.*, 2009). It is a deciduous or semi-evergreen tree that grows up to 35m tall. The bole is straight and cylindrical, branchless up to 20m and 100cm in diameter, bark is light grey to greyish brown or dark brown. Young plants produce taproots, but the tree tends to become surface rooted. Leaves are alternate, with dormant glandular leaflet at the apex, pinnate leaves are usually 6-9 pairs on a stalk. Flowers are small, whitish in colour. According to an article from Agroforestry.org entitled *Carapa procera* (*C. grandiflora*) *Meliaceae* (n.d), the fruits cracks open into 5 pairs when it falls to the ground releasing 12-20 smooth seeds each 3cm, shiny dark brown in colour and angular in shape.

Carapa procera oil is one of the most sold medicinal oils; it is used to repel mosquitoes, can be formed into paste and applied topically to protect the body from mosquito bites (Miot *et al.*, 2004). The wood is mainly used for high quality furniture and cabinet work, stairs and flooring and as veneer for furniture, interior work and plywood. It is also used as building materials. In Columbia, shoemakers prefer it for making shoe pieces (Kenfack and Peréz 2011).

Experiences have shown that lack of technical knowledge on how to improve propagation or germination for this species with hard seed coat, presents a major hindrance to nursery operators and farmers wishing to grow these species. Dormancy is an obstacle to the germination of sown seeds and may be caused by physical or physiological factors. According to Finch-Savage and Leubner-Metzger, 2006) “Seed dormancy could be considered simply as a block to the completion of germination of an intact viable seed under favourable conditions”. This phenomenon has necessitated the need to device a means of breaking it through pre-treatment. To ensure uniform and rapid germination of any seed, the cause of the dormancy must be identified and removed before the seed is sown (Adedire *et al.,* 2008). Pre-germination treatment has helped farmers as well as silviculturists to hasten germination of their seeds and obtain a more increased productivity.

The world’s forests play an important role in maintaining fundamental ecological processes as well as providing livelihood and supporting economic growth (FAO, 2014). However, the over-exploitation of forest resources has endangered tree species including *Carapa procera*. Secondly, there is inadequate knowledge of silvicultural techniques for *Carapa procera,* because the seeds are recalcitrant. The slow process of natural regeneration of many tropical species and the threat of extinction makes it necessary to develop the silvicultural technique for the species. This study has provided information on silvicultural techniques for regeneration of the species. The objective of this study was to determine the effect of four (4) pre-treatment methods which included: hot water (5 minutes), mechanical scarification, cold water (24 hours) and a control (no treatment) on germination and early seedlings growth of *Carapa procera.*

MATERIALS AND METHODS

Study site

The study was carried out at the nursery site of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt on Latitudes 4.90794 and 4.90809 N and Longitudes 6.92413 and 6.92432 E in Obio/Akpor Local Government Area of Rivers State (Chima *et al.,* 2017).

Fruit Collection and Seed Processing

The fruits of *Carapa procera* were harvested from ‘plus’ trees in an arboretum in a natural lowland rainforest in Benin City, Edo State, Nigeria. The seeds were extracted manually. The processed seeds were subjected to viability test through floatation method, the seeds that floated after minutes of soaking were considered unviable and discarded while those that sank were used for the study.

Experimental Design and Treatment Procedure

Seed Germination

The completely randomized design (CRD), involving 4 treatment with 3 replicates was used ~~in~~ for the study. The pre-germination treatments involved soaking seeds of *Carapa procera* in hot water (5 minutes), mechanical scarification, (using nail cutter) cold water (24 hours) and a control. A total of six hundred (600) seeds *were* used for the experiment at 150 seeds per treatment and 50 per replicate. Pre-treated seed were sown in germination trays, filled with washed and sterilized river sand to prevent damping off and the germination trays were placed inside a propagator to conserve moisture. The trays were monitored and watered daily in the morning to maintain adequate moisture content. Germination was assessed to have occurred at the point of radicle emergence on the soil medium. Germination of seeds lasted for six (6) weeks.

Data collected on germination was used to calculate germination percentage (GP), germination emergence (GE) and germination duration (GD) for each treatment using the formulae below.

$$GP = \frac{Number\ of\ germinated\ seeds}{Number\ seeds\ sown} * \frac{100}{1}$$

GE = Seeds germination time after sowing.

GD = period of germination emergence to the end of germination.

Where:

GP = Germination Percentage

GE = Germination emergence

GD = Germination duration

Seedlings Growth Performance

For each treatment, 20 seedlings of uniform height at two (2) leaves stage were transplanted into polypots filled with topsoil from forest floor. Each of the polypots was taken as a replicate of its own. A total of 80 seedlings were used. Seedlings were watered daily and measured immediately after transplanting and monthly thereafter for five (5) months. Seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a digital calliper while leaf production were determined by directly counting the number of leaves.

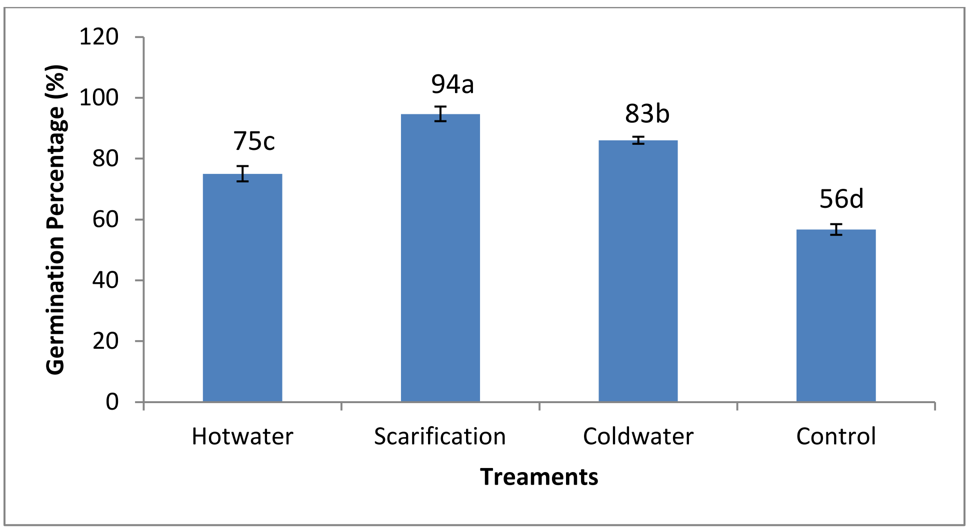
Data Analysis

Data collected on germination and early seedling growths were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). Analysis of variance was carried out to test the effect of treatments on seeds and seedlings of *Carapa procera*. .Duncan Multiple Range Test (DMRT) (at $p \leq 0.05$ level of significance) was used for means separation.

RESULTS

Effect of pre-treatments on germination percentage of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed germination percentage. The mean germination percentage varied from 56 to 94% (Figure 1). Mechanically scarified seeds exhibited highest germination percentage (94%), followed by seeds immersed in cold water (83%), seeds immersed in hot water (75%) while control exhibited lowest germination percentage (56%).

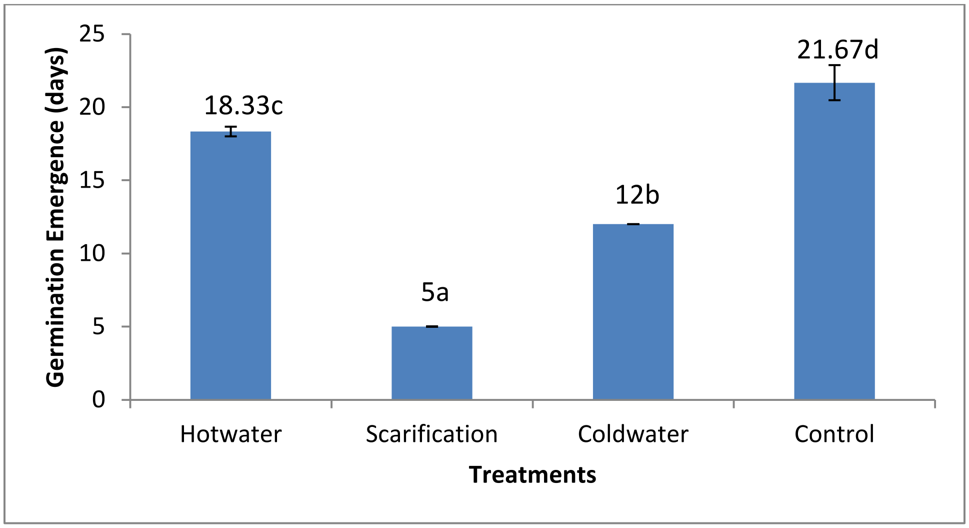


Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 1. Effects of seed pretreatment on germination percentage of *Carapa procera.*

Effect of pre-treatments on germination emergence of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed emergence. The number of days which pre-treated seeds of *Carapa procera* took to emerge after sowing was earliest in mechanically scarified seeds (5 days) when compared to seeds immersed in cold water (12 days), seeds immersed in hot water (18.33 days) and control (21.67 days) as presented in Figure 2.

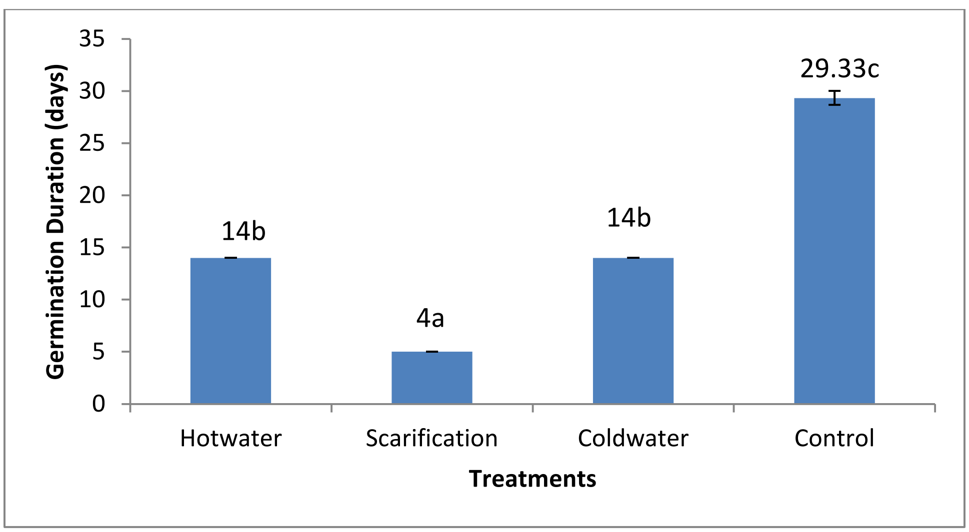


Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 2. Effects of seed pre-treatment on germination emergence of *Carapa procera.*

Effect of pre-treatments on germination duration of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed germination duration. Mechanically scarified seeds exhibited lowest germination duration (4 days) followed by seeds immersed in cold water and hot water (14 days) while control had highest germination duration(29.33 days). Summary of this result is presented in Figure 3.



Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 3. Effects of seed pre-treatment on germination Duration of *Carapa procera.*

Effect of pre-treatments on seedling height (cm) of *Carapa procera*

Seedlings of *Carapa procera* displayed significant differences ($p \leq 0.05$) in height from 1 to 6 months of growth in the nursery. Overall mean seedling height after 1 to 6 months varied from 9.89 cm at month 1 to 25.56 cm at month 6 (Table 1). Mechanically scarified seedlings exhibited highest height at 1 to 6 months (15.83, 16.56, 19.72, 21.61, 23.61 and 25.56cm respectively) while control and cold water treated seedlings had lowest height at month 1 and 2 (9.89 and 11.92 cm respectively) and hot water treated seedlings at month 3 to 6 (12.87, 15.24, 16.92, 18.93cm respectively) (Table 1).

Table 1. Effect of seed pre-treatment on mean seedling height (cm) of *Carapa procera*

	Seedling height (cm)					
Treatments	**HT1**	**HT2**	**HT3**	**HT4**	**HT5**	**HT6**
Hot water	10.98a	12.13a	12.87a	15.24a	16.92a	18.93a
Scarification	15.83b	16.56b	19.72b	21.61b	23.61b	25.56b
Cold water	9.91a	11.92a	13.92a	15.93a	17.93a	19.94a
Control	9.89a	11.97a	13.87a	15.88a	17.87a	19.82a
Mean	11.65	12.89	15.09	17.17	19.08	21.06
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
HT1-6 = height of seedlings at month 1 to 6.

Effect of pre-treatments on seedling collar diameter of *Carapa procera*

Seedlings of *Carapa procera* subjected to different pre-treatments displayed significant differences ($p \leq 0.05$) in seedling collar diameter from the first to the sixth month. Overall mean collar diameter after month 1 to 6 months varied from 0.59mm at month 1 to 1.05mm at month 6 (Table 2). Mean Seedling collar diameter was considerable highest in mechanically scarified seedlings at 1 to 6 months (0.82, 0.89, 0.94, 0.95, 0.99 and 1.05 cm respectively) followed by control (0.72, 0.73, 0.78, 0.80, 0.81 and 0.90 cm respectively) and lowest in hot water-treated seedlings (0.59, 0.61, 0.63 0.70, 0.74 and 0.86 cm respectively) (Table 2).

Table 2. Effect of seed pre-treatment on mean seedling collar diameter (cm) of *Carapa procera*

	Seedling collar diameter (cm)					
Treatments	**CD1**	**CD2**	**CD3**	**CD4**	**CD5**	**CD6**
Hot water	0.59a	0.61a	0.63a	0.70a	0.74a	0.86a
Scarification	0.82c	0.89c	0.94c	0.95b	0.99b	1.05b
Cold water	0.66ab	0.68ab	0.77b	0.77a	0.80a	0.87a
Control	0.72b	0.73b	0.78b	0.80a	0.81a	0.90a
Mean	0.70	0.73	0.78	0.80	0.84	092
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.012

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
CD1-6 = Collar Diameter at I month to 6 months

Effect of pre-treatments on seedling leaf number of *Carapa procera*

Significant variations ($p \leq 0.05$) were also observed for number of leaves among pre-treatments throughout the stages of growth. Overall mean leaf number after 1 to 6 months ranged from 2.78 at month 1 to 7.22 at month 6 (Table 3). Highest leaf number after 1 to 6 months was observed in mechanically scarified seedlings (3.22, 4.22, 4.72, 6.00, 6.78 and 7.22 respectively) while lowest leaf number at month 1 to 3 was observed in cold water-treated seedlings (2.78, 3.44 and 3.78 respectively) and month 4 to 6 in hot water treated seedlings (4.00, 4.81 and 5.00 respectively) (Table 3).

Table 3. Effect of seed pre-treatment on mean seedling leaf number of *Carapa procera*

	Seedling leaf number (cm)					
Treatments	**LN1**	**LN2**	**LN3**	**LN4**	**LN5**	**LN6**
Hot water	3.00a	3.72ab	3.83a	4.00a	4.81a	5.00a
Scarification	3.22b	4.22b	4.72b	6.00b	6.78a	7.22bc
Cold water	2.78a	3.44a	3.78a	4.72ab	4.83a	5.33ab
Control	2.94a	4.00ab	4.28ab	5.22c	6.58b	7.00c
Mean	2.99	3.85	4.15	4.99	5.36	5.89
P value	0.001	0.051	0.004	<0.001	<0.001	<0.001

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
LN1-6 = number of leaves at month 1 to 6.

DISCUSSION

Several studies have shown that different methods of pre- treatments can enhance germination rate and speed up germination process (Hossain *et al.*, 2005). The result of this study shows that there were significant variation ($p \geq 0.05$) among pre-treatments in seed germination percentage, germination emergence and germination duration. Germination started on the fifth day after sowing in scarified seeds and lasted for four weeks in control seeds. Mechanical scarification also exhibited lowest germination durations and highest germination percentage when compared to other treatments used. According to Azad *et al.*, (2010), nicking is known to break physical dormancy of seeds with hard coats which inhibits water uptake and gases. Missanjo *et al.*, (2014) also noted that earlier germination of nicked seeds is a result of cracks or cuts made on the seed which makes it easier for entry of water and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into seedlings. The highest germination percentage observed in scarified seeds is in agreement with the study carried out by Asinwa *et al.* (2012) who observed increased germination percentage of *Calophylum inophylum* seeds treated with scarification and the findings of Fredrick *et al.* (2016) who noted that mechanically scarified seeds had highest germination percentage in *Faidherbia albida* seeds when compared to other treatments used in the study. Aref *et al.* (2011) and Boltsheleng *et al.* (2014) also observed highest germination percentage in five *Acacia spp* and *Afzelia quanzensis* and *Baikiaea plurijuga* seeds treated with scarification. Higher germination parameters observed in cold water could be attributed to the fact that soaking seeds in cold water before planting helps to break down the seed's natural defence against what it expects from nature which then allows it to germinate faster, boost the moisture content around the seeds, which signals to the seeds that it is now safe to grow. This agrees with the findings of Fredrick *et al.*, (2016) who reported that cold water treatment of *F. albida* gave a fair germination percentage and a reduced mean germination time when compared to hot water treatment and the control.

Hot water treatment also enhanced germination of *Carapa procera* seeds. According to Tadros *et al.* (2011) hot water was the most effective presowing treatment in both *Leucaena leucocephala* and *Acacia farnesiana* species compared to sandpaper scarification and the control. Botsheleng *et al.* (2014) reported that hot water treatment was the best treatment for *B. plurijuga* seeds as it attained the maximum germination percentage (100%) and noted that this could be attributed to the weak seed coat of the species. According to Mwase and Mvula (2011), hot water treatment of seeds makes the seed coats permeable to water and the seeds imbibe and swell as the water cools. Poor germination parameters observed in the control treatment is an indication that seeds of this species need to be pre-treated to enhance its germination. Amusa, (2011) and Falemara *et al.*, (2013) noted that the control exhibited longer germination commencement period in *Afzelia africana* and *Adansonia digitata* respectively when compared with other treatments used in their studies. This also conforms to the report by Iroko *et al.* (2013) on the germination of *Vitellaria paradoxa* which showed that the seeds of the species needed to be pre-treated to enhance germination. The result of this study is in conformity with the statement by Luna *et al.*, 2009 that 'the conditions necessary to allow seeds to break dormancy and germinate can be highly variable among species, within species or among seed sources of the same species' with respect to the parameters measured

Pre-treatments significantly affected all growth parameters (seedling height, collar diameter and leaf number) at all stages of growth. Mechanically scarified seeds produced the highest performance for all growth parameters studied (seedling height, collar diameter and number of leaves growths) followed by the control when compared to the other pre-treatment methods. This is the best method that could be used to enhance growth of *Carapa procera* seeds. According to Missanjo *et al.*, 2014, fast growth of *Acacia polyacantha* seedlings from nicked seeds occurred because seedlings from nicked seeds had an advantage of absorbing much water and started the photosynthetic process much faster than others. Seed germination is the most important stage that affects earlier seedling growth and establishment (Tian *et al.* (2014).This result agrees with that of Karaguzel *et al.* (2004) and Missanjo *et al.* (2014) who observed that nicking produced the highest performance for all growth parameters studied in seeds of *Lupinus varius and Acacia polyacantha* respectively.

Higher collar diameter and leaf number produced by the control implies that although *Carapa procera* seeds may require pre-treatment to enhance germination, it does not need to be pre-treated to enhance early growth characteristics. Lowest seedling growth parameters observed in hot water is an indication that hot water treatment is detrimental to the growth of *Carapa procera* seedlings. This finding is contrary to that of Omokhua *et al.*, 2015 who reported that hot water treatment exhibited higher growth parameters when compared to the control in *Maesobotrya barteri* seedlings.

CONCLUSION

The result obtained in this study revealed that pre-germination treatments significantly enhanced the germination process of *Carapa procera* seeds. As the seed coat of *Carapa procera* is hard, it takes more time to germinate with lower germination percentage. However, effective pre-sowing treatments can ensure successful germination. The pre-treatment of *Carapa procera* seeds using scarification was the best treatment that enhanced germination of the seeds and growth of seedlings. Although other treatments can be used to enhance germination, they may not be required for seedling growth since seedlings from untreated seed produced higher growth parameters after scarification treatment.

REFERENCES

Adedire, M.O. and Oladoye, A.O. (2008). Seed and Forest Nursery Technology**.** A lecture note; University of Agriculture, Abeokuta, 1-36.

Amusa, T.O. (2011). Effects of three pre-treatment techniques on dormancy and germination of seeds of Afzelia Africana (Sm. Ex pers). *Journal of Horticultural and Forestry*, 3(4): 96–103. http://www. academicjournals.org/jhf.

Aref, I.M., Ali, H., Atta, E., Al-Shahrani, T. and Ismail, A. (2011). Effects of seed pretreatment and seed source on germination of five *Acacia spp. African Journal of Biotechnology*, 10(71): 15901–15910. doi:10.5897/AJB11.1763

Asinwa, I.O, Ojo, A.R, Ezekiel, J.M., Awosan, E., Olaitan, A.O. and Akanmu, O.O. (2012). Pre- treatment effects on the germination of the seeds of *Calophyllum inophyllum* [Linn] (Indian Laurel). *Journal of Agriculture, Forestry and Social Science*, 10(1): 165–171. doi:10. 4314/joafss.v10i1.15

Azad, S., Al-Musa, Z. and Martin, A. (2010). Effect of pre-sowing treatments on seed germination of *Melia azedarach*. *Journal of Forestry Research*, 21(2):193–196.

Botsheleng, B., Mathowa, T. and Mojeremane, W. (2014). Effects of pre-treatments methods on the germination of Pod mahogany (afzelia quanzensis) and mukusi (baikiaea plurijuga) seeds. *International Journal of Innovation Research in Science, Engineering and Technology* 3(1): 8108–8113. *Carapa procera* (*C. grandiflora*) *Meliaceae* (n.d). Retrieved from http://www.worldagroforestry.org/usefultrees/pdflib/Carapa_procera_UGA.pdf

Chima, U.D., Etuk, E.C. and Fredrick, C. (2017). Effects of sowing depths on the germination and early seedling growth of different seed sizes of *Annona muricata* L. *African Journal of Agriculture, Technology and Environment*, 6(2): 134-144

Falemara, B.C., Nwadike, C. and Obashola, E.O. (2013). Germination response of baobab seeds (Adansonia Digitata L) as influenced by three pre-treatment techniques. In: Forest industry in a dynamic global environment: Proceedings of the 35th Annual Conference of Forestry Association of Nigeria, Sokoto, Sokoto state, pp 44–55

Finch-Savage, W.E. and Leubner-Metzger, G. (2006). Seed dormancy and the control of germination. *New Phytologist*, 171(3): 501-523. http://dx.doi.org/10.1111/j.1469-8137.2006.01787.x

Fredrick, C., Muthuri, C., Ngamau, K. and Sinclair, F. (2016). Provenance and pretreatment effect on seed germination of six provenances of *Faidherbia albida* (Delile) A. Chev. *Agroforestry Systems*, 91(6): 1007-1017. doi:10.1007/s10457-016-9974-3.

Food and Agriculture Organization (2014). State of the World's Forest: Enhancing the Socioeconomic benefit from fruits. Rome. E-ISBN 978-92-5-108270-6

Hossain MA, Arefin MK, Khan BM, Rahman MA (2005). Effects of seed treatments on germination and seedling growth attributes of Horitaki (Terminalia chebula Retz.) in the nursery. *Research Journal of Agriculture and Biological Science*, 1(2):135–141

Iroko, O.A., Asinwa, I.O., Kareem, A.A. and Kasim-Ibrahim, F. (2013). Pre treatment effects on seed germination of *Vitellaria paradoxa* (Gaertn) Hepper. *Journal of Agricultural Science*, 3(4):121–125. http://www.scholarly-journals.com/SJAS

Karaguzel, O., Cakmakci, S, Ortacesme V. And Aydinoglu B. (2004). Influence of seed coat treatments on germination and early seedling growth of *Lupinus varius* L. *Pakistan Journal of Bot*any, 36(1): 65-74.

Kenfack, D. and Peréz, Á.J. (2011). Two new species of Carapa (Meliaceae) from western Ecuador. *Systematic Botany*, 36(1): 124-128.

Luna, T., Wilkinson, K. and Dumroese, R.K. (2009). Seed germination and sowing options. In: Dumroese RK, Luna T, Landis TD (eds) Nursery manual for native plants: A guide for tribal nurseries—Volume 1: Nursery management. Agriculture Handbook, vol 730. Department of Agriculture Forest Service, Washington DC, pp 133–151.

Miot, H.A., Batistella, R.F., Batista, K.D.A., Volpato, D.E.C., Augusto, L.S.T., Madeira, N.G., ... & Miot, L.D.B. (2004). Comparative study of the topical effectiveness of the andiroba oil (Carapa guianensis) and DEET 50% as repellent for Aedes sp. *Revista do Instituto de Medicina Tropical de São Paulo*, 46(5): 253-256.

Missanjo, E., Chioza, A. and Kulapani, C. (2014). Effects of different pretreatments to the seed on seedling emergence and growth of *Acacia polyacantha*. International Journal of Forestry and Research, doi:10.1155/ 2014/583069

Mwase, W.F. and Mvula, T. (2011). "Effect of seed size and pre-treatment methods of *Bauhinia thonningii* Schum. on germination and seedling growth," *African Journal of Biotechnology*, 10(26): 5143–5148.

Omokhua, G.E., Aigbe, H.I. and Uko, I.J. (2015). Effect of pre-treatments on germination and early seedling growth of *maesobotrya barteri*. *International Journal of Scientific & Engineering Research*, 6(3): 921-925

Orwa C, Mutua. A, kindt R, Jamnadass R, Simons.A. (2009).Agrofestree Databases. A tree reference and selection guide version 4.0. (http://www.worldagrofestry.org/af/treedb/). (Retrieved 20/02/2017).

Tadros, M. J., Samarah, N.H. and Alqudah, A.M. (2011). Effect of different pre- sowing seed treatments on the germination of *Leucaena leucocephala* (Lam.) and *Acacia farnesiana* (L.) New Forests. 42: 397-407.

Tian, Y., Guan, B., Zhou, D., Yu, J., Li, G. and Lou, Y. (2014). "Responses of seed germination, seedling growth, and seed yield effect of seed size traits to seed pre-treatment in Maize (Zea mays L.)," *The Scientific World Journal*, 2014: 8,

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Omokhua et al., 2019

GERMINATION AND SEEDLING GROWTH RESPONSE OF *Aframomum melegueta* K. SCHUM TO DIFFERENT PRE-TREATMENTS

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ABSTRACT

An experiment was carried out to check the effect of pre-treatments on germination and early seedlings growth of Aframomum melegueta at the Department of Forestry and Wildlife Management of University of Port Harcourt. The research seeks to investigate the effect of pre-germination treatment on seeds of A. melegueta. The treatments used were Hydrogen peroxide (10 minutes), Cold water (24 hours), Methylated spirit (10 minutes), warm sand at 45^{o}C (30 minutes), Nicking and Control. The experimental design was the completely randomized design (CRD) while analysis of variance (ANOVA) was used to test the effect of treatments on seeds and seedlings of A. melegueta. Result from this study indicated that in nicked seeds germination started 11days after sowing while it was 14 days after sowing in hydrogen peroxide treated seeds. Germination duration was lowest in hydrogen peroxide treated seeds (28.67 days) and highest in seeds buried in warm sand (36.33 days) while germination percentage was lowest in nicked seeds (56%) and highest in seeds soaked in cold water (92.67%). Seedlings of A. melegueta subjected to different pre-treatments displayed significant differences ($P \leq 0.05$) in all growth parameters at all stages of growth. Seedlings in warm sand exhibited the greatest seedling height, collar diameter and leaf number while seeds soaked in methylated spirit displayed lowest seedling height and leaf number; and seedlings treated with hydrogen peroxide had the lowest collar diameter. It was observed that seeds of these species did not exhibit dormancy. However, to enable optimum, rapid, uniform germination and good growth, it is recommended that the seeds of A. melegueta should be pre-treated before sowing.

Keywords*: Aframamum melegueta*, pre-treatment, germination, seedling growth.

INTRODUCTION

Aframamum melegueta commonly called alligator pepper is a species in the ginger family, *Zingiberaceae* (Obike *et al.,* 2014). According to Ajayi *et al.*, 2016, the species is native to the tropics and commonly found in swampy habitats of Nigeria, Uganda, Angola, Benin, Gambia, Ghana, Guinea, Cote d'Ivoire (Ivory Coast), Liberia, Sierra Leone, Togo, Cameroon, Congo, Gabon and Guinea-Bissau in West Africa and as far as the Democratic Republic of the Congo and is also widely cultivated in other parts of tropical Africa and South America. It has a tufted leafy stem that grows up to 1.5m high; the leaves are simple, alternate and lanceolate and can grow as long as 40cm and 12cm-15cm wide when mature (Ajayi *et al.,* 2016). It produces purple-coloured flowers which develop into pods as long as 8cm and about 3cm wide. A pod can contain about 300 reddish-brown seeds (Anjah *et al.*, 2015).

The seed looks like cardamom in appearance and pungent and are reddish-brown in colour (Umukoro and Aladeokin, 2011). They are also used for alleviating stomach ache and diarrhoea as well as hypertension, as an aphrodisiac and against measles and leprosy (Kokwaro, 1993). They are taken for excessive lactation and post-partum haemorrhage and are used as purgative, anthelmintic and haemostatic agent (Dzoyem *et al.*, 2017). The seeds contain 1-2% essential oil with a typical odour (Ajaiyeoba and Ekundayo, 1999).

Dormancy is an obstacle to the germination of sown seeds and may be caused by physical or physiological factors. Physical dormancy is as a result of hard impervious seed coat which prevents water and oxygen from entering the embryo, an underdeveloped embryo or some combination of these factors. Dormancy results in irregular germination of seeds and consequently resulting in production of nursery stock of varying ages and sizes. This phenomenon has necessitated the need to device a means of breaking dormancy through seed pre-treatment (Adedire and Oladoye, 2008). Dormancy in seeds can be broken naturally by mechanical abrasion by rocks in the soil, changes in the environmental conditions around the seed, that is, alternate thawing and freezing or in some cases, bacterial action while some artificial methods include the use of hot water, cold water, hydrogen peroxide, tetraoxosulphate IV acid (H_2SO_4), mechanical scarification using knife, plier, sandpaper, pin file, nail cutter, hammer etc. (Schmidt, 2007). Pre-germination treatment has helped silviculturist as well as farmers to hasten germination of their seeds, obtain a more even germination as well as increase productivity. (Ajiboye *et al.*, 2009).

The species is endangered due to deforestation. Forest loss is occurring throughout Africa, knowing that this species is found commonly in the tropical rain forest, this suggests that loss of forest habitat will affect the population of this species. Secondly, seed dormancy is a serious problem of the species in the nursery. Based on the problem mentioned above, there is need as to what can be done to develop an effective propagation technique for its regeneration. The study on the germination and early seedling growth of *A. melegueta* can provide some information on its biology for regeneration and conservation; this justifies the need for the study. The objective of this study was therefore to determine the effect of different pre-treatment methods on germination and early seedlings growth of *A. melegueta.*

MATERIALS AND METHODS

Study Location

The research was carried out at the nursery site of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt which lies on Latitudes 4.90794 and 4.90809 N and Longitudes 6.92413 and 6.92432 E in Obio/Akpor Local Government Area of Rivers State (Chima *et al.*, 2017).

Fruit Collection and Seed Processing

The fruit was collected from the swampy forest research station of the Forestry Research Institute of Nigeria (FRIN) Benin city, Edo State, Nigeria which lies between latitudes 6°11 to 6°29 N and longitude 5°33 to 5°47 (Erhabor, 2015). The seeds were extracted manually. The processed seeds were subjected to viability test through floatation method, the seeds that floated after ten minutes of soaking were considered unviable and discarded. The seeds that sank were collected and regarded as viable seeds used for the study.

Experimental Design and Treatment Procedure

The Completely Randomized Design (CRD), involving 6 treatments with 3 replicates was used in this study. The pre-germination treatments involved soaking seeds of *A. melegueta* in hydrogen peroxide (10 minutes (T_1), cold water (24 hours) (T_2), methylated spirit for (10 minutes) (T_3), burying in warm sand at 45^oC (30 minutes) (T_4), Nicking (T_5), and control (untreated) (T_6). A total of one thousand eight hundred (1800) seeds of *A. melegueta* were used for the experiment at 300 seeds per treatment. Pre-treated seeds were sown in germination trays, filled with washed and sterilized river sand to prevent damping off and were placed inside a propagator to conserve moisture, maintain the temperature of about 36^{0}C and to protect the plants from rodent attack. The trays were monitored and watered daily in the morning to maintain adequate moisture content. Germination was said to have occurred when the plumule emerged from the soil surface.

Early Seedlings Growth

For each treatment, 20 seedlings of uniform height at two (2) leaves stage were transplanted into 20 polypots with each of the polypots taken as a replicate of its own. The polypots were filled with forest topsoil and organic manure in the ratio of 5:1. A total of 120 seedlings were used. Seedlings were watered daily and measured immediately after transplanting and bi-weekly thereafter.

Data Collection

Germination

Germination count was taken daily until no more germination occurred (50 days). Data collected on germination was used to calculate germination percentage (GP), germination emergence (GE) and germination duration (GD) for each treatment using the formulae below.

Germination Percentage (GP) = $\frac{Number\ of\ germinated\ seeds}{Number\ seeds\ sown} * \frac{100}{1}$

Germination emergence (GE) = time to germinate after sowing.

Germination duration (GD) = period of germination emergence to the end of germination.

Early seedling growth

Data was collected on early seedlings growth parameters for twelve (12) weeks. Seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a digital calliper while leaf and tiller production were determined by directly counting the number of leaves and tillers.

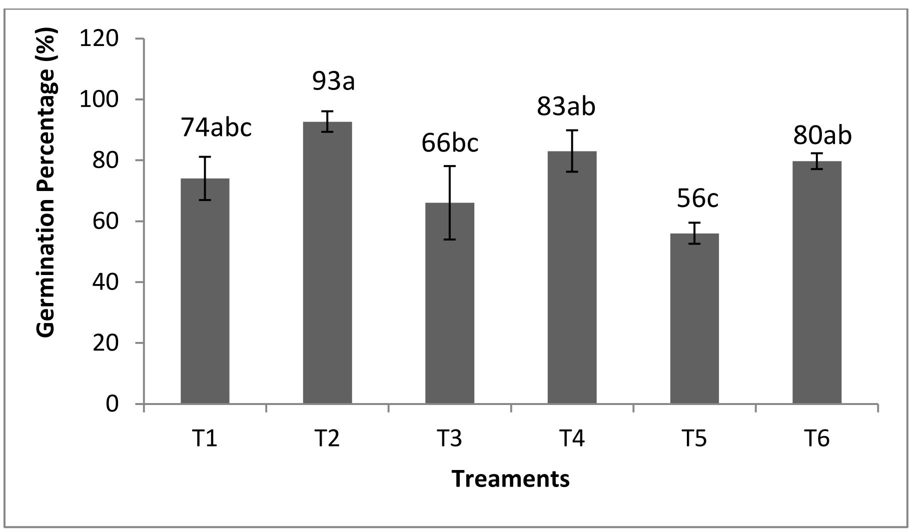
Data analysis

Data collected on germination and early seedling growths were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). Analysis of variance was carried out to test the effect of treatments on seeds and seedlings of *A. melegueta* and Duncan Multiple Range Test (DMRT) at $p \leq 0.05$ level of significance was used for means separation.

RESULTS

Effect of pre-treatments on germination percentage (GP) of *A. melegueta*

The Analysis of Variance (ANOVA) revealed that germination percentage of *A. melegueta* was affected significantly ($p \leq 0.05$) by the pre-treatments applied in the experiment. Seeds in T_2 exhibited the highest germination percentage (93%), followed by T_4 (83%) while seeds in T_5 exhibited lowest germination percentage (56%) followed by T_3 (66%) as shown in Figure 1.

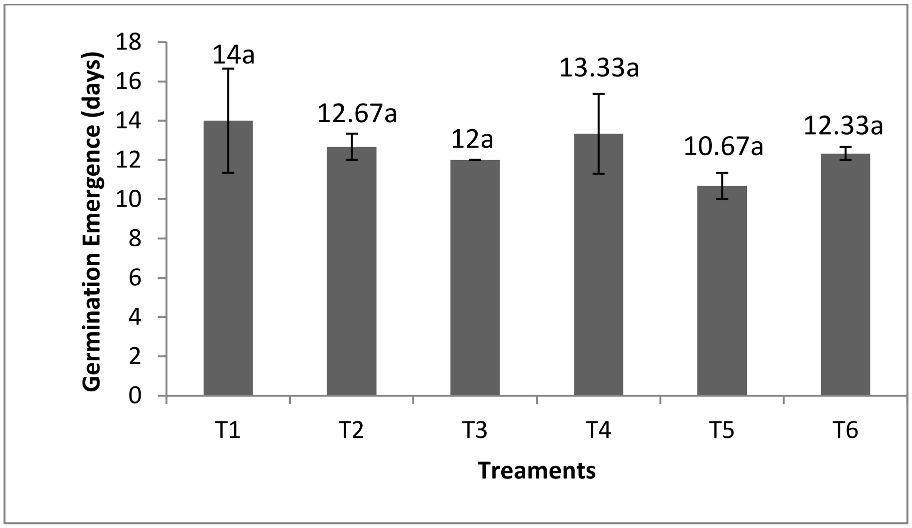


Bars with the same letter (s) are not significantly different at the 0.05 level. Where T_1, T_2, T_3, T_4, T_5 and T_6 correspond to soaking in hydrogen peroxide, soaking in cold water, soaking in methylated spirit, burying in warm sand, nicking, and control respectively

Figure 1. Mean germination percentage of *A. melegueta.*

Effect of pre-treatments on germination emergence (GE) of *A. melegueta*

The results showed that there were no significant differences ($p \geq 0.05$) between the pre-treatments used in the experiment. The number of days in which pre-treated seeds of *A. melegueta* took to emerge after sowing was shortest in T_5 (10.67 days) when compared to T_3 (12 days), T_6 (12.33 days), T_2 (12.67 days) and T_4 (13.33 days) while the longest seedling emergence period was observed in T_1 (14 days) as shown in figure 2.

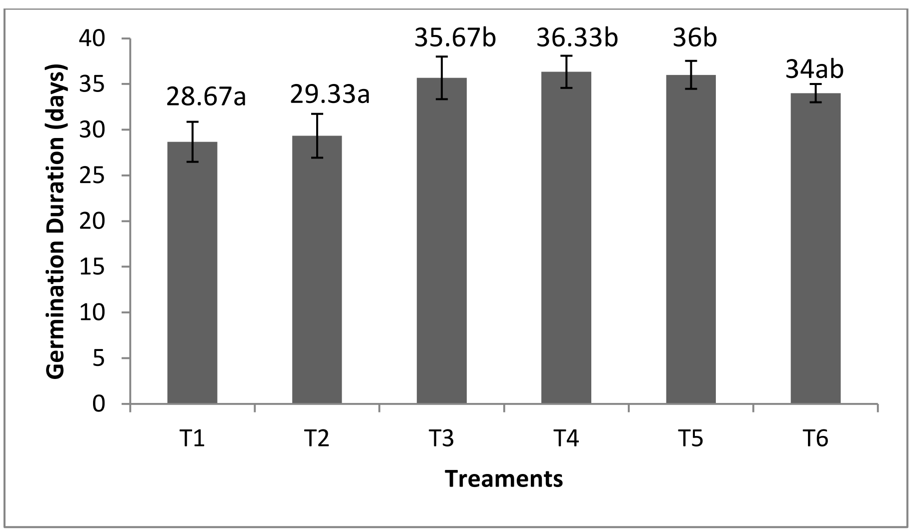


Bars with the same letter (s) are not significantly different at the 0.05 level. Where T_1, T_2, T_3, T_4, T_5 and T_6 correspond to soaking in hydrogen peroxide, soaking in cold water, soaking in methylated spirit, burying in warm sand, nicking, and control respectively.

Figure 2. Mean germination emergence of *A. melegueta.*

Effect of pre-treatments on germination duration (GD) of *A. melegueta*

Seed pre-treatments significantly ($p \leq 0.05$) affected germination duration. Seeds in T_1 exhibited lowest germination duration (28.67 days) followed by seeds in T_2 (29.33 days), T_6 (34 days), T_3 (35.67 days), T_5 (36 days) and T_4 (36.33 days) Summary of this result is presented in Figure 3.



Bars with the same letter (s) are not significantly different at p> 0.05 level. WhereT_1, T_2, T_3, T_4, T_5 and T_6 correspond to soaking in hydrogen peroxide, soaking in cold water, soaking in methylated spirit, burying in warm sand, nicking, and control respectively.

Figure 3. Mean germination duration of *A. melegueta*.

Effect of pre-treatments on seedling height (cm) of *A. melegueta*

Seedlings of *A. melegueta* subjected to different pre-treatments displayed significant difference ($P \leq 0.05$) in height at week 2 - 12 after transplanting. Overall mean seedling height at 2 - 12 weeks varied from 1.43cm at week 2 to 6.03cm at week 12. At week 2, seeds buried in warm sand had highest seedling height (2.22cm), followed by nicked seeds (1.85cm), while hydrogen peroxide treated seeds had lowest seeding height (1.43cm) followed by seeds soaked in cold water (1.54 cm) which was not significantly different from seeds soaked in methylated spirit (1.59cm). At week 4 to 12, highest seeding height was observed in warm sand treated seeds (2.76, 3.05, 5.03, 5.53 and 6.03 cm respectively), followed by nicked seeds (2.22, 2.72, 4.22, 4.72 and 5.22 cm respectively) while lowest height was observed in seeds soaked in cold water (1.90cm) at week 4 and seeds soaked in methylated spirit at month 6 to 12 (2.33, 3.55, 4.05 and 4.550 cm respectively). Summary of this result is presented in Table 1

Table 1. Effect of pre-treatment on mean seedling height (cm) of *A. melegueta* seeds from two to twelve weeks after sowing

Treatment	Seedling Height (cm) (Bi-weekly)					
	2	4	6	8	10	12
Hydrogen peroxide for 10 mins	1.43^{d}	2.17^{b}	2.71^{b}	3.70^{c}	4.20^{c}	4.70^{c}
Cold water (24 hrs)	1.54^{cd}	1.90^{b}	2.52^{bc}	3.60^{c}	4.10^{c}	4.60^{c}
Methylated spirit for 10 mins	1.59^{cd}	1.97^{b}	2.33^{c}	3.55^{c}	4.05^{c}	4.55^{c}
Burying in warm sand at 45^{o}C for 30 mins	2.22^{a}	2.76^{a}	3.05^{a}	5.03^{a}	5.53^{a}	6.03^{a}
Nicking	1.85^{b}	2.22^{b}	2.72^{b}	4.22^{b}	4.72^{b}	5.22^{b}
Control (untreated)	1.72^{bc}	2.14^{b}	2.56^{bc}	4.20^{b}	4.70^{b}	5.20^{b}
Mean	1.72	2.19	2.65	4.05	4.55	5.05
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values in the same column with the same letter (s) are not significantly different at the 0.05 level.

Effect of pre-treatments on seedling leaf number of *A. melegueta*

Seedlings of *A. melegueta* subjected to different pre-treatment displayed significant difference ($P \leq 0.05$) in height at weeks 2 - 12 after transplanting. Overall mean seedlings leaf number varied from 2.50 at week 2 to 7.90 at week 12. At week 2, control had highest seedling leaf number (3.05mm), followed by seeds buried in warm sand (3.00mm) while seeds soaked in methylated spirit had lowest seeding height (2.50mm) followed by seeds soaked in cold water (2.70 mm). At week 4 to 12, highest mean leaf number was observed in seeds buried in warm sand (4.05, 4.90, 5.90, 6.90 and 7.90 respectively) while lowest mean height was observed in seeds soaked in methylated spirit (3.15. 3.60, 5.05, 6.05 and 7.05 respectively) as shown in Table 2.

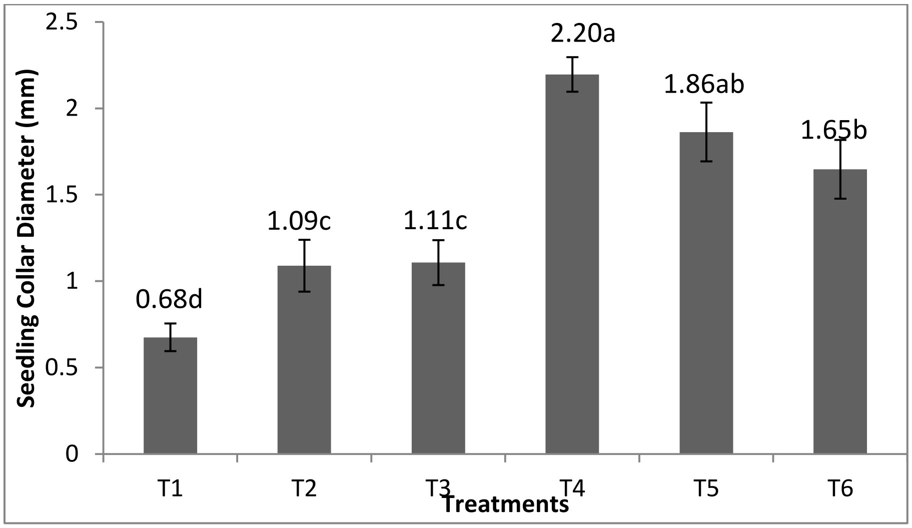
Table 2. Effect of pre-treatment on mean seedling leaf number of *A. melegueta* seeds from two to twelve weeks after sowing

Treatment	Mean Seedling Leaf Number (Bi-weekly)					
	2	4	6	8	10	12
Hydrogen peroxide for 10 mins	2.90^{ab}	3.60^{bc}	4.25^{b}	5.70^{a}	6.70^{a}	7.70^{a}
Cold water (24 hrs)	2.70^{bc}	3.40^{cd}	4.15^{b}	5.45^{ab}	6.45^{ab}	7.45^{ab}
Methylated spirit for 10 mins	2.50^{c}	3.15^{d}	3.60^{c}	5.05^{b}	6.05^{b}	7.05^{b}
Burying in warm sand at 45^{o}C for 30 mins	3.00^{ab}	4.05^{a}	4.90^{a}	5.90^{a}	6.90^{a}	7.90^{a}
Nicking	2.90^{ab}	3.50bc	4.40^{b}	5.75a	6.75^{a}	7.75^{a}
Control (untreated)	3.05^{a}	3.80^{ab}	4.50^{b}	5.80^{a}	6.80^{a}	7.80^{a}
Mean	2.84	3.58	4.30	5.61	6.61	7.61
P-value	0.003	<0.001	<0.001	0.001	0.001	0.001

Values in the same column with the same letter (s) are not significantly different at the 0.05 level.

Effect of pre-treatment on seedling collar diameter (mm) of *A. melegueta* at week 12

The results showed that there was significant difference ($p \leq 0.05$) between the pre-treatments used on *A. melegueta* in the experiment at 12 weeks. Growth in seedling collar diameter was highest in T_4 (2.20mm), followed by T_5 (1.86mm) and lowest in T_1 (0.68mm).



Bars with the same letter (s) are not significantly different at the 0.05 level. Where T_1, T_2, T_3, T_4, T_5 and T_6 correspond to soaking in hydrogen peroxide, soaking in cold water, soaking in methylated spirit, burying in warm sand, nicking, and control respectively.

Figure 4. Mean collar diameter of *A. melegueta* twelve weeks after planting.

DISCUSSION

The six (6) pretreatments including the control were significantly different from each other at 5% level of probability for all parameters except for germination emergence. The range of emergence of *A. melegueta* was between 10.67-14 days. This differed from the results obtained by Omokhua *et al.*, (2015a) who worked on *Maesobytra bateri*; the authors reported a range of 4-22 days. Similarly, Oboho and Igharo (2017) reported a range of 18-31days when *Pycnanthus angolensis* was subjected to pre-germination treatments in the nursery. In addition, Billah *et al.*, (2015) reported a range of 17-28days when *Tectona grandis* seeds were subjected to various pre-germination treatments. The implication of this study is that different forest species respond in various ways to pre-treatments.

Also, duration of germination varied among the 6 pretreatments used on seeds of *A. melegueta* at 5% level of probability. The range of germination duration was 29-36days. Hydrogen peroxide had the best germination performance, with the lowest germination duration of 29days compared to the other pretreatments. This is similar to the work of Omokhua *et al.*, (2015a) and Fredrick *et al.*, (2017) who reported that hydrogen peroxide had the best result on duration of germination in *Maesobytra bateri* (14days) and *Trichilia tessmannii* (7days) respectively compared to other treatments. Also Olatunji *et al.*, (2012) worked on pre-treatments of *Acacia auriculformis* seeds with hydrogen peroxide. The authors reported that hydrogen peroxide treatment was the best with germination duration of 7days. The implication of these findings is that hydrogen peroxide is an effective pre-germination treatment agent for rapid, uniform and maximum propagation of forest species.

The percentage germination of *A. melegueta* was affected by the type of pre-treatments used in this study. Seeds that were treated with cold water had the highest percentage germination, while the least percentage germination was in seeds treated by nicking. This result clearly showed that cold water is an excellent pretreatment for *A. melegueta*. This supports the fact that seed germination is a function of water available to the seeds, the dry dormant seeds absorb moisture by imbibition. This process stimulates the rapid and uniform emergence of the radicle (Hartmann *et al.*, 2002). Billah *et al.*, (2015) observed similar trends with the performance of cold water which had 73.3% germination for *Tectona grandis*. Mabundza *et al.*, (2010) also reported a germination percentage of 71% when cold water was used to treat passion fruit seeds. This result however is contrary to that of Missanjo *et al.*, (2014) and Fredrick *et al.*, 2016 who reported that nicked seeds had highest germination percentage in *Acacia polyacantha* and *F. albida* respectively when compared to other pre-treatment methods used in their study. According to Luna *et al.*, 2009, some necessary conditions which allow seeds to "break" dormancy and germinate can vary greatly among species, within a species, or among seed sources of the same species.

Survival of *A. melegueta* was excellent for all the pretreatments with 100% recorded; this implies that there was no seed mortality after transplanting. This result does not agree with the work of Missanjo *et al.,* (2014). The authors reported a range of seedlings survival percentage of 44.3-97.40% on *Acacia polyacantha* in the nursery.
Seedlings height growth of *A. melegueta* at 12weeks varied from 4.55-6.03cm for the treatments. Seeds treated with warm sand had the highest seedlings growth of 6.03cm. This species is slow-growing compared to a report by Ehiagbanare and Onyibe (2007). The authors reported a range of 18-46cm on seedlings growth of *Tetracarpidum conophorum* at 6weeks. The report is similar to the range of early seedling height growth reported on *Acacia polyacantha* by Missanjo *et al.,* (2014) with 6.46-9.37cm at 12weeks. Also Olatunji *et al.,* (2012) reported early seedling height growth range of 4.61-5.92cm at 4 months after transplanting. However, the implication of this is that the temperature of the warm sand (45^0c) most likely positively affected germination and consequently early growth of *A. melegueta* seedlings.

The study revealed a significant difference at 5% level of probability in leaf production among the treatments which varied from 7.05 in methylated spirit to 7.90 in warm sand. An average of 8 leaves was produced per plant at 12weeks. The mean number of leaves produced monthly was 3 leaves, this is similar to the report by Missanjo *et al.,* (2014), who reported monthly a mean leaf production of 2 leaves in *Acacia polyancatha*. The implication of this study is that the more the leaves, the more the amount of leaf area available for photosynthetic activities, the greater the amount of photosynthate and the higher the growth of the subject forest species. A higher leaf number observed in control seedlings implies that *Aframamum melegueta* seeds do not require much pretreatment to improve in leaf production.

The effect of pretreatments of *A. melegueta on s*eedling collar diameter (mm) revealed significant effect of pretreatment. Warm sand treatment at 45^0C had the highest collar diameter of 2.3mm. The implication of this study is that temperature is important in seed germination and early seedlings growth. Hence, *A. melegueta* seems to have responded well to warm sand treatment in germination and early seedling growth. Several authors have also reported on the different variations recorded on collar diameter in forest species, for instance, Omokhua *et al.,* (2015b) reported a range of 0.48-0.49mm in collar diameter of *Tetrapleura tetraptera*. Similarly Oboho and Igharo (2017) reported collar diameter growth range of 3.51-3.82mm in *Pynacthus angolensis*. Diameter growth is an important characteristic in forest species because it can influence the amount of wood available and can be used to develop growth and yield models. Lowest seedling height and leaf number observed in seedlings treated with methylated spirit is an indication that it does enhance growth in *A. melegueta.* Also, the lowest collar diameter seen in seedlings treated with hydrogen peroxide is an indication that the treatment did not enhance growth in collar diameter of the species.

CONCLUSION

It was observed that seeds of these species did not exhibit dormancy. However, to enable optimum, rapid, uniform germination and good growth, it is important that the seeds of *A. melegueta* are pre-treated before sowing. The pre-treatment of *A. melegueta* seeds using warm sand seems to be the best treatment when compared to other treatments that enhanced germination, seedlings height, seedlings leaf number and collar diameter. This will definitely facilitate availability of seedlings for reforestation and agroforestry projects. Burying seeds in warm sand at 45^0C will be useful to both the local tree planters and silviculturist to break dormancy.

REFERENCE

Adedire, M.O. and Oladoye, A.O. (2008). Seed and Forest Nursery Technology**.** A lecture note; University of Agriculture, Abeokuta, 1-36.

Ajaiyieoba, O.E and Ekundayo, O. (1999). Essential oil constituents of *Aframomum melegueta* (Roscoe), K. Schum. Seeds (alligator pepper) from Nigeria. *Flavor and fragrance Journal*, 14(2): 109-111.

Ajayi, A.O., Fadeyi, T.E. and Olumekun, V.O. (2016). Antimicrobial properties of *Aframomum melegueta* seeds on *Staphylococcus aureus* and *Streptococcus* species. *European Journal of Biomedical and Pharmaceutical sciences*, 3(8): 49-55.

Ajiboye, A.A., Atayese, M.O. and Agboola, D. A. (2009). Effect of presowing treatments on seed germination and percentage starch content levels in Tamarindus indica, Prosopis africana, Parkia biglobossa and Albizia lebbeck. *Journal of Applied Sciences Research*, 5(10): 1515-1519.

Anjah, G. M., Nguetsop, V. F., Tsombou, F.M. and Njoya, M.T.M. (2015). Effect of field capacity of sacred forest soils on regeneration of *Aframomum melegueta* on Western Highlands in Cameroon. *Journal of Horticulture and Forestry*, 7(5): 141-148. DOI: 10.5897/JHF2015.0393. http://www.academicjournals.org/JHF

Billah, M.A.S., Kawsar, M.H., Titu, A.P., Pavel, M.A.A., and Masum, K.M. (2015). Effect of Pre-Sowing Treatments on Seed Germination of *Tectona grandis*. *International Journal of Bioinformatics and Biomedical Engineering*, 1: 37-42.

Chima, U.D., Etuk, E.C. and Fredrick, C. (2017). Effects of sowing depths on the germination and early seedling growth of different seed sizes of *Annona muricata* L. *African Journal of Agriculture, Technology and Environment*, 6(2): 134-144

Dzoyem, J.P., McGaw, L.J., Kuete, V., and Bakowsky, U. (2017). Anti-inflammatory and Anti-nociceptive Activities of African Medicinal Spices and Vegetables. In *Medicinal Spices and Vegetables from Africa* (pp. 239-270). Academic Press.

Ehiagbanare, J.E and Onyibe, H.I.(2007). Effect of pre-sowing treatments on seed germination and seedling growth of *Tetracarpidium conophorun*. *African Journal of Biotechnology*. 6(6):697-698

Erhabor, T. A. (2015). Evaluation of wood wastes from sawmilling operations in Benin City, Edo State. *Journal of Forestry Research and Management*, *12*, 113-124.

Fredrick, C., Muthuri, C., Ngamau, K. and Sinclair, F. (2016). Provenance and pretreatment effect on seed germination of six provenances of*Faidherbia albida* (Delile) A. Chev. *Agroforestry System*, 91(6): 1007-1017. DOI 10.1007/s10457-016-9974-3.

Fredrick, C., Omokhua, G.E. and Chinedu, W.N. (2017). Effects of pre-treatment on seed germination of *Trichilia tessmannii* (Harms) in Nigeria. *Nigerian Journal of Agriculture, food and environment*, 13(2): 90-93.

Hartman, H.T., Davies, F.T., and Geneve, R.L. (2002): Plant Propagation: Principles and Practice. 6th Edition. Publication of Prentice Hall of India. Pp 770.

Kokwaro, J.O. (1993). *Medicinal plants of east Africa*. Ed 2, kenya Literature Bureau.

Luna, T., Wilkinson, K. and Dumroese, R.K. (2009). Seed germination and sowing options. In: Dumroese, R. K., Luna, T. and Landis, T. D. (eds). Nursery manual for native plants: A guide for tribal nurseries Volume 1: Nursery management. Agriculture Handbook 730. Washington, D.C.: U.S. Department of Agriculture, Forest Service. Washington DC. 1: 133-151.

Mabundza, R.M., Wahome, P.K. and Masarirambi, M.T. (2010). Effects of different pre-germination treatment methods on the germination of passion (*Passiflora edulis*) seeds. *Journal of Agriculture and Social Sciences*, 6(3): 57-60.

Missanjo, E., Chioza, A. and Kulapani, C. (2014). Effects of different pretreatments to the seed on seedling emergence and growth of Acacia polyacantha. *International Journal of Forestry Research*. doi:10.1155/2014/583069

Obike, H.I., Ezejindu, D.N. and Akingboye, A.J. (2014). The effects of *Aframomum melegueta* aqueous extract on the adrenal gland of adult wistar rats. *International Journal of Research in Medical and Health Sciences*, 3(6): 1-6. http://www.ijsk.org/ijrmhs.html

Oboho, E.G. and Igharo, B. (2017). Effect of Pre-Germination Treatments on Germination and Watering Regimes on the Early Growth of Pycnanthus Angolensis (Welw) Warb.

Journal of Agriculture and Veterinary Science. 10(3): 62-68

Olatunji, D., Maku, J.O. and Odumefun, O.P. (2012). Effects of pre-treatment on the germination and early seedling growth of *Acacia auriculiformis* Cunn. Ex. Benth. *African Journal of Plant Science*, 6(14): 364-369.

Omokhua, G. E., Aigbe, H. I., & Ndulue, N. B. (2015b). Effect of Pregermination Treatment and Early Seedlings Growth of *Tetrapleura tetraptera*. *International Journal of Scientific and Technology Research*, 4(3): 160-164.

Omokhua, G. E., Aigbe, H. I., & Uko, I. J. (2015a). Effects of Pretreatments on Germination and Early Seedlings Growth of *Maesobotrya bateri*. *International Journal of Scientific and Engineering Research*, 6(3): 921-924.

Schmidt, L. (2007). Tropical Forest Seed: Seed Dormancy and Presowing Treatment. Springer-verlag Berlin Heidelberg. 199-245

Umukoro, S., and Aladeokin, A.C. (2011). Therapeutic Effects of Grains of Paradise (Aframomum melegueta) Seeds. In *Nuts and Seeds in Health and Disease Prevention*. 1st Edition. London, Burlington, San Diego.535-543.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Oyelere et al., 2019

RADIAL AND AXIAL VARIATION IN RING WIDTH OF CARIBBEAN PINE (*Pinus caribaea* MORELET) IN AFAKA PLANTATION, KADUNA STATE, NIGERIA

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ABSTRACT

This paper examines the within tree variation (radial and axial) in Ring Width of Caribbean Pine (Pinus caribaea Morelet) Plantation Grown in Afaka plantation, Kaduna State, Nigeria. Samples of wood used in this study were obtained from different age series of P. caribaea. Fifteen trees were randomly harvested with their total tree height and diameter at breast height (DBH) measured. Discs of 5 cm in thickness were obtained at breast height. Additional bolts of 20 cm for pulping materials were obtained at the base, middle and top of trees sampled among the age series. Each disc was cut at the pith, smoothened and the numbers of rings were counted. Each disc was then divided into sections based on the ring numbers and the ring width were measured and recorded. The result showed that there was radial variation in the ring widths where the rings closest to the pith had the highest mean value of 8.4580±0.24608 mm, 8.3920±0.32679 mm, 6.5560±0.14006 mm at Diameter at Breast Height (DBH), 25% Total Height of Tree (THT) and 50% THT, respectively while the ring width decreases from pith to bark with rings closest to the bark having a mean value of 1.0580±0.10514 mm, 1.0100±0.09187 mm, 1.1940±0.13743 mm at DBH, 25% THT and 50% THT respectively which are significantly different ($p < 0.05$). Axially, there is no variation in the ring width of the growth rings ($p > 0.05$).

Keywords: Silviculture, dendrochronology, growth rate, wood property, wood quality

INTRODUCTION

Variability in wood makes it exhibit certain behaviours that are not favourable for different end uses which affect the quality of the product (Ishiguri *et al.*, 2007; Sharma *et al.*, 2013). Wood is quite variable and a significant portion of variation can be attributed to genetic factor and growing conditions i.e. wood produced by trees of the same species are not identical even when grown under the same or similar conditions (Bown, 2016). Variation in wood characteristics within the individual tree is basically related to changes resulting from ageing of the cambium and modifications imposed on the cambial activity by the environmental conditions, genetical and silvicultural effect (Walter and Menzies, 2010). Uniformity in wood is highly desired as it means the same will display a similar character.

Anatomical properties such as tracheid length and growth characteristics such as growth ring width are one of the most essential tools for understanding tree growth and its reaction to varying climatic settings (Tian *et al.*, 2009). They form the basis for wood anatomy which includes dendroclimatology, dendrochronology, and dendroecology (Sousa *et al.*, 2012). They are valuable instruments in forest management as well as in product manufacturing as they are closely connected with tree growth rate and wood properties (Oluwadare, 2007). This is an indication that information on radial variation pattern of ring width and tracheid length can facilitate tree growth and wood quality in forest management and wood utilization (Anoop *et al.*, 2014; Saravanan *et al.*, 2013). Reports from different research have shown that radial variation in anatomical properties and growth characteristics are caused by both specific environmental factors, forest management practices and within controlled genetic factors (Mmolotsi *et al.,* 2013)

Growth rate, as measured by the width of annual rings, is considered to influence wood density. The width of the growth ring indicates the rate of growth of the tree. When there is fast growth, wider growth rings will be produced than when there is slow growth. The effect of growth ring will indicate in the density of wood (Osadare, 2001). For the growth rate-wood density relationship, different responses among the major tree groups (softwoods, ring-porous hardwoods, diffuse-porous hardwoods) have been recognized (Adamopoulos *et al.*, 2010). Most studies indicate that high wood density in ring-porous hardwoods is associated with fast growth (Shinya and Zhang, 2002). According to Kretschmann and Cramer (2007), the width of earlywood remains fairly constant from year to year while the dense latewood with fewer vessels increases as ring width increases. However, there are some exceptions to this generalization. The first rings near the pith (juvenile wood) do not necessarily follow the above pattern and the proportion of different types of cells might also have a substantial influence on wood density. Ring width was not found to be an accurate indicator of wood density in a number of ring-porous species such as *Quercus falcata*, *Q. nigra*, *Q. stellata*, *Q. suber*, *Carya ovata*, *C. tomentosa* and *C. illinoensis* (Shinya and Zhang, 2002). There were several reports that (annual) ring density decreases with increasing ring width, for instance in Norway spruce (Bouriaud *et al.*, 2015). Wood density was also proved to vary between trees (Guilley *et al*., 2004). The importance of basic density as a sole trait that is often measured in wood cannot be over-emphasized. It is a trait that gives an indication of the relative value of other wood properties such as strength properties, calorific value and pulp properties (Gomez *et al.*, 2010). Ring width has however been acknowledged as a highly variable characteristic, and several major sources of annual density variations (Morling, 2002).

Phenotypic plasticity plays an important role in plant fitness and is especially important in long-lived trees (Chuine and Beaubien, 2010). All pine species grown in Nigeria are grown to provide long fibre pulp to produce pulp and paper as it has been used internationally for this purpose (Oluwadare, 2007). However, due to lack of the non-functional paper mills in Nigeria, its potential to serve this purpose has been jeopardized. Hence, the established plantations are being exploited for timber ~~and~~ in order to ensure the efficient and sustainable utilization of this species. It is, therefore, necessary to investigate the wood properties in meeting the objective of establishment as well as alternative wood utilization. This paper provides information on the radial and axial variation of the ring width of Caribbean Pine with a view of providing information on the suitability of the species for different end-use requirement.

MATERIALS AND METHODS

Study Area

Samples of wood used in this study were obtained from five age series of *P. caribaea* grown in guinea savanna at Afaka, Kaduna Nigeria. Afaka Forest Reserve is situated some 30km N-W of Kaduna township, along Kaduna – Lagos Express Highway road, and is about 12,243.760 hectares in a real extent (Nwadialor, 2001). Afaka Forest Reserve was established in 1954 as an experimental plantation site to increase the productivity and arrest the deterioration and desertification of the semi-arid zone of the Northern Guinea Savannah of Nigeria (Nwadialor, 2001). The Afaka Forest Reserve is situated west of Kaduna on latitude 10°7´N and longitude 7°17´E on 600 m above sea level. Mean annual rainfall is about 1300 mm with daily minimum and maximum temperatures of 18°C and 24°C respectively.

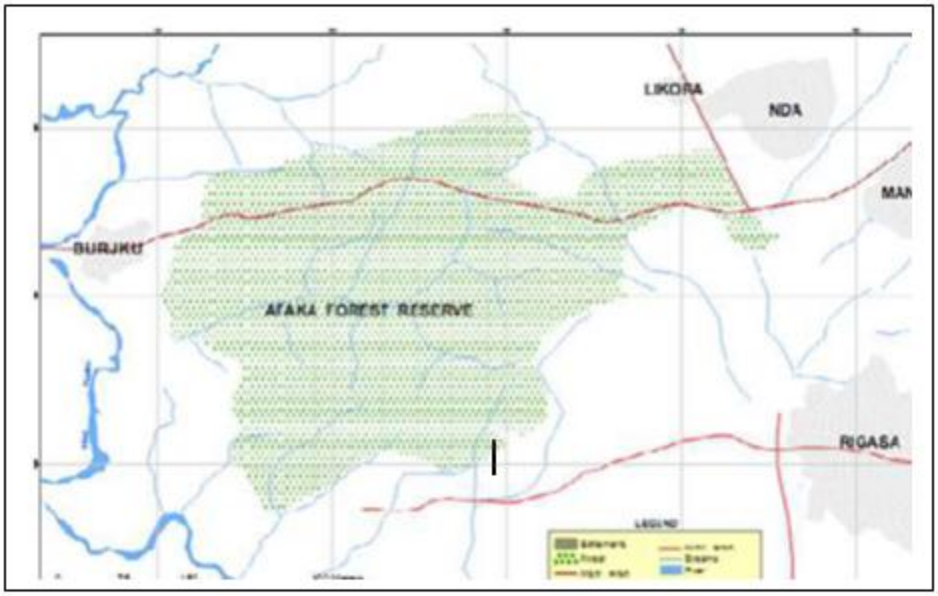


Fig. 1: Map of Afaka Forest Reserve

Source: *Department of Geography, NDA Kaduna*

Sampling Technique

A reconnaissance survey of the plantation was carried out to know the different age series available. The trees were randomly selected from different age series. Fifteen trees were randomly harvested with their total tree height and diameter at breast height measured. Discs of 5 cm in the thickness were obtained at breast height. Additional bolts of 20 cm for pulping materials were obtained at the base (DBH), middle (25% THT) and top (50% THT) of trees sampled in the different age series (Fig. 2). The experimental design adopted for the study is a Completely Randomized Design (CRD) and data obtained were subjected to Analysis of Variance at $\alpha_{0.05}$.

The following variables of the sample trees were measured:

(a) Diameter at breast height over bark (DBH)

(b) Total tree height (TH)

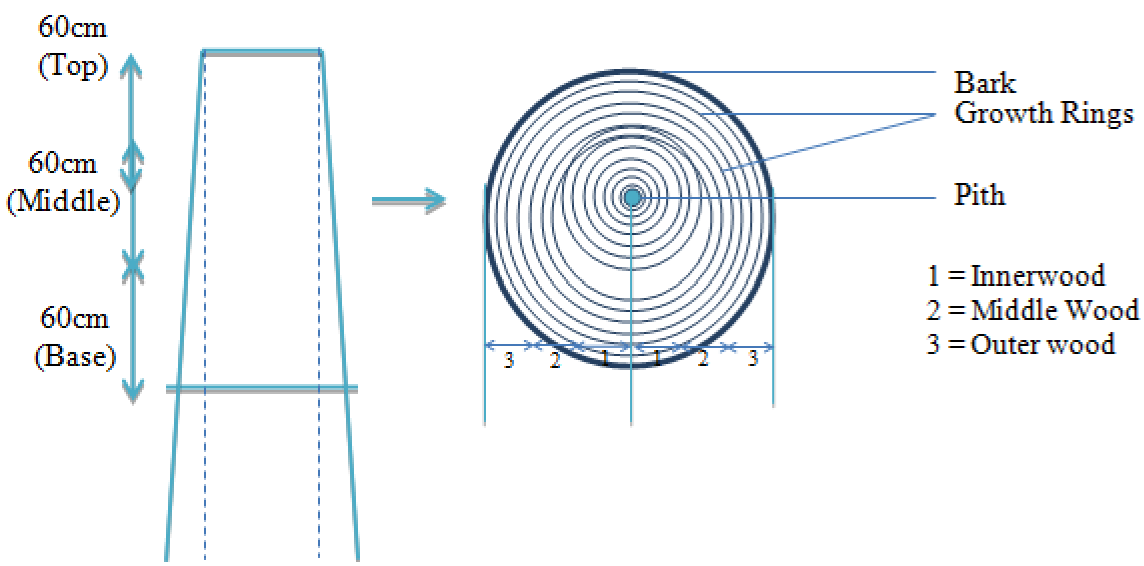


Fig. 2: Schematic Diagram of Sample Collection

From the 2.5cm thick disc, a radial strip of 5cm in width was cut which was later halved. Each of the halves was planned and the annual ring numbered from pith to bark. Form the visible bands of darkened latewood; it was easier to identify the growth rings of the tree. The number of annual growth rings was later determined by counting using a magnifying hand lens.

Plate 1: Transverse Surface of *Pinus caribaea* disc

Ring Width Determination (in millimeter, mm)
The ring width determination was estimated by direct measurement on the transverse surface of each disc from the pith towards the bark using a magnifying hand lens over a calibrated transparent ruler. This involved measuring the distance between the transition zone of the late wood of previous years and the early wood of succeeding year.

Data Analysis
Data collected were analyzed using analysis of variance (ANOVA) by adopting Statistical Package for the Social Sciences (SPSS) version 20.

RESULTS
Radial Variation of Ring Width
The result in Table 1 shows the radial variation of mean ring width of *Pinus caribaea* at various level i.e. DBH (base), 25% (middle) and 50% (top) of total tree height. At DBH, the rings closer to the pith has the highest mean of 8.458 mm and ring 16-20 and 21-26 have the lowest mean of 1.512 mm and 1.058 mm respectively, the trend was also the same at 25% of total height of tree where the rings closest to the pith i.e. ring 1-6 has the highest mean value of 8.392 mm, followed by ring 7-12 having a mean value of 2.864 mm and ring 13-18 has a mean value of 1.4 mm while the farthest ring class from the pith i.e. closest rings to the bark has the lowest mean ring width of 1.01 mm which is not significantly different from ring 13-18 but is different from ring 1-6 and 7-12. At 50% of the total height of the tree, the result also follows the same trend where ring 1-6 has the highest mean value of 6.556 mm, ring 7-12 has a mean value of 2.26 mm while ring 13-18 which is the closest to the bark has a mean value of 1.194 mm.

The result also indicates that there is a significant difference in the mean of the ring width among different ring number classes at various levels. At DBH, the ring widths are significantly different ($p<0.05$) from one another along the ring numbers moreover ring 16-20 and 21-26 are not significantly different ($p>0.05$) from each other. At 25% total height of the tree, it follows the same trend as DBH level, the ring widths are significantly different (p<0.05) from one another along the ring numbers moreover ring 13-18 and 19-22 are not significantly different (p<0.05) from each other. At 50% total height of the tree, the ring widths are significantly different from one another at 1% and 5% level of significance.

Table 1: Descriptive and ANOVA on mean radial variation in Ring width (mm) of *Pinus caribaea* (Afaka) at various levels

Position	Ring Number (Pith – Bark)	Minimum Ring Width	Maximum Ring Width	Mean ± SE	Sig.
	1-5	7.79	9.23	8.4580±0.24608[a]	0.000**
	6-10	4.41	5.35	5.0120±0.17471[b]	
DBH	11-15	1.81	3.39	2.5180±0.25943[c]	
	16-20	0.94	1.92	1.5120±0.16402[d]	
	21-26	0.80	1.39	1.0580±0.10514[d]	
	1-6	7.36	9.37	8.3920±0.32679[a]	0.000**
	7-12	2.34	3.37	2.8640±0.18057[b]	
25%THT	13-18	0.86	1.78	1.4000±0.17481[c]	
	19-22	0.77	1.25	1.0100±0.09187[c]	
	1-6	6.09	6.95	6.5560±0.14006[a]	0.000**
50%THT	7-12	1.71	3.09	2.2600±0.24876[b]	
	13-18	0.83	1.52	1.1940±0.13743[c]	

**= significant at 0.01, *=significant at 0.05

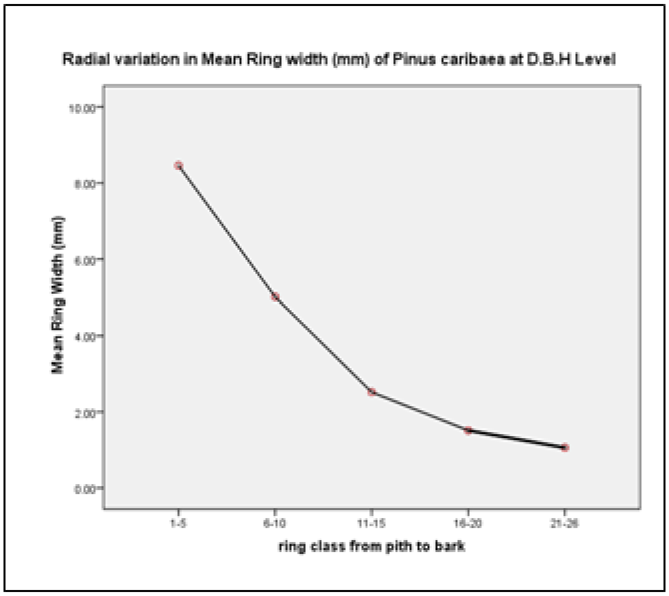
Axial variation in ring width

The result in Table 2 shows the axial variation in ring width along different position from top to the base of the tree which display the mean ring width (mm) value of 3.176 mm, 3.146 mm and 3.336 mm for DBH level, 25% of total height of tree and 50% of total height of tree respectively. It also shows that there was no significant difference in the ring width (mm) from base to top of the tree at 95% significance level (i.e. p = 0.05) which implies that there was no variation in the ring width of the plantation grown *P. caribeae* from base to top. The trends of the variation in radial and axial directions are shown in Figure 1 below which supports the claims of the result discussed above.

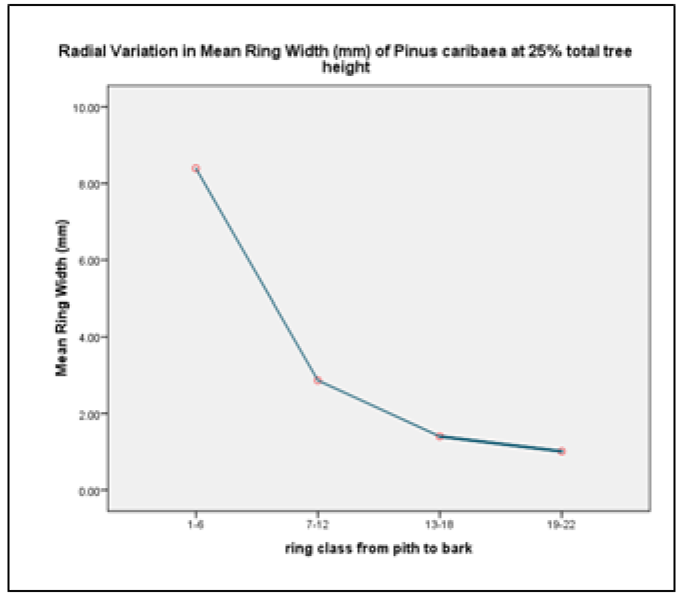
Table 2: Descriptive and ANOVA on mean axial variation in Ring width (mm) of *Pinus caribaea* (Afaka) at various levels

Position	Minimum	Maximum	Mean ± S.E	Sig.
DBH	3.45	4.03	3.7160±0.10332[a]	0.092[ns]
25%	3.12	3.72	3.4160±0.10884[a]	
50%	3.02	3.71	3.3360±0.13626[a]	

ns = Not Significant



(A)



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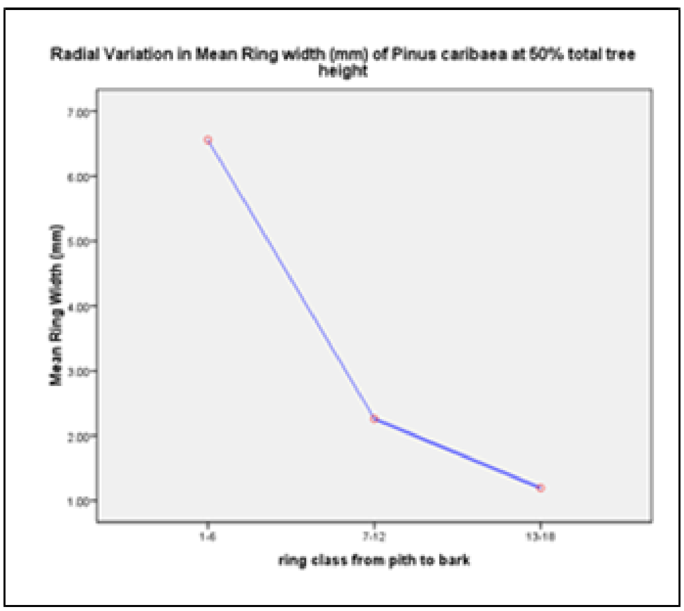

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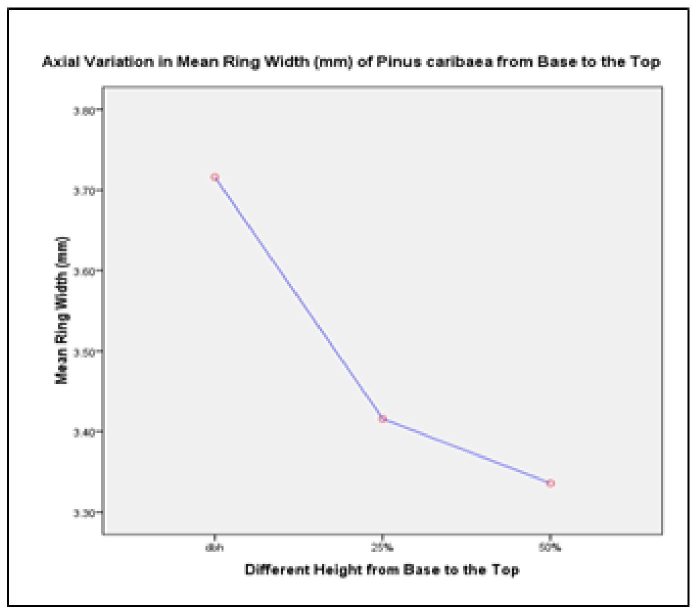

(D)

Figure 3: Trend showing the radial, (A-C), and axial, (D), variation in ring width (mm) of Plantation Grown *Pinus caribaea*

DISCUSSION

Radial Variation of Ring Width

Trees and shrubs grown in temperate climates produce growth rings that reflect the spring onset and autumn cessation of cambial division and cell differentiation. The study shows that there is radial variation in the width of the growth ring at different sampling height along the tree which is corroborated with study done by Diaz *et al.*, (2007); Mmolotsi *et al.*, (2013) and Pant, (2003) that radial variation exist in temperate tree species which may be caused by a specific environmental factors, forest management practices and within controlled genetic factors or the interaction between or among these factors which in turn influence cambial activity (Osadare, 2001).

Growth rings affect softwood and hardwood quality with the width of the rings and the ratio of earlywood to latewood within each ring both contributing to wood anatomies as well as wood quality (Ishiguri *et al.,* 2007; Saravanan *et al.,* 2013). The narrower the growth ring, the higher the proportion of latewood cells present in each ring. This has the effect of increasing the wood stiffness in the outer region of trunks especially at lower levels in the tree. Variations in the proportion of early to latewood are also a result of species differences and climatic variations. The different properties of early and latewood tracheids and fibres in softwoods and hardwood respectively have significant effects on both wood quality and tree physiology (Bhat *et al.,* 2001; Walter and Menzies, 2010). The variety of cell types present in hardwoods increases the complexity of the cell pattern within the rings.

Many variations in tree rings were due to variation year to year in abundant rainfall which increases growth thus producing a wider ring. Drought decreases growth, producing a narrower ring. Crowding of neighboring trees, this causes a series of narrow rings. Crowding is suspected when the series of narrow ring is more than three (Guo and Chen, 2011)**.**

Growth ring has also been identified as an indication for growth rate which in turn affects the density as well as some other properties that determine the suitability of a species for a particular end use (Osadare, 2001; Adamopoulos *et al.,* 2010; Bouriaud *et al.,* 2015; Evans, 1991). There were several reports that (annual) ring density decreases with increasing ring width, for instance in Norway spruce (Shinya and Zhang, 2002; Lundgren, 2004; Bouriaud *et al.,* 2015). It is very important to establish the difference between juvenile and mature wood when studying the effect of growth rate on basic density. Wide growth rings and low density are associated with juvenile wood close to the pith and narrow growth rings and high density are typical for mature wood (Mata *et al.,* 2012).

Axial Variation in Ring width

There was no variation in the growth ring width along the height of the tree i.e. from base to top of the tree. This trend may change as a result of formation of reaction wood as well as incidence of defects such as knots which is the point of attachment between the branch and the bole and as such cause deviation of ring width from normal at that particular point where it is found. This result is corroborated by the findings of Yu *et al.* (2014) who reported that there is no variation in the mean ring width along different position on the stem of a tree, however, the variation of the annual ring width greatly differed among different ring ages. In contrary, Udoakpan (2013) reported that there is a strong correlation between the ring width and level of merchantable length without a definite pattern.

CONCLUSION

Based on this study, the following conclusions were made. There was radial variation in the growth ring width of *Pinus caribaea*, while there was no variation in the axial trend of the growth ring width of this species. It was also established that the pattern varies considerably and sometimes contradictorily, even for the same species.

Recommendations

Pinus caribaea has been selected for different end use because of its vigor, stem quality, branch habit and crown characteristics. It is also recommended that the use of more positions should be taken into consideration during determination of ring width so as to avoid the influence of reaction wood; this is because ring width is one of the most essential tools for understanding tree growth and its reaction to varying climatic settings.

REFERENCES

Adamopoulos, S. E., Voulgaridis, C.and Passiali, S. (2010). Ring width, latewood proportion and density relationships in black locust wood of different origins and clones. *IAWA Journal*, ~~Vol.~~ 31 (2): 169–178.

Anoop, E. V., Jijeesh, C. M., Sindhumathi, C. R. and Jayasree, C. E. (2014). Wood physical, anatomical and mechanical properties of big leaf Mahogany (*Swietenia macrophylla* Roxb) a potential exotic for South India, *Research Journal of Agriculture and Forestry Sciences*, 2(8), 7 – 13.

Bhat, K. M., Priya, P. B. and Rugmini, P. (2001). Characterization of juvenile wood in teak, Wood Science and Technology, 34(6): 517 – 534.

Bouriaud, O., Teodosiu, M., Kirdyanov, A. V. and Wirth, C. (2015). Influence of Wood density in tree-ring-based annual productivity assessments and its errors in Norway spruce. *Biogeosciences*, 12: 6205–6217.

Bown, N. (2016). Prioritising and Protecting Nigeria's Threatened Trees: The Work of the IITA Forest Unit in Promoting the Propagation and Cultivation of Indigenous Tree Species. 1st Commonwealth Forestry Association (CFA) Conference, Nigeria Chapter 1 Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State, Nigeria.

Chuine, I. and Beaubien, E. G. 2010. Phenology is a major determinant of tree species range. *Ecology Letter* , 4, 500 – 510.

Diaz, R., Zas, R. and Fernandez-Lopez, J. (2007). Genetic variation of *Prunus avium* in susceptibility to cherry leaf spot (*Blumeriella jaapii*) in spatially heterogeneous infected seed orchards, *Journals of Forest Science*, 64(1): 21 – 30.

Evans, P. D. (1991). The strength properties of clear wood materials. Forums, 15: 231-244.

Gomez, L. D., Whitehead, C., Barakate, A., Halpin, C. and Mcqueen-Mason, S. J. (2010). Automated saccharification assay for determination of digestibility in plant materials. *Biotechnol*. *Biofuels* 3, 1–12 DOI:10.1186/1754-6834-3-23.

Guilley, E., Harve, J. C. and Nepveu, G. (2004). The Influence of Site Quality, Silviculture and Region on Wood Density mixed Model in *Quercus petraea* (Liebl), *Journal of Forest Ecology and Management*, 189:111-121.

Guo Minghui and Chen Jianming (2011). Infleunce of Climate Factors upon Growth Ring Width of Plantation *Populus ussuriensis* Kom on the Basis of Analyzing Growth Ring Materials. *Procedia Engineering* 15(2011):4465-4469

Guyette, R. P. and Stambaugh, M. (2003). The age and density of ancient and modern oak wood in streams and sediments. *IAWA Journal*. 24: 345–353.

Ishiguri, F., Eizawa, J., Saito, Y., Iizuka, K., Yokota, S., Priadi, D., Sumiasri, N. and Yoshizawa, N. (2007). Variation in the wood properties of *Paraserianthes falcataria* planted in Indonesia. *IAWA Journal*. 28: 339–348.

Kretschmann, D.E. & Cramer, S.M (2007). The Role of Earlywood and Latewood Properties on the Dimensional Stability of Loblolly Pine. Proceedings of the Compromised Wood Workshop, 2007 January 29-30. Christchurch, NZ: Wood Technology Research Centre, School of Forestry, University of Canterbury, 2007: pages 215-236.

Lundgren, C. (2004). Microfibril angle and density patterns of fertilized and irrigated Norway spruce, Silva Fenn., 38:107–117.

Mata, Y., Griesbauer, H. P. and Green, D. (2012). Growth responses of three coexisting conifer species to climate across wide geographic and climate ranges in Yukon and British Columbia. *Journal of Forest Ecology Management*, 259:514–523.

Mmolotsi, R. M., Chisupo, O., Mojeremane, W., Rampart, M., Kopong, I. and Monekwe, D. (2013). Dimensional relations and physical properties of wood of *Acacia saligna* an invasive tree species growing in Botswana, *Research Journal of Agriculture and Forestry Sciences*, 1(6):2 – 15.

Morling, T. (2002). Evaluation of annual ring width and ring density development following fertilization and thinning of Scots pine. Ann. *Journal of Forest Science*, 59: 29-40.

Nwadialor, I. J. (2001). An assessment of spatio-temporal variabilities of deforestation for sustainable forestry development: a case study of Afaka forest reserve. International Conference on Spatial Information for Sustainable Development Nairobi, Kenya. 2–5 October 2001.

Oluwadare, A. O. (2007). Wood properties and selection for rotation length in Caribbean pine (*Pinus caribaea* Morelet) grown in Afaka, Nigeria. *American-Eurasian Journal of Agriculture and Environmental Science* 2 (4): 359-363.

Osadare A. O. (2001). Basic wood and pulp properties of Nigerian grown Caribean Pine (*Pinus caribeae*. Morelet) and their relationship with tree growth indices. Ph.D Thesis at the University of Ibadan.

Pant, G. B. (2003). Long-term climate variability and change over monsoon Asia, *Journal of Indian Geophysical Union*, 7(3): 125 – 134.

Saravanan, V., Parthiban, K. T., Kumar, P., Anbu, P. V. and Ganesh-Pandian, P. (2013). Evaluation of Fuel wood properties of *Melia dubia* at different age gradation, *Research Journal of Agriculture and Forestry Sciences*, 1(6): 8–11.

Sharma, C. l., Sharma, M. and Carter, M. J. (2013). Radial variation in fibre length and wood density of *Melanorrhoea usitata* Wall, *The Ind. For.*, 139 (6): 518-520.

Shinya K. and Zhang S.Y (2002). Relationships between Wood Density and Annual Growth Rate Components in Balsam Fir (*Abies balsamea*). Wood and Fibre Science. 34(1). 2002. pp. 146-157

Sousa, V. B., Cardoso, S., Quilho, T. and Pereira, H. (2012). Growth rate and ring width variability of teak, *Tectona grandis* (Verbenaceae) in an unmanaged forest in East Timor, *International Journal of Tropical Biology and Conservation*, 60(1), 483 – 494.

Tian, Q., Gou, X., Zang, Y., Wang, Y and Fan, Z. (2009). May-June temperature reconstruction over the past 300 years based on tree rings in the Qilian mountains of the Northeastern of the Tibetan Plateau, *IAWA Journal*, 30(4): 421 – 434.

Udoakpan, U. I. 2013. An evaluation of wood properties of *Pinus caribeae* (morelet) in oluwa forest reserve, Ondo state, Nigeria. *Ethiopian Journal of Environmental Studies and Management* Vol. 6 No.2 2013. http://dx.doi.org/10.4314/ejesm.v6i2.6

Walter, C. and Menzies, M. (2010). Genetic modification as a component of forest biotechnology in forestry. In: FAO, 2010.

Wilhelmsson, L., Arlinger, J., Spangberg, K., Lunqvist, S. O., Grahn, T., Hedenberg, O. and Olsson, L. (2002). Models for Prediction Wood Properties in stems of *Picea abies* and *Pinus sylvestris* in Sweden. *Scandinavian Journal of Forest Resources*, 17: 330-350.

Yu, M., Cheng, X., He, Z., Wu, T.,Yin, Z. (2014). Longitudinal variation of ring width, wood density and basal area increment in 26-year-old loblolly pine (*Pinus taeda*) trees. Tree-Ring Research 70(2):137-144.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adebawo, 2019

FUNGAL RESISTANCE OF OBECHE (*Triplochiton Scleroxylon* K. SCHUM) WOOD TREATED WITH NEEM (*Azadirachta indica,* A. JUSS) SEED OIL EXTRACT

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ABSTRACT

This study aimed to providing eco-friendly wood preservatives from neem (Azadirachta indica) seed oil extract against wood decay fungi. Seed oil was extracted from the neem seed using soxhlet apparatus with N-hexane as the solvent. After extraction, the phytochemical screening of the oil was carried out. Sixty wood blocks of Triplochiton scleroxylon were treated with five different concentration levels (0 mL, 25 mL, 50 mL, 75 mL and 100 mL) of the seed oil extract and the untreated wood samples served as the control. The wood blocks were exposed to Sclerotium rolfsii (brown rot fungus) and Pleurotus ostreatus (white rot fungus) for 16 weeks and their weight loss determined. The phytochemical screening of the oil revealed that alkaloids (2141.7 mg/100g), tannins (975.0 mg/100g), flavonoids (1418.3 mg/100g), terpenoids (826.7 mg/100g), saponins (43.3mg/100g) and steroids (218.3mg/100g) were present. There were significant differences in the weight loss at different concentration levels at $p< 0.05$. The control has the highest weight loss of 36.48% ±2.03 and 47.89% ±2.34 for Pleurotus ostreatus and Sclerotium rolfsii respectively while the lowest weight loss for white and brown rot was 8.23% ± 1.07 and 11.84% ± 1.24 for Pleurotus ostreatus and Sclerotium rolfsii respectively. From this study, it is established that Azadirachta indica seed oil extract is a potential bio-preservative against wood decay fungi.

Keywords: *Azadirachta indica*, fungi, bio-deterioration, phytochemical screening

INTRODUCTION

Wood is one of the most valuable natural resources that is readily available. It is easily worked with tools and machines and it has a very high strength to weight ratio. The fact that wood can be used for both in-door and out-door services and their exposure to different weather conditions shows that wood can be used for many years if properly preserved. Some timbers have excellent resistance to various agents of deterioration and are therefore highly valued for this property - usually summed up as durability. Many others have only moderate resistance or hardly any resistance and it is in these cases, which are very numerous, that wood preservation becomes a necessity (FAO, 1986). Hence, due to the nature and character of wood, durable wood species are being selected and exploited for structure and construction purposes (Oluwafemi and Adegbenga, 2007). However, there are other wood species of low durability that can be used for construction purposes if properly treated with wood preservatives. Wood preservatives such as creosote and inorganic preservative chromate copper arsenate (CCA) are highly effective in protecting wood. However, due to their harmfulness, there has been a restriction in their use. Hence, developing biocides that are environmental friendly has become a viable option.

Recently, great interest has been focused on some wood preservatives that are relatively cost – effective and eco- friendly. Ability of wood and natural plant extractives to protect wood against wood degrading fungi and insects has been one possible approach for developing new wood preservatives (Kartal *et al*., 2004). Several scientist have reported that plant extracts are good source of fungicides (Kabir *et al*., 2007). Most reported works on the use of ecofriendly wood preservatives is on extractives from heartwood, leaf, bark, root and oil from herbaceous plants (Onuorah, 2000; Saxena and Dev, 2002; Swathi *et al*., 2004 and Adetogun *et al*., 2007). Moreover, there are also reports on the use of neem oil to preserve different wood species evergreen tree (Venmalar and Nagaeveni, 2005). Despite the extensive studies on the use of preservative of plant origin to protect wood, there is little or no information on the use of neem seed oil to preserve *Triplochiton scleroxylon* and *T. scleroxylon* is a tropical species, a timber of commerce that is used in many wooden applications.

Neem tree (*Azadirachta indica*) is an evergreen tree; it belongs to Meliaceace family, and grows rapidly in the tropic and semi-tropic climate (Puri, 1999). It is properly known as village pharmacy as all parts of this plant are used for several types of diseases since centuries. Extracts of leaves and seeds exhibit the property of antibacterial, antifungal, antiviral (Tewari, 1992). Neem wood is known to be durable against wood rotters (Rao, 1990). Neem seed oil with the main constituent of Azadirachtin has been evaluated to find out the effectiveness as wood preservatives. In this vein, this study was undergone to assess the antifungal activity of neem seed oil against *Pleurotus ostreatus* and *Sclerotium rolfsii* fungi on *T. scleroxylon* wood.

MATERIAL AND METHODS

Preparation of Wood Samples: A total of 60 wood blocks of dimension 2x 2 x 6 cm were obtained from 22 years old *Triplochiton scleroxylon* wood species according to the ANSI/ASTM D 1413 – 76/10 – 11 standard procedure. The initial weight of the samples (W_1) were taken using an electronic weighing balance and then oven dried for 24 hours at 103±2 °C to constant weight. After oven drying, the weight of the samples (W_2) was taken and percentage moisture content was estimated using the equation (1).

$$\%\,\mathrm{M.C.} = \frac{W_1 - W_2}{W_2} \,\mathrm{X}\, 100 - - - 1$$

Where:
M.C. = Moisture content
W_1 = weight of wood samples before oven drying
W_2 = weight of wood samples after oven drying

Preparation of *Azadiracta indica* seed oil extract: Matured neem fruits were collected by picking from neem stands within the Polytechnic of Ibadan, Ibadan, Oyo state, Nigeria. The seed coats were removed and sun dried for seven days to reduce the moisture and ground with an electric blender. 100 g of neem powder was placed into the thimble and 500 mL of N-hexane was poured in a round bottom flask and placed in the soxhlet chamber to extract the oil from the neem seed. The extract obtained was stored in a sterilized bottle.

Phytochemical Analysis of Neem Seed Oil Extract: Phytochemical screening of Neem seed oil was done following the standard procedure by the method of Brain and Turner (1975). The seed oil extract was subjected to phytochemical screening for the presence of alkaloids, tannins, flavanoids, fats, saponins, phenolic compounds, steroids and terpenoids.

Preparation of Test Fungicide: The volume-to-volume method according to Ajala *et al*., 2014 was used for the preparation of different concentration levels of the oil extract using kerosene as the diluent. This implies that, 1mL of neem oil in 99 mL of Kerosene (diluent) is equivalent to 1% dilution. Hence, 0 mL neem oil in 100 mL kerosene, 25 mL neem oil in 75 mL kerosene, 50 mL neem oil in 50 mL kerosene, 75 mL neem oil in 25 mL kerosene and 100 mL neem oil in 0 mL kerosene is represented as 0 mL, 25 mL, 50 mL, 75 mL and 100 mL respectively while the untreated sample is represented as control. For each concentration, ten replicates were used for each oil treatment which was thereafter separated into five replicates each for *Pleurotus ostreatus* and *Sclerotium rolfsii* fungi.

Treatment of Test Blocks: Dipping impregnation method (FAO, 1986) was used for treatment of the wood test blocks with the preservatives. They were completely immersed in the fungicides for 24 hours. The wood blocks were conditioned and treated with various concentrations of neem oil (0 mL, 25 mL, 50 mL, 75 mL and 100 mL) so as to obtain maximum absorpti. They were removed and air dried for three days and then weighed (W_3).The absorption rate was calculated using equation (2) according to Adetogun (2009).

$$A = \frac{TA \times Conc. \times 10}{VW \times PN} \text{ - - - - - -2}$$

Where:
A = Absorption, (kg/m^3)
TA= Totaal Absorption
Con. = Concentration
VW = Volume of wood
NP = Number of piece

Preparation of Culture Medium: The pure culture of brown rot fungi (*Sclerotium rolfsii*) was obtained from the International Institute of Tropical Agriculture (IITA) Ibadan, Oyo State; while the white rot fungi (*Pleurotus ostreatus*) was obtained from the Pathology Department of Forestry Research Institute of Nigeria (FRIN). A nutrient medium of Potato Dextrose Agar (PDA) in distilled water was prepared. PDA of 40 mL was poured into McCartney bottles and sterilized by autoclaving at 0.1 N/mm^2 (120 °C) for a period of 20 minutes. The medium was inoculated with the test fungi within 6 days after preparation of the bottles (Sarker *et al.*, 2006).

Infection of Test Blocks: The blocks were infected by placing them in the bottles in which there were actively growing cultures of the test fungi. The blocks were placed in the bottles containing each of the two test fungi such that they came in contact with the aerial mycelium of the fungus. The control test blocks were wrapped in aluminum foil and sterilized in the oven before introduction to the test fungi.

Duration of test: The bottles were inoculated with the test fungi and then incubated at room temperature (27 ± 2 ^{o} C) in the laboratory for 14 weeks. At the end of incubation period, the blocks were removed from the culture bottles, cleaned of the adhering mycelium and oven dried at 103 ^{o}C) to constant weight (Sarker *et al.*, 2006).

Weight Loss Determination of treated wood samples: At the end of incubation period, test blocks were carefully removed, oven dried and reweighed to determine weight loss. Percentage weight loss of each sample due to fungi attack was calculated using equation (3)

$$\% \text{ WL} = \frac{T_3 - T_4}{T_3} \times 100 ----3$$

Where:
WL = Weight Loss
T_3 = weight of test block after treatment.
T_4 = weight of test block after exposure to fungi attack.

Statistical Analysis: All the data obtained were subjected to an analysis of variance and means were separated with the aid of Duncan Multiple Range. Statement of significance are based on P≤0.05

RESULTS

Phytochemical Constituents of Neem Seed Oil

The results of quantitative phytochemical analysis of *Azadirachta indica* seed oil extract are presented in Table 1. Phytochemical screening of the *T. peruviana* oil revealed that the main constituents found at highest concentrations were alkaloids (2141.7 mg/100 g) followed by flavonoids (1418.3 mg/100g). Tannins, terpenoids, steroids and saponins are also present but saponins gave the lowest constituents of 43 mg/100 g.

Absorption Rate of Neem seed oil by wood blocks

The absorption rate ranged between 0.69 – 73.07 kg/m3 with 75 mL concentration level having the highest absorption of 73.07 (kg/m^3) as presented in Table 2.

Table 1: Phytochemical constituents of Neem seed oil (NSO)

Parameters	Value (mg/100 g)
Saponins	43.3
Flavonoids	**1418.3**
Tannins	975.0
Alkaloids	**2141.7**
Steroids	218.3
Terpenoids	826.7

Table 2: Mean values of percentage absorption of Neem seed oil by *T. scleroxylon* wood

Concentration level (mL)	Mean (kg/m^3)
0	0.69^a
25	23.63^b
50	38.15^c
75	73.07^e
100	58.75^d

Mean with the same alphabet are not significantly different from each other at α = 0.05

There were significant differences among the treatments for the absorption rate of wood samples treated with Neem seed oil extract at different concentration levels. The absorption rate increases as the concentration level increases except for the 75 mL and 100 mL. The least absorption was recorded in the test blocks treated with kerosene i.e. 0 ml concentration level.

Determination of decay resistance by weight loss: Resistance of *T. scleroxylon* wood treated with Neem seed oil at varying concentrations was assessed by exposure to fungi for 16 weeks. The decay resistance of treated and untreated wood samples was determined by weight loss as presented in Figure 1. The weight loss ranged from 8.23% - 36.48% and 10.24% - 47.89% for *pleurotus ostreatus* and *Scleorotium rolfsii* respectively. The highest weight loss (47.89%) is observed in control for wood blocks exposed to *Sclerotium rolfsii*, brown fungus while its counterpart, *Pleurotus ostreatus* produced a weight loss of 36.48%. However, there is no significant difference in the weight loss of the wood blocks at 100 mL concentration level for both fungi.

Table 3: Mean values of percentage weight loss of *Triplochiton scleroxylon* after 14 weeks exposure to fungi

Treatment (mL)	Fungi	
	Pleurotus ostreatus **Mean ± Sdv**	***Sclerotium rolfsii*** **Mean ± Sdv**
Control	36.48±2.03^a	47.89±2.34^a
0	32.13±1.33^b	44.56±1.58^b
25	31.4±1.25^b	36.63±1.25^c
50	21.46±0.68^c	29.67±1.17^d
75	8.23±1.07^d	11.84±1.24^e
100	10.24±1.20^e	12.53±0.98^e

Each value is an average of 5 replicates. Mean with the same alphabet in each column are not significantly different from each other at α = 0.05

DISCUSSION

Phytochemical Constituents of Neem Seed Oil

Phytochemicals generally exert their antimicrobial activities through different mechanisms and are known to be biologically active because they protect the plants against infections (Scalbert, 1991). From the present study, it was observed that Saponins, Flavonoid, Tannins, Alkaloids, Steroid and Terpenoids were present in the extract. This agrees with the findings of Dooh *et al.* (2014), who reported the same results for the qualitative analysis of methanol extract of *Thevetia peruviana*. Quantitatively, alkaloids had the highest value in the seed oil extract and this has been reported that it acts as deterrent against microbial and insect attacks (Smith 1996; Macel 2011). Alkaloids are organic heterocyclic nitrogen compounds that are basic-forming water-soluble salts. They contain nitrogen, which is usually derived from an amino acid. Alkaloids have been reported to have antimicrobial properties which are effective against fungal growth (Carson and Hammer, 2010. The higher concentrations of alkaloids (2141.7 mg/100g) could have contributed to the reduced weight loss of the wood samples treated with the oil after the fungal attack.

Flavonoids are phenolic structures found abundantly in photosynthesizing cells. Esmaeili *et al.* (2013) reported that they are secondary metabolites that provide UV protection and color to almost all terrestrial plants and fruits. They are usually found in many common edible plant parts such as fruits, vegetables, nuts and seeds. Flavonoid compounds have a structural feature of the 2-phenyl-benzopyrane or flavine nucleus, which consists of two benzene rings linked through a heterocyclic pyrane ring (Savoia 2012; Carson and Hammer, 2010). Flavonoids are important plant components due to their active hydroxyl groups and anti-oxidative properties (Güder *et al*., 2014). They are known to have antioxidant, anti-inflammatory and antitumor activity. Flavonoid compounds have been reported to inhibit wood decay fungi (Onuorah 2000; Yen *et al*., 2008; Tumen *et al*., 2013; Li *et al.*, 2014).

Saponins are a major family of secondary metabolites that occur in a wide range of plant species (Osbourn 1996). These compounds are present in plants and are reported to be involved in plant disease resistance because of their well-known antimicrobial activity (Papadopoulou *et.al*, 1999; Bouarab *et.al*, 2002; Wittstock and Gershenzon, 2002, Elisa *et.al*, 2007). Saponins has been characterized and reported to act as deterrent for biological activity against insects (Macel, 2011).

Flavonoids, steroids and terpenoid have antioxidants and antimicrobial properties. Tannins are formed via the Shikimic acid pathway and have significant anti-feedant properties attributed both in angiosperms and gymnosperms (Barbehenn and Constabel, 2011). They are found in bud and foliage tissues, seeds, bark, roots, heartwood and sapwood. The highest levels are in heartwood and barks. Terpenoids are also used as flavoring agents, insect repellents, fungicides and for medicinal purposes (Johnson and Morgan, 1997).

Absorption Rate of Neem seed oil by wood blocks

The absorption rate indicated that at different concentration levels, wood blocks absorbed the oil extract at different rate. This study has been able to show that *T. scleroxylon* absorbs more oil at higher concentration level. The result revealed that the wood samples were easily impregnated without difficulty with Neem seed oil extract due to low viscosity of the diluents which consequently lowered the viscosity of the extract. This result is in consonance with the work of Adetogun (2011).

Determination of decay resistance by weight loss

It is clear from the result that the control groups suffered the highest level of damage for both fungi. However, *Sclerotium rolfsii*, a brown rotter, was more virulent in their attack than *Pleurotus ostreatus*, a white rot fungus as seen in the result (Table 3). The differences in the weight loss as a result of different fungi used is in accordance with the work of Ogunsanwo *et.al.*, 2006 who also observed variation in the weight loss as a result of different fungi used. Analysis of variance (Table 3) further established the fact that level of attack was minimal at higher concentration level of the seed oil extract (75 mL and 100 mL) for both the white rot and brown rot fungi. However, there is no significant difference in the weight loss of the wood blocks exposed to brown rot at 75 mL and 100 mL concentration level. The results also showed that higher concentration of the oil seems to have higher phytochemicals that accorded the wood blocks with resistance against fungal attack. In view of the fact that phytochemicals have been reported to have antifungal properties, this could have contributed to the reduced weight loss seen in the wood blocks after 16 weeks as compared to their untreated counterparts. The effect of the seed oil extract was clearly seen in the wood blocks which were significantly different from each other in their weight loss at different concentration levels.

CONCLUSION

This study has shown the potential of Neem seed oil extract as a biopreservative against decay fungi on *Triplochiton scleroxylon* wood. The phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, terpenoids, steroids and saponins in the oil. The results showed that the rate of attack of the treated wood blocks by *Sclerotium rolfsii* was more virulent than the *Pleurotus ostreatus*, however, the untreated wood blocks had the highest weight loss. The treatment of the wood with the oil provided resistance against *Pleurotus ostreatus* and *Sclerotium rolfsii* at 75 mL and 100 mL concentration levels. It is therefore concluded that neem seed oil is effective as biopreservative against decay fungi on *Triplochiton scleroxylon* wood.

REFERENCES

Adetogun A.C. (2009). Investigating the fungicidal activities of cashew nut extract against wood. Ph. D thesis, University of Ibadan, Nigeria.

Adetogun A.C, Sobowale A.A, and Ogunjobi K.M. (2007). Seed-borne mycoflora of *Tectona grandis* (Linn) and their control with extract of *Occimum gratissimum. Asset Journal Series A*, 1: 339-344.

Adetogun A.C. (2011). Evaluation of Cashew nut Shell Liquid Incorporated with Sodium Chloride (Table Salt) as Fungicide against Wood Decay. *Innovations in Science and Engineering* 1: 74-78.

Ajala O. O., Adebawo F.G., Yekeen O.M, and Owoade O. D. (2014). Potentials of seed oil extract of *Azadirachta indica* (A. JUSS) as preservative against wood-decaying fungi of *Aningeria robusta* (A. CHEV.) In: Sudano-sahelian landscape and renewable natural resources development in Nigeria. Ogunsanwo *et.al*. (Eds). *Proceedings of the 37th Annual conference of the Forestry Association of Nigeria held in Minna, Niger State, 9th - 14th November, 2014, pp. 588-595.*

Barbehenn, R.V, and Constabel, P.C. (2011). Effect of the plant alkaloid plant-herbivore interactions. *Phytochemistry*, 72:1551–1565.

Bouarab K., Melton R., Peart J., Baulcombe D, Osbourn A.E. (2002). A saponins-detoxifying enzyme mediates suppression of plant defense. *Nature*, 418: 889–892.

Brain, K. R. and Turner T. D. (1975). The practical evaluation of Phytopharmaceutical, Ist edition, Britol Wright Scientechnia. 105.

Carson C. F., and Hammer K. A., (2010). Chemistry and Bioactivity of Essential Oils. In: Lipids and Essential Oils as Antimicrobial Agents, Thormar, H. (Ed.). John Wiley & Sons, New York, USA. ISBN-13: 9780470976678, pp 203-238.

Dooh J.P.N., Ambang Z., Ewola A.T, Heu A., Kosma P., Yalen E.J.M., and Goghomu R.T. (2014). Screening and the effect of extracts of *Thevetia peruviana* on the development of *Colletotrichum gloeosporioides*, causal agent of cassava anthracnose disease. *Journal of Agricultural Research and Development*, 4(4):054-065

Elisa B., Giuliano B., Vincenzo A, Behzad Z, Ebrahim S, Felice S, and Virginia L. (2007). Saponins from *Allium minutiflorum* with antifungal activity. *Phytochemistry,* 68:596–603.

Esmaeili A., Mousavi Z., Shokrollahi M., and Shafaghat A. (2013). "Antioxidant activity and isolation of luteoline from *Centaurea behe*n L. grown in Iran," *Journal of Chemistry*, 1-5. DOI: 10.1155/2013/620305

Food and Agriculture Organization of the United Nations. (1986). Wood preservation manual. FAO Forestry Paper 76, pp: 152.

Güder A, Engin M. S, Yolcu M, and Gür M. (2014). "Effect of processing temperature on the chemical composition and antioxidant activity of *Vaccinium arctostaphylos* fruit and their jam," *Journal of Food Processing and Preservation*, 38(4): 1696-1704. DOI: 10.1111/jfpp.12132

Johnson S, and Morgan ED. (1997). Supercritical fluid extraction of oil and triterpenoids. Neem seeds *Phytochemical Analysis*, 8: 228-232.

Kabir A. H., Rahman M. A., and Alam M. F. (2007). Reduction of environmental toxicity through eco-friendly wood bio preservatives. International Research Group on wood preservation, IRG/WP: 07-50243.

Kartal, S. N., Yosuimura T, and Imamura, Y. (2004). Decay and termites' resistance of boron-treated and chemically modified wood by intensity co-polymerization of allyl glycidylether (AGE) with methyl methacrylate (MMA). *International Biodeterioration and Biodegradation*, 53: 111-117.

Li Q., Wang X. X., Lin J.G, Liu J., Jiang M. S, and Chu L. X. (2014). Chemical composition and antifungal activity of extracts from the xylem of *Cinnamomum camphora*. *BioResources* 9(2): 2560-2571.

Macel M, (2011). Attract and deter: a dual role for pyrrolizidine alkaloids in plant–insect interactions. *Phytochemistry Review*, 10 (1): 75-82.

Ogunsanwo O.Y., Adetogun A.C., Ogunbiyi A.O. (2006). Preliminary Investigation on the Efficacy of Wood Extract of Teak *Tectona grandis* as Preservative against Wood Decay. Proceeding of ECOWOOD 2006 Conference, Portugal, September, 2006.

Oluwafemi O.A, and Adegbenga S.O., (2007). Preliminary report on Utilization Potential of *Gliridia sepium* (Jacq) steud for timber. *Research Journal of Forestry, 1:80-85*.

Onuorah E. (2000). The wood preservative of extract of teak (*Tectonia grandis* Lim. F) as a fungicidal against wood decays. M.Sc. Thesis, University of Ibadan pp 163.

Osbourn A.E. 1996. Saponins and plant defense – a soap story. Trends in Plant Science. 1: 4–9.

Papadopoulou K, Melton R. E, Leggett M, Daniels M.J, and Osbourn A. E. (1999). Compromised disease resistance in saponins-deficient plants. *Procedings of the National Academy of Science*, 96:12923–12928

Puri H.S. (1999). Neem the divine tree. Hardwood academic publishers Amsterdam, pp.22-24

Rao R.V. (1990). Natural decay resistance of neem wood. *Journal of Indian Academy of Wood Science*, 21 (1): 19-21.

Sarker, P.K, Rahman M.A, Bulbul M.R, Das T, Ilias G.N.M (2006). Standard test Methods for wood preservatives by laboratory Agar-Block test. The International Research Group On Wood Preservation, Doc. No. IRG/WP06-20350. (Paper for the 37th Annual Meeting, Tromso, Norway, 18-22, June, 2006).

Savoia D. (2012). Plant-derived antimicrobial compounds: Alternatives to antibiotics. *Future Microbiology*, 7: 979-990.

Saxena P, Dev I. (2002). Preliminary studies on termites' resistance of water soluble phenolic fraction of western red cedar. *Canadian Journal of Botany*, 32(1): 308-309.

Scalbert A. (1991). Antimicrobial properties of tannins. *Phytochemistry*. 30(12): 3875-3883.

Smith B. D, 1966. Effect of the plant alkaloid sparteine on the distribution of the aphid *Acyrtosiphon spartii* (Kock). Nature, 212.

Tewari D.N, (1992). Monograph on Neem International book distributer Dehradun. Pp 34.

Tumen I, Eller F.J, Clausen C.A, and Teel J.A. (2013). "Antifungal activity of heartwood extracts from three Juniperus species," *Bioresources* 8(1):12-20. DOI: 10.15376/biores.8.1.12-20

Venmalar D, and Nagaveni, H.C. (2005). Evaluation of copperised cashew nut shell liquid and neem oil as wood preservatives. *The International Research Group on Wood Preservation. IRG/WP 05-30368.* Paper prepared for the 36th Annual Meeting Bangalore, India. 24th-28th April, 2005.

Wittstock U, and Gershenzon J. (2002). Constitutive plant toxins and their role in defense against herbivores and pathogens. *Current Opinion in Plant Biology*, 5: 1–8

Yen T.B, Chang H.T, Hsieh C.C, and Chang S.T. (2008). Antifungal properties of ethanolic extract and its active compounds from *Calocedrus macrolepis* var. formosana (Florin) heartwood. *Bioresource,* 99 (11): 4871 - 4877. DOI: 10.1016/j.biortech.2007.09.037..

ASSESSMENT OF SILT DEPOSIT AND SOIL PHYSICAL PROPERTIES ALONG RIVER BENUE BANK, ADAMAWA STATE

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ABSTRACT

This research was aimed at assessing the presence of silt deposit and soil physical properties along the River Benue bank, Shinko area in Yola North Local Government Area of Adamawa State, Nigeria. This was to determine the soil textural classes which are important when transplanting and going into farming in the area. Three plots of 20m x 20m were randomly established at the solid waste area (SWA), silt + solid waste (SSW), silted (SA) and no-silt; no-waste (NWS) areas. Soil samples were collected at various depth levels (D_1 – 15cm, D_2 – 30cm, D3 – 60cm) of the three plots laid in each of the four areas at a distance of 5m, 15m and 25m. 4x3 Factorial Experiments in Randomized Completely Block Design (RCBD) was used. Mechanical analysis tests for soil textural classes were also carried out. The result shows mean sizes of soil textural classes at 5m, 15m and 25m distances and at different depth levels of the study areas. At $\alpha = 0.05$, the mean value of pH was significantly different at the various sampling locations. The silted area textural class shows sandy-loam, sandy and loamy-sand at 15cm, 30cm and 60cm depth level at 5m distance. To prevent future impacts and to curtail silt deposition, various measures should be considered in an attempt to reduce the effects of deforestation on the environment. Artificial regeneration should be encouraged in areas with trait of flooding and tree planting should be considered as part of all developmental projects.

Keywords: Siltation, River Benue, Soil, Flood and Deforestation.

INTRODUCTION

The origin of the increased sediment transport into an area may be erosion on land, or activities in the water. In rural areas the erosion source is typically soil degradation due to intensive or inadequate agricultural practices, leading to soil erosion, especially in fine-grained soils such as loess. The result will be an increased amount of silt and clay in the water bodies that drain the area. A main source of silt in urban rivers is disturbance of soil by construction activity. A main source in rural rivers is erosion from ploughing of farm fields, clear-cutting or slash and burn treatment of forests. In water the main pollution source is sediment spill from dredging, from the transportation of dredged material on barges, and the deposition of dredged material in or near water Nahon and Trompette; (as cited in Crouvi, *et al*, 2010).

Silt is easily transported in water and is fine enough to be carried long distances by air in the form of dust. Silt and clay contribute to turbidity in water. Silt is transported by streams or by water currents in the ocean (Wright *et al*., 1998). Silt, deposited by annual floods along the Nile River, created the rich, fertile soil that sustained the Ancient Egyptian civilization. Silt deposited by the Mississippi River throughout the 20th century has decreased due to a system of levees, contributing to the disappearance of protective wetlands and barrier islands in the delta region surrounding New Orleans. Any form of sustained human activity result in some modification of natural environment. The modification will affect the relative abundance of species and in extreme cases lead to extinction of certain plants and animals (Groombridge, 1992).

In ecological terms, 'environment' mean essentially physical and biological. Environment in this sense encompasses an array of ecosystem. An ecosystem consists of both living (including man) and non-living components and their physical surrounding: land, water, air etc. (Muhammed, 2004). The rapid environmental degradation taking place in Nigeria is increasingly becoming a major threat and is gradually changing the landscape, destroying the sources of livelihood (Ola, 2012). Exploitation of forest resources often causes deforestation, which has been a big problem in this Nation. Nigeria destroys 600,000 ha of forest annually whereas only 25,000ha are replenished Food and Agricultural Organization (FAO, 1983). This is often done to service wood base industries apart from fuel. However, a huge sum of N180 Billion is lost annually to deforestation (Eboh, 2005).

River Benue

The River Benue is a river in Africa. It is the major tributary of the River Niger. The river is about 1,400 km long. It starts in the Adamawa Plateau of northern Cameroon. It flows west, and through the town of Garoua and Lagdo Reservoir, into Nigeria south of the Mandara mountains. Then it goes through Jimeta, Ibi and Makurdi before meeting the Niger at Lokoja. Large tributaries are the Gongola River and the Mayo Kebbi. Other tributaries are Taraba River and River Katsina Ala (Udvardy, 1975). There is a high level of vertebrate species richness in the Benue Basin. In the catchment area there is a very high level of plant endemism. Plant endemism in the upper catchment of the Benue is very high, with typical trees including trees such as *Anogeissus leiocarpus*, *Kigelia aethiopica*, *Acacia seyal* and tree species of *Combretum* and *Terminalia*. Grass cover often features the statuesque tussocks Elephant Grass (*Cenchrus purpureum*). The lower basin of the River Benue can be construed as the region below the joining of the Gongola River at the Numan town, northwest (downstream) of Yola (Jimeta). In this northern part of this area the terrestrial ecoregion is characterised chiefly by the sprawling floodplain of the West Sudanian savannah, while Guinean forest-savannah mosaic covers much southern part of the lower basin. Flood stage is not uncommon, as exemplified by recent lower basin flows in the year 2012. The River Benue flooded in October 2012, resulting in a large increase in the population of venomous snakes in the Duguri District, Alkaleri Local Government Area, Bauchi State. Seasonal flooding is common in the lower Benue Basin, with attendant wildlife invasions of villages, disease outbreaks and loss of life and property (Happold, 1987 and Stuart *et al.,* 1990).

MATERIALS AND METHODS

Study Area

The study was carried out along Doubeli bypass road, in Shinko Ward of Yola North Local Government Area, Adamawa State. Geographical coordinates are between latitudes 9^o 7′ 30″ and 10^o 50″ N, and longitude 11^o 40″ and 13^o 20″ E. Figure (1), is Jimeta map showing River Benue, Figure (2) satellite image showing the map of the study area. This area is comprised of both indigenous and exotic flora species and fauna species (Adefioye, 2013).

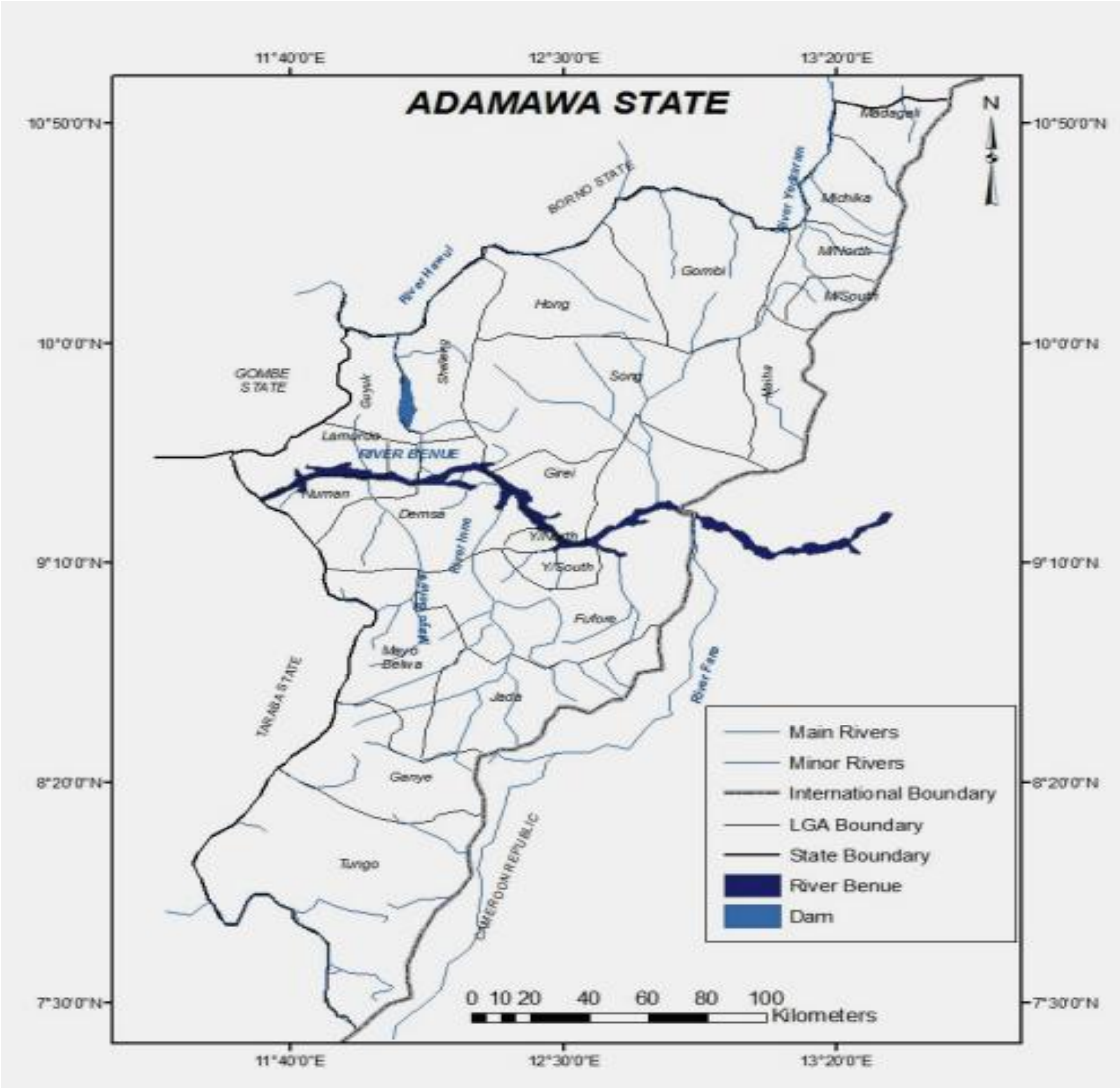

Figure 1: Map of Adamawa State Showing River Benue
Source: Ikusemoran, *et al*. (2013).

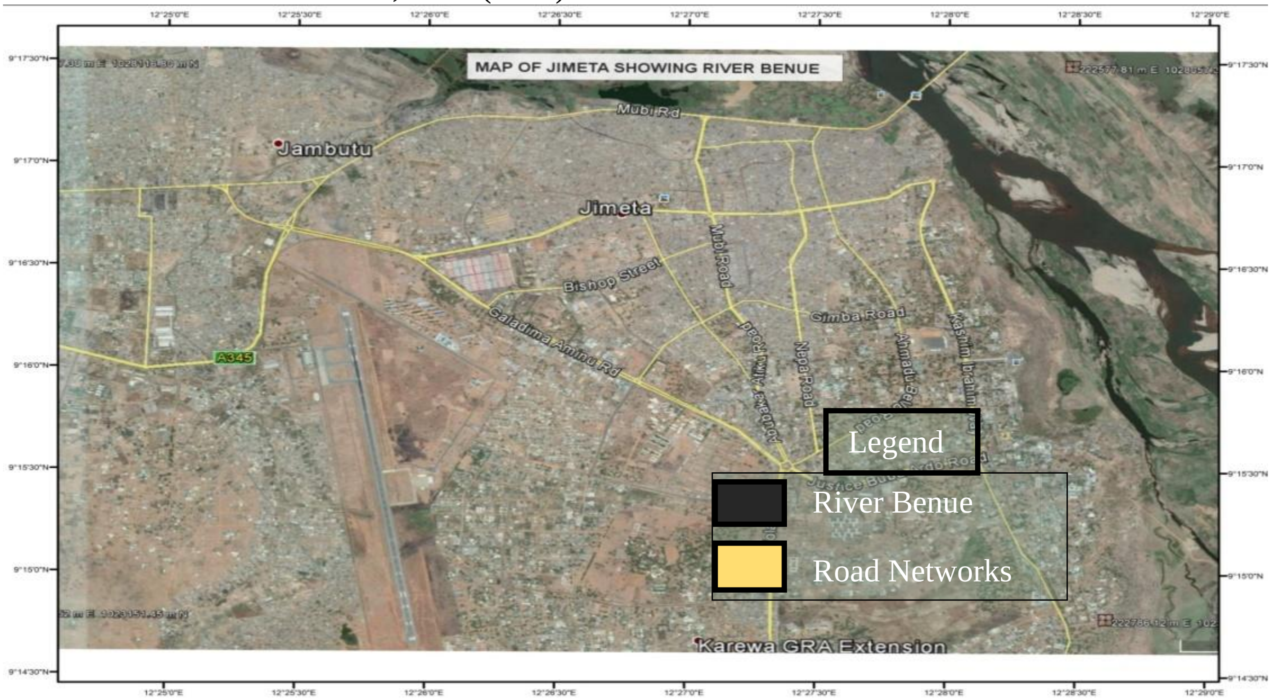

Figure 2: Satellite Image of Jimeta Map Showing River Benue
Source: Google Earth

Experimental Design:
The sampling technique used is stratified random sampling. 4 x 3 Factorial Experiments in Randomized Completely Block Design (RCBD) was used. Factor (A) is the sampling locations at 4 levels; solid waste area (SWA); silt + solid waste area (SSW); silted area (SA); and no-silt; no-solid waste area (NSW). Factor (B) is the distance from the waste dump at 3 levels (5m, 15m and 25m). The Analysis of Variance (ANOVA) model is given as follows.

$$Y_{ij} = \mu + A_i + B_j + AB_{Ij} + £_{ij} \quad \text{.................... 1}$$

Where:
Y_{ij} = individual observation
μ = overall mean
A_i = Effect of factor A
B_j = Effect of factor B
AB_{ij} = Effect of interaction AB
$£_{ij}$ = Experimental error normally distributed around the zero mean.
The treatment combinations are shown in Table 1.

Table 1: Treatment Combinations

B1			B2			B3			B4		
W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1
W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2
W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3

B1= solid waste area (SWA); B2= silt + solid waste area (SSW); B3= silted area (SA); and B4= no-silt; no-solid waste area (NSW). Levels of Depth (Siltation) = D_1 – 15cm, D_2 – 30cm, D_3 – 60cm; Levels of distance (Waste Effluents) = W_1-5m, W_2-15m, W_3-25m.

Data Collection and Analysis:
Three plots of 20 m x 20 m were randomly selected in each of the sites using Clegg *et al.*, (1996) and Barbour *et al.*, (1987) methods. The study area was divided into four natural representative areas; Solid waste area, silt + solid waste area, silted area and no-silt; no-solid waste area. A 1m x 1m quadrat was laid at an interval of 5m within each plot as described by James, (1996). Soil samples were collected in each of these laid quadrats at 15cm, 30cm and 60cm depth levels using the soil auger. Below is a layout of the sampling points (Figure 3).

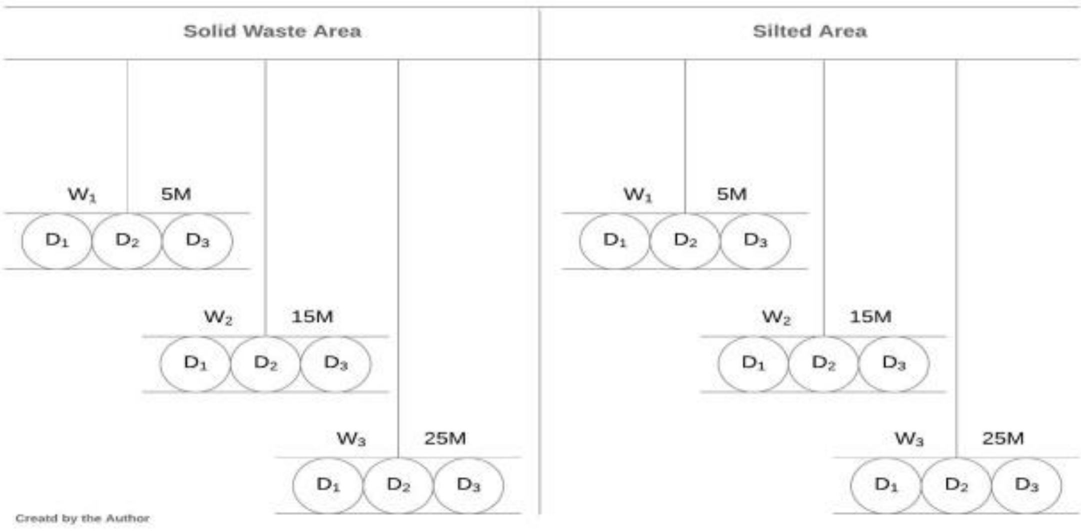

Figure 3: Layout of Sampling Points

Soil Textural Class in the Study Area:
Mechanical analysis tests for soil textural classes were carried out in the laboratory using the following procedure: The soil samples were dried; particles greater than 2 mm, such as gravel and stones, were removed. The remaining part of the sample, the fine earth, was finely grounded to separate all the particles. The total weight of the

fine earth was measured. The fine earth was passed through a series of sieves with mesh of different sizes, from 3 mm mesh down to about 0.5 mm mesh sieve. The weight of the contents of each sieved soil were calculated separately and expressed as a per cent of the total initial weight of the fine earth. The weights of the very small particles of silt and clay which have passed through the finest sieve were measured by sedimentation. They were also expressed as a per cent of the total initial weight of the fine earth. The procedure is based on that described by Metson (1971).

The Influence of Siltation in the Study Area:

Soil samples were taken at 5 m, 15 m and 25 m distance apart; starting from the edge of each of the study sites (solid waste, silt + solid waste, silted and no-silt; no-solid waste areas) and the various depth levels of silt were recorded. The textural class was analysed using the United States Department of Agriculture (USDA) system.

Determination of Soil pH:
Soil pH was determined by mixing 10g of soil sample into 25 ml beaker. 20ml of distilled water was added and stirred, then left for 30 minutes to settle down. Then the reading was taken from the pH meter also known as the electronic probe method. The electrode was immersed in the solution and the meter read the pH value. The method is based on that described by Blakemore *et al*., (1987).

RESULTS
Soil pH and Textural Classes at the Various Sampling Locations
Table 2 shows mean sizes of soil textural classes at 5m, 15m and 25m distances at the study areas. At α = 0.05, the mean value of pH was significantly different at the various sampling locations (Figure 4). However, LSD shows that the highest value of pH (6.930) was found at 15m distance at silted area (SA). The lowest pH value (5.640) (which is a neutral pH) was found 25m away at silt + solid waste (SSW) area. It was however not significantly different from values obtained 5m away at solid waste (SWA) areas (5.693) and (5.980) at no-silt; no-waste (NSW) areas. The mean value of percentage sand was highest (97.600) at 15m at silted area (SA). The lowest (36.933) percentage sand was found 25m at NSW area. A similar result was obtained at 5m showing percentage clay (38.133) at SWA. The lowest (1.133) clay was obtained at 15m and 25m SA. More so, at NSW silt was highest (29.600) percentage at 25m and lowest (14.600) percentage at 15m distance.

Table 2: Mean Values of Soil pH and Textural Classes at the Various Sampling Locations

Distance	pH	% Sand	% Clay	% Silt
SWA				
5m	5.693^{cd}	43.600^{cd}	38.133^{a}	18.267^{bc}
15m	5.750^{cd}	89.267^{ab}	6.133^{d}	4.600^{de}
25m	6.330^{b}	95.600^{a}	2.133^{ef}	2.267^{e}
SSW				
5m	6.170^{bc}	87.933^{a}	6.467^{de}	5.600^{de}
15m	6.017^{c}	83.933^{b}	7.800^{d}	8.267^{d}
25m	5.640^{d}	92.267^{a}	2.800^{d}	4.933^{de}
SA				
5m	6.293^{bc}	89.933^{ab}	2.800^{ef}	7.267^{de}
15m	6.930^{a}	97.600^{a}	1.133^{f}	1.267^{e}
25m	5.840^{c}	97.267^{a}	1.133^{f}	1.600^{e}
NSW				
5m	5.980^{cd}	54.933^{c}	21.727^{c}	23.267^{b}
15m	6.293^{bc}	75.933^{b}	9.467^{d}	14.600^{c}
25m	6.513^{a}	36.933^{d}	30.133^{b}	29.600^{a}

LSD Values (α: 0.05): pH = 0.352, Sand = 9.781, Clay = 5.359, Silt = 5.324
Means followed by similar alphabets are not significantly different at 5% level of significance.

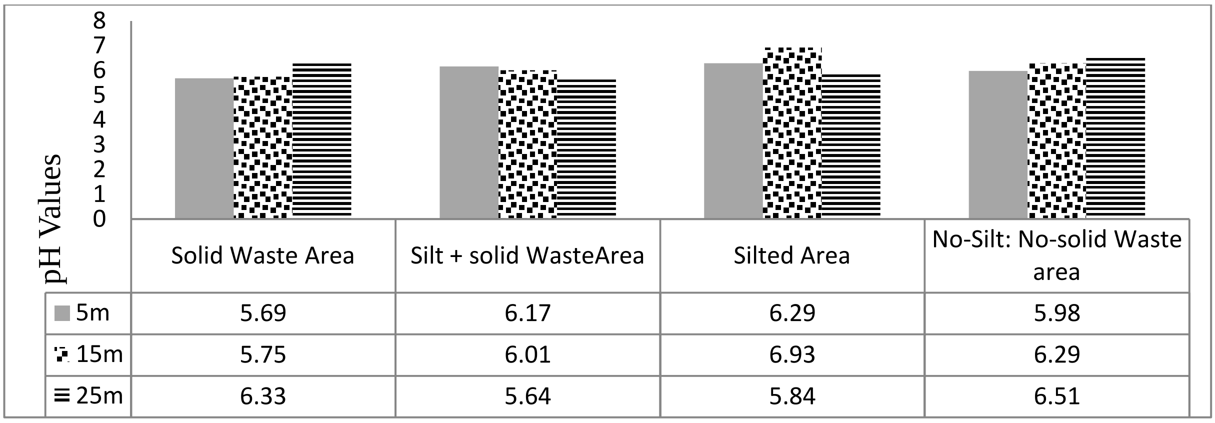

Figure 4: Shows the pH Levels at the Various Sampling Locations.

Table 3: Depth of Silt at the study Area

Distance	Solid waste area	Silt + waste area (cm)	Silted area	No-silt; no-waste area
5m	-	40	65	40.2
15m	43.6	57.2	58.7	45
25m	33.4	46.8	64.5	-

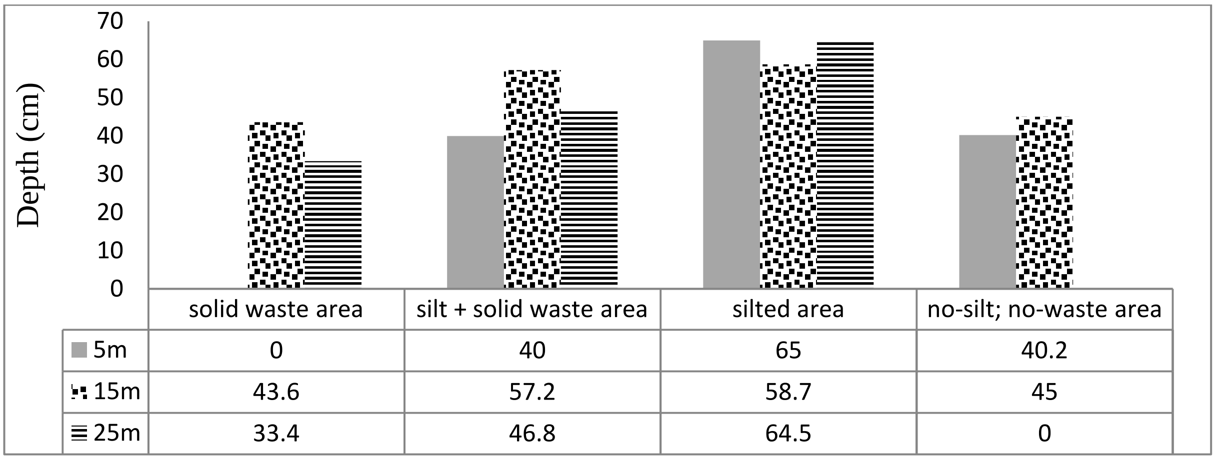

Figure 5: Depth of Silt at the Various Sampling Locations

DISCUSSION

Soil pH and Textural Classes at the Various Sampling Locations:

The pH level was not different at the various distances, but different within the sampling areas. This perhaps could be attributed to the waste effluents migration from the dumpsite and silt deposits from the river Benue during high rainfall that result in flooding and or when the river over flow its banks. However, pollution by heavy metals might also be a contributory factor influencing the pH levels at the various sampling location as observed during the study.

However, textural classes (TC) differed in the sampling locations. At 5m distance, SWA had textural class clay-loam, loam and sandy soil while sandy-loam and sandy soils were found at 15m and 25m distances. The silted area textural class shows sandy-loam, sandy and loamy-sand at 15cm, 30cm and 60cm depth level at 5m distance. While at 15m and 25m at silted area, the textural class shows sandy soils at 15cm, 30cm and 60cm depth levels. While no-silt; no-waste area had sandy-clay-loam, loamy and sandy-loam soils at 15cm, 30cm and 60cm soil depth respectively at 5m distances. While at 15m, the textural class for NSW were sandy-loam, sandy-clay and sandy soils. At 25m, the textural class were clay-loam and loamy soils. Loamy soils as obtained in the studied area are highly desirable for cultivation (Nagajyoti *et al.*, 2010).

The presences of sandy soils are characterized with good aeration and drainage; this was a trend which was observed in the study area similar to Chesworth (2008) report. The clay soils which were depicted in the study are best in nutrient retention; these areas also hold too much moisture and drain poorly (Voroney, 2006). The findings in this study revealed that there are clayey soils at SWA and NSW areas which therefore portray characteristics stated by Voroney as observed during the study. Textural classes with sandy-loam and clay-loam soils are ideal for garden soil or farming purposes as reported by Bruce (1997). This was observed in the study sites (SWA, SSW, SA, and NSW) as there were cultivated farmlands. Also, the result obtained from the four areas (SWA, SSW, SA, and NSW) suggests that NSW area is a more suitable site for harbouring of different plant species since the chemical analysis and textural class obtained suggests moderate availability of nutrients and clay-loam respectively in this site.

Depth of Silt at the Various Sampling Locations:

The depth of silt is shown in Table 3 and Figure 5. At 5m and 25m distances, silt was not recorded at 15cm and 60 cm depths in the solid waste (SWA) and no-silt; no-solid waste (NSW) areas respectively. This was due to the clayey nature of some parts of solid waste and no-silt; no-solid waste areas. These areas were muddy. There was difficulty in digging with soil auger. Figure 5, suggests that the depth of silt is high at the silted area followed by the silt + waste area. The solid waste area shows a low level of silt deposited at 25m distance (33.4cm).

The presence of silt in the area has caused harm to the habitat and the ecosystem at large. As Wolman (1971) stated in his paper on "The Nation's Rivers, ‘we are particularly weak in our ability to detect subtle initial changes from a natural to a polluted condition’. The effect of siltation in the area cannot be over emphasized, if we are to have a healthy habitat for biodiversity. Individual plant species and macro-faunas in the study area varied as observed during the study at the SWA, SSW, SA and NSW areas in other reports. This suggests that siltation has effect on the diversity and distribution of macrofauna, and plant species in the study area. The silt depth level in the area could be among the factors threatening and causing variations in plant species diversity in the area as seen in the report. The land use system (farming) which is involved with the use of some fertilizers, in the NSW area could also be the reason for inadequate natural regeneration in the area as these chemical content may be harmful to some flora and fauna species.

CONCLUSION

Flooding has accentuated the rate and volume of siltation over the years in the study area; the accumulation of silt and the anthropogenic activities such as farming, nomadic pastoralism and fuel wood harvesting does not encourage biodiversity increase in some areas as observed during the study. This study has provided information on the physical properties of soil which is important when transplanting and going into farming in the area. The findings of this study can enhance the practice of agro-forestry in the study areas; as both indigenous and exotic tree species were present. Also, this study points to the hazards caused due to deterioration of the habitat as well as the ecosystem because of the silt that is deposited and solid waste pollution in the area.

Recommendations

If the current trend of deforestation at the expense of the natural environment continues, and no active response to the deteriorating pattern of land cover and environmental changes is initiated, the effects would be greater than the intending benefits of the product. More research is needed so we can understand changes in biological systems due to changes in environment. Artificial regeneration should be encouraged in areas with trait of flooding and tree planting should be considered as part of all developmental projects

REFERENCES

Adefioye, S. A. (2013). Analysis of Land Use/Land Cover Pattern along the River Benue Channel in Adamawa State, Nigeria. Department of Geography, Obafemi Awolowo University, Ile Ife, Nigeria. *Academic Journal of Interdisciplinary Studies*, 2:128-138.

Bartsch, A. F. (1960). Settleable solids, turbidity and light penetration as factors affecting water quality. Second Seminar on Biological Problems in Water Pollution, U.S. Department of Health, Education. and Welfare, Public Health Service, R. A. Taft San. Eng. Cent. Cincinnati, Ohio, Pp. 118–127.

Blakemore, L.C.; Searle, P.L.; Daly, B.K. (1987). Methods for Chemical Analysis of Soils. New Zealand Soil Bureau Scientific Report 80. 103 Pp.

Bruce, R. H. (1997). Soil Testing Handbook for professionals in agriculture, horticulture, nutrient and residuals management. Third edition. Formerly "Soil Testing Handbook for Professional Agriculturalists" Written/Revised by: Bruce R. Hoskins. Maine Forestry & Agricultural Experiment Station University of Maine. 14 pp.

Chan, Y.S.G., Chu, L. M. and Wong, H. M. (1997). Influence of landfill factors on plants and soil fauna – an ecological perspective. Environmental Pollution. 97(1-2): 39-44.

Chesworth, W. (2008). Encyclopedia of soil science. Dordrecht, Netherlands: *Springer*. xxiv. ISBN 1-4020-3994-8. Pp.512

Crouvi, O., Rivka, A., Yehouda, E. and Alan, R. G. (2010). Active sand seas and the formation of desert loess. *Quaternary Science Reviews* 29: 2087-2098.

Eboh, E. (2005). Harnessing Renewable Resources Sectors for Economic Prosperity. Paper presented at the Economic Workshop Organized by AIEA and Department of International Development Abuja 22nd June 2005.

F.A.O. (United Nation Food and Agriculture Organization) (1983) Simple Technologies Charcoal Making, FAO, Rome, Italy, www.fao.org/docrep/s5328e/x5328e00.h

Google Earth (2015). © 2015 Google (viewed: September 22, 2015). http://earth.google.com. 9°17'25.10″N 12°27'17.76″E; elevation 157m eye alt. 1.41km

Groombirdge, B. (1992). Global Biodiversity: status of the earth's living resources. A report compiled by the World Monitoring Centre. London, Glasgow, New York, Tokyo, Melbourne, Medras: Chapman and Hall. ISBN 0412472406. P. 585.

Happold, D.C.D. (1987). *The mammals of Nigeria*. Oxford University Press, Oxford. ISBN: 0198575653. URL: http://dx.doi.org/10.5539/jms.v2n1p217

Ikusemoran, M., Anthony, D. and Maryah, U. M. (2013). GIS Based Assessment of Flood Risk and Vulnerability of Communities in the Benue Floodplains, Adamawa State, Nigeria. *Journal of Geography and Geology* 5(4): 148-160.

Lavelle, P., Bignell D. E., and Lepage M. (1997). Soil function in a changing world: the role of invertebrate ecosystem engineers. Eur. J. Soil Biology. 33: 159-193.

Lukkari, T., Aatsinki M., Viraraghavan A., and Haimi J. (2005). Toxicity of copper and zinc assessed with three different earthworm tests. Applied Soil Ecology. 30: 133-146.

Metson, A.J. (1971). Methods of Chemical Analysis for Soil Survey. New Zealand Soil Bureau Bulletin 12. 14: 334-351.

Muhammed, T. L. (2004). *Environmental Law and Land Use in Nigeria*. A Paper for the Second Colloquium on Environmental Law and Land Use. Organised by the IUCN Academy of Environmental Law, Bonn, Germany in Collaboration with the University of Nairobi, Kenya. 4th-8th October, 2004.

Nagajyoti, P. C., Lee K. D., and Sreekanth, T. V .M. (2010). Heavy metals, Occurrence and Toxicity for Plants: A Review. Environmental Chemistry Letter 8(3):199–216.

Nahon, D. and Trompette, R. (1982). Origin of siltstones: glacial grinding versus weathering. *Sedimentology* 29: 25–35.

Ola, E. A. (2012). Environmental Degradation and the Lingering Threat of Refuse and Pollution in Lagos State. *Journal of Management and Sustainability*. URL: http://dx.doi.org/10.5539/jms.v2n1p217.

Stuart, S.N., Richard, J., Adams, and Martin, J. (1990). *Biodiversity in sub-Saharan Africa and its islands: conservation, management, and sustainable use,* Biodiversity Conservation Strategy Programme, International Union for Conservation of Nature and Natural Resources. Species Survival Commission, Published by IUCN, ISBN 2-8317-0021-3. P. 242.

Udvardy, M.D.F. (1975). A classification of the biogeographical provinces of the world. IUCN Occasional Paper No. 18. International Union of Conservation of Nature and Natural Resources, Morges, Switzerland.

Voroney, R. P. (2006). The Soil Habitat. In Paul, Eldor A. *Soil Microbiology, Ecology and Biochemistry*. ISBN 0-12-546807-5. Pp. 552.

Wolman, M. G. (1971). The Nation's rivers. Science, v. 174, no. (4012): Pp. 905-918.

Wright, J. S., Smith, B. J. and Whalley, W. B. (1998). "Mechanisms of loess-sized quartz silt production and their relative effectiveness: laboratory simulations". *Geomorphology* 45: 15–34.

MARKETING ANALYSIS OF SNAIL IN SELECTED MARKET IN IBADAN METROPOLIS, OYO STATE, NIGERIA

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ABSTRACT

The study on the marketing analysis of snail farming was carried out in Ibadan metropolis; using 100 structured questionnaire to collect data out of which 95 were retrieved. A multistage sampling technique was used in sample enumeration. Descriptive and inferential statistical methods were employed in analyzing the data collected. Archachatina marginata is the commonest species (73.7%) in the markets, sold mostly for consumption (72.6%) and primarily sourced from the wild. Snail marketing is dominated by youths, mostly females (86.3%). The supply of snails is irregular and the business is funded from personal savings and support from cooperative society. Economic analysis showed that marketers require ₦50,000 – ₦250,000 as working capital, with a resultant profit of ₦ 100,000 – ₦150,000. Snail marketing efficiency was 1.33. In conclusion snail market is profitable in the study area.

Keywords: Snail, Marketing, efficiency, constraints

INTRODUCTION

Food and Agriculture Organization (FAO, 1989) has reported that the average animal protein intake in Nigeria is low, calling for concerted efforts towards alleviating this crisis of protein shortage. Unfortunately, the conventional and regular sources of animal protein in the country like beef, pork, goat meat, fish, poultry etc are getting out of the reach of common populace, due to their high price, as a result of the economic down-turn (Olayide, 2004). Also, Wufueke (2004) reported that the consumption of animal protein in Nigeria is 5.5g per head per day which is absolutely below the Food and Agriculture Organization recommendation of 35g per head per day. To bridge this gap, various non-conventional animal protein sources like snail, cricket, and winged termites are now being explored. Snail meat is reported to be high in protein, low in fat, and a good source of ion (Ademolu *et.al.*, 2004). Though snails are gathered from the forest, they are also produced through snail farming (heliculture).

Snail is a terrestrial shell bearing animal of approximately 100,000 species of Molluscs, of the *Phyllum mollusca*, or alternately, any of the twelve species of land pulmonate gastropods used as human food (Akinnusi, 2002). It is air breathing, usually a monogastric herbivore, with a complex hermaphroditic reproductive system, though demanding cross fertilization. Snail is a small soft creature with a hard shell on its back that moves very slowly and often eats garden plants. Snails are the largest groups of mollusks constituting the largest animal groups after arthropods (Yoloye, 2002). Land snails habitat ranges from the dense tropical high forest in southern Nigeria to the fringing riparian forests of the derived guinea savanna (Odaibo, 1997).

The snail is usually found in damp places, under leaves, tree stumps and stones (Amusan *et al*, 1999). They are abundant in the raining season, but undergo aestivation and hibernation, during the dry season, by forming a membrane over the shell opening, to reduce water loss. Amusan *et al*. (1999), indicated that snails are well adapted to adverse environmental conditions, such as cold, heat and temperature fluctuation and they have natural immunity against disease causing organisms, such as Streptococcus, Staphylococcus and Penicillin species. The special adaptability found in snails in their natural habitat accounts for very low mortality rate, compared to other conventional livestock (Hamzat, 2003

Snails as human food have been known since Roman times. In the middle ages, they were loved as some food rich in protein (Agbelusi and Ejide, 1992). Cobbinah (1993) reported that snails are gathered in the wild, packed into bags, wooden crates or basket and transported to main roads or to urban centres as a source of income.The edible portion (foot) of *A. marginata*, contained 17 – 18% crude protein (Odukoya, 1998, Omole, 1999), which compares to conventional livestock meat like Multon, Duck and Chicken, which have crude protein content of 16.9, 18.6 and 20.5% respectively (FAO, 1969). The fat content of snail meat ranged between 0.96 – 1.36% (Odukoya, 1998; Bright, 1999), which is very low, when compared to 9.6, 21.4 and 23.0%, found in chicken egg, Multon and Duck products respectively.

The low fat content makes snail meat a good antidote for the hypertensive patient and those that have fat related diseases (Bright, 1999). The iron content ranges between 2.7 and 3.5 mg/100g (Imevbore and Ademosun, 1988), while chicken egg, multon and duck have 1.6, 2.0 and 1.08 mg/100g respectively (FAO, 1969), hence it is good for curing anaemia.In traditional African medicine, snail meat is used in the preparation of concoctions for the treatment of various cases such as reduction of labour pains and blood loss in pregnant women during delivery (Cooper and Krowder, 1991; Akinwusi, 1998).

In order to solve the problem of protein deficiency and alleviate the effects of the present global food crisis, snail domestication should be given more attention in terms of funding and research focus. To reduce the cost of snail feed due to its high requirement for crude protein 24% and metabolizable energy 2400 Kcal/kg (Omole, 2002), the inclusion of cassava by-products in snail diet will go a long way to enhance performance and reduce cost of snail production.

Snail markets are found in the rural and urban settlements of Ibadan, Oyo State, Nigeria. The snails are mainly hunted or gathered during the raining season (Olufowobi *et al*, 1989), except of recent when efforts are made to domesticate snails, which makes it a means of poverty alleviation through job creation (Amusan *et al*, 1989). It is now a lucrative business for house wives, retired civil servants, young school leavers, and those looking for business to augment their salaries.

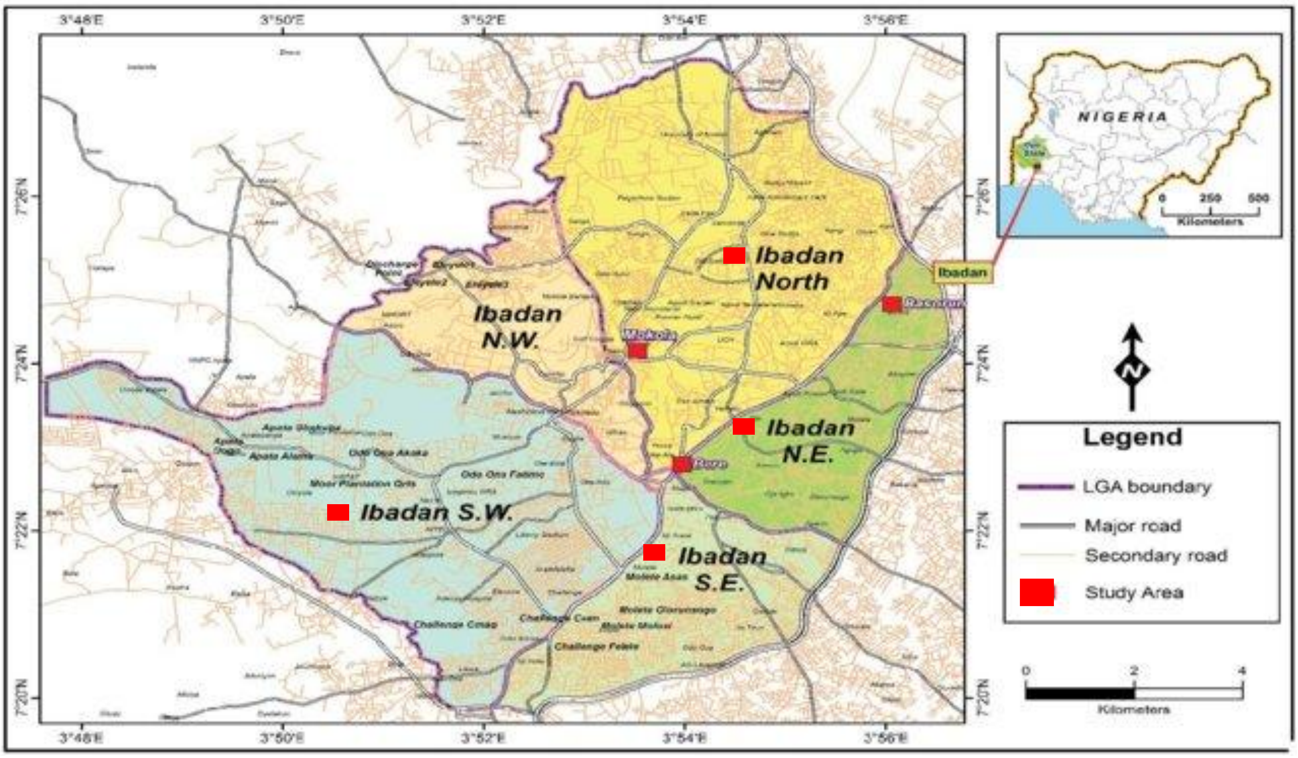
Handling is an important aspect of snail marketing, which has been abused by most marketers, through habits like starving, perforation of shells, improper method of transportation and packaging (Akinnusi, 1998). Snail marketing, if properly handled could be high income yielding and also owing to the fact that snail production is not complete until the product gets to the hands of the consumers.

This study therefore was intended to assess the marketing of snail in Ibadan metropolis. Snail marketing is a seasonal business in most parts of West Africa and it has huge potential to create job along its value chain. Snail markets are traditional, crude and small; with a great hidden potential. There is therefore the need to examine its feasibility for empowerment and maximization of marketing efficiency.

MATERIAL AND METHODS

Study Area

The study was carried outing Ibadan and environs. Ibadan is located in the tropical zone, lying between latitudes 7^{o} N and 9^{o} N of the equator and longitudes 3^{o} E and 5^{o} E of the Greenwich Meridian. The city is characterised by mean daily maximum temperature of 24.5^{o}C and an annual rainfall of 1120mm-1140 mm. The city consists of eleven Local Government Areas (LGAs). According to 2006 census, a population of 2,872,890 peoples was recorded in the study area out of which 49.38%were male and 50.42. % was female (NPC, 2006).The major occupation of the people in the study area is trading. Predominant occupation of the inhabitants is farming, with diversity in crop and animal production. The study examined snail marketing in the area.



Map of Ibadan metropolis **Source: Salami etal,(2016)**

Sampling Technique
Multistage sampling was used to sample the respondents. In the first stage, four LGAs were purposively selected from the Ibadan metropolis, which were Ibadan North, Ibadan Southwest, Ibadan South East and Ibadan North East because these LGAs housed the major snail marketers in the study area. In the second stage, one market was selected from each LGA which were Bodija Market, Bode Market, Oritamerin Market and Oje Market. In the third, stage 25 snail marketers (respondents) were randomly selected from each market.
A total number of 100 copies of questionnaires were administered among the snail marketers but only 95 were retrieved.
Marketing Efficiency =Total return from sales /Total marketing cost.
Gross market margin was applied by calculating difference between Total Revenue and Total Variable cost
GM= TR-TVC
Where:
GM=Gross margin
TR=Total Revenue
TVC=Total Variable Cost

Data Analysis
Descriptive statistics such as frequencies and percentages were applied to analyse the socio-economic characteristics and constraints of respondents while marketing efficiency was determine using Total returns from sales divided by Total marketing cost.

RESULTS
Table 1 revealed that 13.7% of the snail marketers were males and 86.3% were females. This showed that the females dominated the business. It further revealed that 47.4% of the respondents were within the age group of 39-40years while age range of 50 – 69yrs and 1-29yrs accounted for 36.8% and 10.5% respectively. This result showed that majority of the respondent were in their active age . Snail marketing can engage many people as an empowerment programme, since it does not require any special skill and education. The result revealed that snail marketers did not require high level of education, since most of the practitioners (94.3%) had at most secondary school education. The low level of education could be attributed to the primitive nature of the business, poor handling of snails and the poor fund outlay of snail marketing,. Majority of the snail marketers are married (73.7%) while 15.8% and 10.5% of the respondents were single and widowed. This result shows that all categories of people were involved in the marketing of snail though dominated by married women probably to increase household income.. The result showed that 83.2% had no

regular supply, while 16.8% had regular supply, this implies that snail marketing is seasonal. Majority of the respondents 52.6% were Christian while 36.8% and 10.5% of the respondents were Muslims and traditional worshippers respectively. The result implies that there is no religion prohibition against snail marketing due to nutritional and medicinal and economic importance of snail. The result show that 42.1% of the respondents have 3-4yrs of experience, 36.8% and 11.6% have 5-6yrs and 1-2yrs of experience. This implies that more people are going into snail marketing and production due to increase in the awareness on the importance attached to snail production and promotion of small scale business by government.

The result reveals that 55.8% of the respondent used personal savings as initial capital to set up their business, 31.6% and 12.6% raised their capital from cooperatives and friends and relatives respectively.. The result further reveals that 40% of the respondents could mobilized N50,000 – N100,000 as their business operation capital, 30.5% , mobilized less than 50,000.(24,2% mobilized ₦100,000 – 200,000 while 5.3% could mobilized ₦ 200,001 – ₦ 250,000 as their business operational capital. The result reveals that 49.5% of the respondents realized 100,000 – 150,000 as annual income, 26.3% realised ₦150,000 – 250,000 as income while 21.1% above ₦ 300,000 as annual income. This result implies that Snail business is profitable.

Table 2 reveals that 73.7% of *Archachatina marginata,* 14.7% *Achatina achatina,* 7.4% and *Achatina fulica* were found in the market The result implies that *Archachatina marginata* was predominantly in the markets. This is due to the fact that it has more meat than other species and this command higher price thereby giving more revenue to the marketing of snail in Ibadan metropolis was *Archachatina Marginata* and this could be due to its high level of availability and acceptability.

The result revealed that 47.4% of the respondents stored snails in the drums or pots, 42.1% stored their snail in the tyres while 5.3% stored their snail in the fenced pen. This implies that drums or pots are the most preferred storage facility in the study area. The snails were purchased for consumption as reflected by 72.6% of the respondents while 21.1% indicated that they purchased snails for medicinal purpose and 5.3% purchased snails for domestication. It was obvious from the result in the study area that majority of the consumers procured snails for consumption; this could be due to the increased awareness of nutritional benefits of snails meat as a good source of protein coupled with its low fat and cholesterol contents.

The result reveal that 77.9% of the respondents sourced their snail from the wild, 14.7% from snail farmers 5.3% sourced their snail from the research institutes. This result implies that the source of the snail was predominantly from the wild (77.9%).

Table 3 revealed the marketing margin of 200 kilogramme of *Archachatina marginata*, this is defined as the difference between purchase and sales prices (Tomek and Robinson, 1981). The marketing margin was ₦50, 000 The economic marketing efficiency of snail was determined to be (1.33), and was found to be efficient The efficiency of snail marketing could be further enhanced, with strict adherence to the proffered solutions, such as repairing of bad roads to reduce transportation cost, improved financing to snail marketers, through enhanced micro-financing and creation of more awareness on snail domestication

Table 1:Socio Economic Characteristics of Respondents

Variables	Frequency	Percentage
Gender		
Male	13	13.7
Female	82	86.3
Total	**95**	**100**
Age Distribution		
1-29	10	10.5
30-49	45	47.4
50-69	35	36.8
70 Above	65	5.3
Total	**95**	**100**
Educational Level		
No Formal Education	20	21.1
Primary	40	42.1
Secondary	30	31.1
Tertiary	5	5.3
Total	**95**	**100**
Supply Of The Product		
Regular Supply	16	16.8
NOT Regular	79	83.2
Total	**95**	**100**
Religion		
Christian	50	52.6
Muslim	35	36.8
Traditional	10	10.5
Total	**95**	**100**
Year Of Experience		
1-2yrs	11	11.6
3-4yrs	40	42.1
5-6yrs	35	36.8
Above 6yrs	9	9.5
Total	**95**	**100**
Source Of Capital		
Personal Savings	53	55.8
Co-Operative Society	30	31.6
Relatives And Friends	12	12.6
Total	**95**	**100**
Business Operational Capital		
Less Than- ₦50,000	29	30.5
50,001 – 100,000	38	40.0
100,001 – 200,000	23	24.2
200,001 – 250,000	5	5.3
Total	**95**	**100**
Annual Income		
Less Than 100,000	20	21.1
100,001- 150,000	47	49.5
150,001- 250,000	25	26.3
Above 300,000	3	3.2
Total	**95**	**100**

Source: Survey 2018

Table: 2. Management practices of snail in Ibadan Metropolis

Variables	Frequency	Percentage
Breed of snail		
Archachatina marginata (igbin apinnu)	70	73.7
Achanna achatina (Igbinilako)	14	14.7
Achatina fulica	7	4.2
A. Marginata, A. achatina and A. fulica	4	4.2
Total	**95**	**100`**
Means of storage		
Fence pen	5	5.3
Drums or pots	45	47.4
Tyres	40	42.1
Others	5	5.3
Total	**95**	**100**
Snail usage		
Consumption	69	72.6
Medicinal	20	21.1
Domestication	6	6.3
Total	**95**	**100**
Source of supply		
Wild	74	77.9
Snail farmers	14	14.7
Research Institutes	5	5.3
Wild, Snail Farmers and Research Institutes	2	2.1
Total	**95**	**100**

Source: Survey 2018

Table 3: Estimate of Market Margin of 200 kg of *Archachatina marginata* (Igbin Pinnu)

Parameter	Amount(₦)
Cost of purchase (N600 per kg)	120,000
Marketing Cost	
Cost of loading	1,000
Cost of unloading	1,000
Cost of feeding	2,000
Rent	3, 000
Total variable cost	9,500
Sales price (800 per kg)	170,000
Gross margin	50,000
Net Margin	40,500

Marketing channels for edible land snail in Ibadan Metropolis.

Figure 1 revealed that snails found in selected Markets in Ibadan were mainly from the wild collectors, which were from the following Local Government Areas like Akinyele, Ido, Ona Ara, Oluyole. Snails were also brought from nearby states like Osun, Ogun and Ondo. Other minor sources of snail to the final consumers were snail farmers and research Institutes, because they have embraced domestication. The retailers purchased from these sources and finally sold them to the consumers.

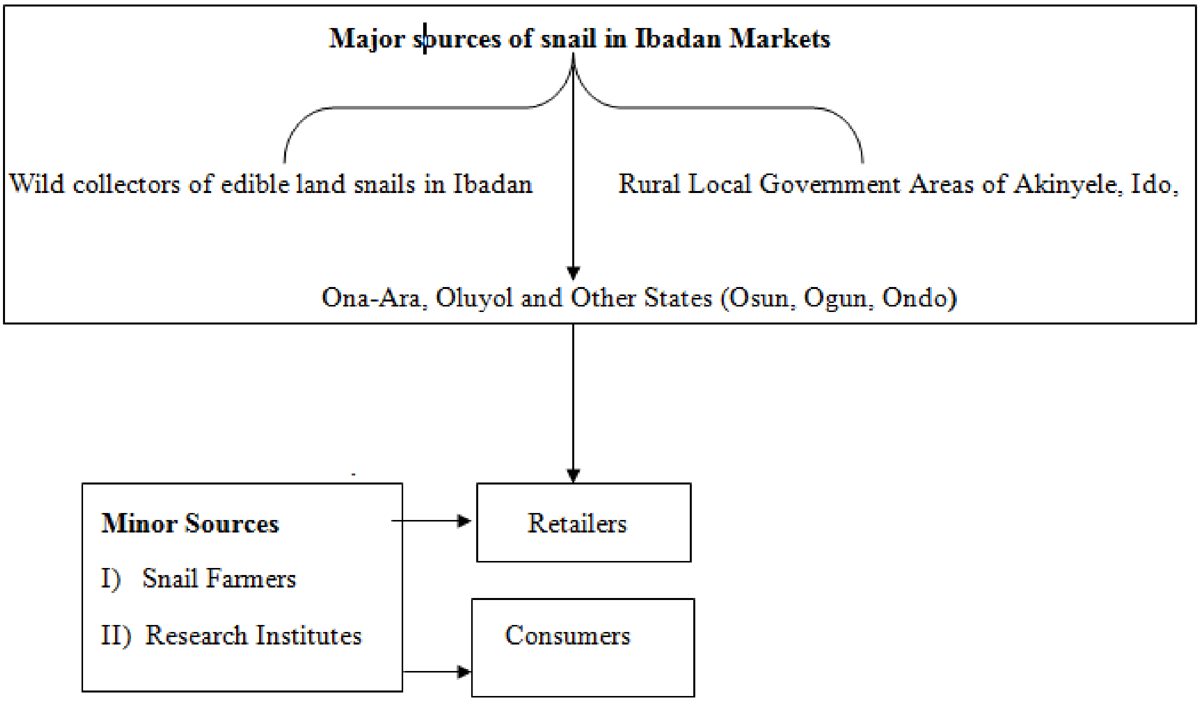


Figure 2: Marketing channels for edible land snail from selected Markets in Ibadan

Constraints of Snail Marketing in Ibadan Metropolis

Table 4 shows that snail marketing in selected Local Government in Ibadan metropolis encountered several constraints. About 31.6% of marketers faced with irregular supply.26.3% complained of high cost of purchase, 21.1% complained of lack of finance, 15.8% faced with inadequate storage facilities, and 5.3% complained of high cost of transportation.

Table 4: Constraint of Snail Marketing in Ibadan Metropolis

Constraint	Frequency	Percentage
Lack of finance	20	21.1
Irregular supply	30	31.6
High cost of purchase	25	26.3
Inadequate storage facilities	15	15.8
High transportation	5	5.3
Total	**95**	**100**

Source: Survey 2018

DISCUSSION

Result showed that the females dominated the business. This results is in agreement with Souley and Sanni (2008) when they stated that women are not only consulted but have a major role to play in marketing of livestock and other related activities. They also opined that most decisions on snail marketing and production involved women. This result showed that majority of the respondent were in their active age and this was attributed to the rigour of transportation and sourcing of snails.(Ogunniyi 2009) when he reported that snail business is most embraced by young people, most of which has small family size and less domestic responsibility which avails time to travel to source for snails. Snail marketing can engage many people as an empowerment programme, since it does not require any special skill and education.

The low level of education could be attributed to the primitive nature of the business, poor handling of snails and the poor fund outlay of snail marketing, thus agreeing with observation of Fakoya and Eniola (2002) that mental horizon of marketers and eventually improve their ability to source for fund. This result shows that all categories of people were involved in the marketing of snail though dominated by married women probably to increase household income, this is in line with findings of Yusuf (2002) and Ogunniyi (2009) when they found out that married people were more involved in snail farming. Snail marketers raised their capital from cooperatives and friends and relatives respectively. The results also agreed with the findings of Raheem (2001) that 96% of snail farmers used their personal savings as a source of initial capital. . This result agreed with Akanni and Adetayo (2011),Babatunde (2008) which found out that the amount of working capital for business enterprises often determines the level of output and the accruable profit margin. market The result implies that *Archachatina marginata* was predominantly in the markets. This is due to the fact that it has more meat than other species and this command higher price thereby giving more revenue to the marketers. This result agrees with the findings by Hamzat (2000) that *Archachatina marginanta* is common in Nigeria and it is an excellent source of animal protein, having large body size and easy to manage. The findings also agreed with Akinnusi (2004) which stated that the commonest breeds of snail in Ibadan metropolis was *Archachatina marginata* and this could be due to its high level of availability and acceptability.

It was obvious from the result in the study area that majority of the consumers procured snails for consumption. This could be due to the increased awareness of nutritional benefits of snails meat as a good source of protein coupled with its low fat and cholesterol contents Ayodele and Asimolowo (1999). This result implies that the source of the snail was predominantly from the wild (77.9%). These result corroborated the findings of Eze *et al.* (2006) and Kehinde 2009, when they confirmed that most snails in Nigeria were sourced from wild through hunters and gatherers, who eventually sell to the retailers or marketers. The economic marketing efficiency of snail was determined to be (1.33), and was found to be efficient. Nwosu and Onubuogu (2008) stated that economic marketing is efficient, if the computed ratio is greater than one, and inefficient, if otherwise, the value obtained was close to 1.08 obtained by Eze *et al*, (2006), for wet and dry season marketing efficiency of snail.

The efficiency of snail marketing could be further enhanced, with strict adherence to the proffered solutions, such as repairing of bad roads to reduce transportation cost, improved financing to snail marketers, through enhanced micro-financing and creation of more awareness on snail domestication

CONCLUSION

It could be concluded that the market was dominated by females and the dominant age group of the marketers was 30-49yrs because it is a youth dominated venture. The respondents sourced their capital from personal savings. While some through cooperatives. The commonest breed of snail found in all the market is *Archachatina marginata*. The level of snail domestication was low because majority of the respondents sourced snails from the wild.

Recommendation

Based on the findings the following recommendations were drawn

i. Snail farmers and marketers should be empowered with low interest loan.
ii. Advocacy on Snail farming should be encouraged to ensure conservation to prevent extinction.

REFRENCES

Agbelusi, E. A. and Ejide, B. N. (1992). Utilization of the African giant land snail (Archachatina marginata) in the humid areas of Nigeria. *Tropical Agriculture (Triacdad)*, 69: 67-72

Akanni. K.A and Adetayo A.O (2011): Estimationof cost-return structure and technical efficiency in sawmilling industry in Ijebudivision Ogun State, Nigeria. *Journal of forestry research and management*, 8: 64-79.

Akinnusi, O. (2000). Snail rearing. Case study of Abeokuta, Ogun State, Nigeria. Proceedings of the 5th Annual Conference of Animal Science Association of Nigeria. Held in Phort Harcourt, Nigeria.

Amusan, A. J. and Omole, A. J. (2000). A paper presented on learning and sharing on snail farming management, organized by UFID's, capacity building for decentralized development on 5th – 7th July, 2002 at I. A. R. & T., Ibadan.

Amusan, J. A. and Omidiji, M. O. (1999). Edible land snail, a technical guide to snail farming in the Tropics. Verity Printer Limited, Ibadan. Pages 5-50

Amusan, J. A., Oluokun, A. J., Ogundola, F. I. and Omole A. J. (1998). Snail farming

Ayodele, I. A. and Ashimolowo, A. A. (1999). Essential of snail farming. Agape prints, Ibadan guide. Technical bulletin, I. A. R. & T., Ibadan.

Bright, S. O. (1999). Prospects and problems associated with snail farming. Heritage Printers Nigeria Limited, Lagos. Page 96.Cobbinah, J. R. (1993). Snail farming in West Africa. A practical guide CTA publication. Sayce Publishing. United Kingdom.

Cooper, J. E. and Krowler, C. (1991). Snails and snail farming. An introduction for the veterinary profession. *Veterinary Record* 129: 541-549.

Eze, C. C., Ohakenya, D. O. and Oguoma, N. N. O. (2000). Analysis of land snail marketing in Owerri Agricultural Zone of Imo State, Nigeria. Animal *Production Research Advances,* 2(2): 94 – 97

Fakoya, E. O. and Eniola, F. (2002). Identification of information needs of farmers in rabbit production in Ondo State. Proceeding of the 7th Annual Conference of Animal Science Association of Nigeria Pages 294 – 296.

F. A. O. (1989). Food and Agricultural Organization Production Year Book, Rome Italy.

Imevbore, E. A, and Ademosun, A. A. (1988). The nutritive value of the African giant land snail. *Journal of Animal Production Resource*, 8 2: 76 – 78.

Odukoya, A. A. (1998). Comparative effect of four different leaves on the growth performance of grower snails (Archachatina marginata). M. Sc., Thesis, University of Ibadan, Nigeria.

Olufokumbi, B., Phillips, E. O., Omidiji, J. O., Ogbona, V. O., Makinde, H. P. and Apasile, O. J. (1989). The economics of commercial domestication of the African land snail (Archachatina marginata) in Nigeria. *Slugs and snails in World Agriculture,* 41: 40 - 47

Omole, A. J. (1998). Utilization of different energy supplements on performance characteristics of growing snail (*Archachatina marginata*). M. Sc. Thesis, University of Ibadan, Nigeria, Page. 22.

Omole, A. J. (2002). Nutrient requirements for different stages of growth of African giant snail (Archachatina marginata). Ph. D. Thesis, submitted at the department of Animal Science, University of Ibadan. Page 2.

Salami,R.O,Von meding,J.K and Giggins,H (2016) Assessing Habitat of Vulnerability in African Cities,(a Case study of Poverty Housing in Ibadan Metropolis.

Souley, Y. N. and Sanni, S. A. (2008). Gender diversity in access and control of resources among integrated crop – livestock farmers in Southern Niger Republic. 23rd Annual Conference of N S A P. Pages 324 – 326.

Yoloye, V. L. (1988). Basic invertebrate zoology. Ilorin. University Press. Pages 134 – 144.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Malik et al., 2019

BUSHMEAT TRADE AND WILDLIFE CONSERVATION IN MAKURDI METROPOLIS, BENUE STATE–NIGERIA

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ABSTRACT

This study was conducted to identify sources of bushmeat supply to Makurdi metropolis,wild animal species sold as bushmeat in Makurdi Markets and their conservation status and income from the sales of bushmeat Reconnaissance survey was carried out to identify major markets where bushmeat are sold and purposively selected. Data were collected through structured questionnaires, direct observation and personal interviews within selected target groups in the markets. 100 questionnaires were administered to bushmeat traders across six markets namely; High level, Modern market, North Bank, Wadata and Wurukum, Fidii. Data was analysed using Descriptive statistics such as tables, percentages, charts and figures to present data obtained from the study. A total of 1452 dry carcasses of 14 bushmeat species were encountered in the markets during the study period. Giant rat (Cricetomys gambianus) had the highest rate with 14.74% while the least is red duiker with 3.3%. Among the council wards surveyed Wurukum, has the highest numbers of bushmeat sellers (42%) while the least was Fiidi (5%).The conservation status of all the bushmeat encountered were least concern. The study also shows that there is high income from the sales of bushmeat Based on the findings it is recommended that there is need for wildlife conservation education to bushmeat sellers, provision of alternative livelihood and protein source, wildlife domestication should be encourage by bushmeat sellers to meet market demand, reviewing and enforcing the law, routine inspection of bushmeat stalls in the market. There is also need to also carry out research on bushmeat trade in other local government areas of the state.

Keywords: Bushmeat Trade, wildlife conservation, Consumption, Conservation status

INTRODUCTION

Wildlife trade is likely a major cause for the decline of wild fauna and flora worldwide. Global trade in wildlife and their products, estimated to be worth 11 to $15 billion (U.S.) annually and more than 30% could be illegal (Oldfield, 2002), second only to narcotics and illegal arms trade (Reeve, 2002). Bushmeat trade has long been recognized as a major threat to biodiversity in forest areas of Central and West Africa (Fa *et.al.*, 2003).Unsustainable harvests of bushmeat threaten not only the survival of the exploited species but also livelihoods of those people who depend on it(Brown,2003).

In many communities including Nigeria, bushmeat constitutes a large proportion of the animal protein being consumed and significant component of local and even national economies contributing significantly to food security(Bowen-Jones *et.al.*, 2003; Wilkie *et.al.*, 2008: Okiwelu, 2009: Tee *et.al*, 2012).

Bushmeat is by far the most expensive meat in many countries. Often the demand for bushmeat and the consequent prices are increasing much more than domestic meat. In many part of Africa the high demand for and the cost of bushmeat compared to other form of protein has created a situation where the hunter finds it more profitable to sell his catch rather than eat it. The income derived from hunting is often spent on cheaper protein with savings used to meet other expenses.

Key drivers of illegal hunting and bushmeat trade include increase demand of bushmeat in rural and urban areas due to population increase, encroachment into wildlife areas, lack of enforcement, lack of alternative livelihood, lack of alternative food source, lack of clear rights over wildlife or land, and/or inadequate benefits from wildlife, Political instability, corruption and poor governance and demand for wildlife body parts for traditional medicine and ceremonies (Lindsey *et.al*., 2012) Trade in bushmeat and its impacts have not been given much attention in the savanna biome due to misconception that hunting for bushmeat is largely subsistence and is practiced on a limited scale (Barnett, 1998 and Lindsey et al. 2011).
In Nigeria one of the main objectives of wildlife management is bushmeat production to increase the animal protein available in rural and urban areas of the country with particular emphasis on rural areas. With the rate of decline in wildlife species in the country it is no longer visible, there is need for policy maker to review the objective to focus more on ecotourism which has alots of value chains.
The study was carried out to identify sources of bushmeat supply to Makurdi metropolis, wild animal species sold as bushmeat in Makurdi Markets and income from the sales of bushmeat and their conservation status.

MATERIALS AND METHODS

Study Area

This study was carried out in Makurdi metropolis Benue State, Nigeria. It is situated on latitude 6°22' and 7°56' to the North and longitude 7°37' and 9°05' east has a total area of 325km^2. The population of the inhabitants is about 300,317 people comprising 158,838 males and 141,479 females respectively (Tee *et al*, 2012). The inhabitants of Makurdi metropolis are predominantly civil servants however; fishing, trading and farming are the prominent occupations of the traditional inhabitants. Other people are involved in burnt bricks production and irrigation farming (vegetables) along the course of River Benue (Tee *et al*, 2012).

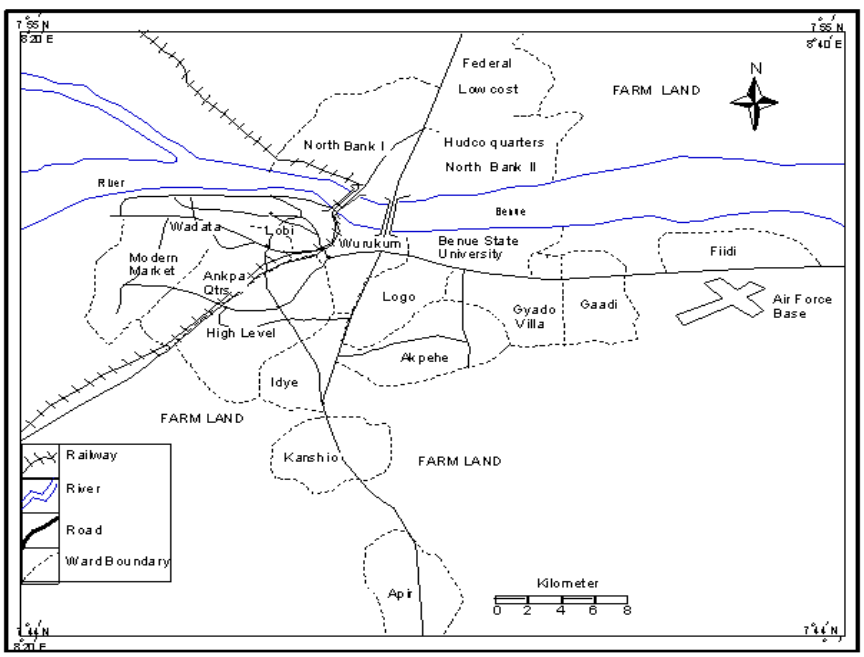

Figure 1: Map of Makurdi Metropolis
Source: Benue State Ministry for Land and Survey (2016)

Experimental Design

A reconnaissance survey was carried out to identify Major markets where bushmeat are sold in Makurdi metropolis and from this the number of questionnaires was deduced. Thereafter, six (6) markets in Makurdi metropolis, namely: High level, Modern, Northbank, Wadata, Wurukum, and Fiidi markets were selected based on the intensity of bushmeat trade. Questionnaires were administered to a total number of hundred (100) bushmeat traders.

Data Collection

Data were collected through structured questionnaires, direct observation and personal interviews within the target groups. The detail of Happold (1987) Mammals of Nigeria was used for identification of bushmeat species. Data on number of difference species brought to the market were collected weekly.

Data Analysis

The data collected were processed into suitable format for analyses by Microsoft excel. Descriptive statistics such as tables, percentages, charts and figures were used to present data obtained from the study.

RESULTS

Demographic Characteristics of Bushmeat Traders

As illustrated in table 1 the result indicates that gender was 50% for both male and female respondents. More of the traders (49.0%) were single while (48.0%) were married. Most of the traders (57.1%) were between age brackets 31-40 followed by 41-50 (23.5%) and the least age was between 51- 60 (1.0%). Result also shows that most of the bushmeat traders (43.9%) were Secondary School Certificate holders while the least were Tertiary Certificate holders (13.3%). Most of the respondents were Christian (61.2%) with other forms of religion being the least (12.2%). On years of bushmeat trade experience; 57.1% of the respondents had between 1-5 years' experience trading on bushmeat while 2% had between 16-20 years' experience.

Table 1: Demographic Characteristics of Bushmeat Traders in the Study Area

Characteristics	Category	Frequency	%
Gender	Male	49	50.0
	Female	49	50.0
Marital status	Single	48	49.0
	Married	47	48.0
	Others	3	3.1
Age	20-30	18	18.4
	31-40	56	57.1
	41-50	23	23.5
	51-60	1	1.0
Educational status	Primary	15	15.3
	Secondary	43	43.9
	Tertiary	13	13.3
	Non-formal	27	27.6
Religion	Christianity	60	61.2
	Muslim	26	26.5
	Others	12	12.2
Years of experience	1-5	56	57.1
	6-10	31	31.6
	11-15	9	9.2
	16-20	2	2.0

Sources of Bushmeat supply to Makurdi metropolis

The result of the study revealed that bushmeat traders obtain bushmeat from four supply sources namely; Borno state 36%, Cross River state 26%, Adamawa state 20% and Kaduna state 18% respectively (Figure 2).

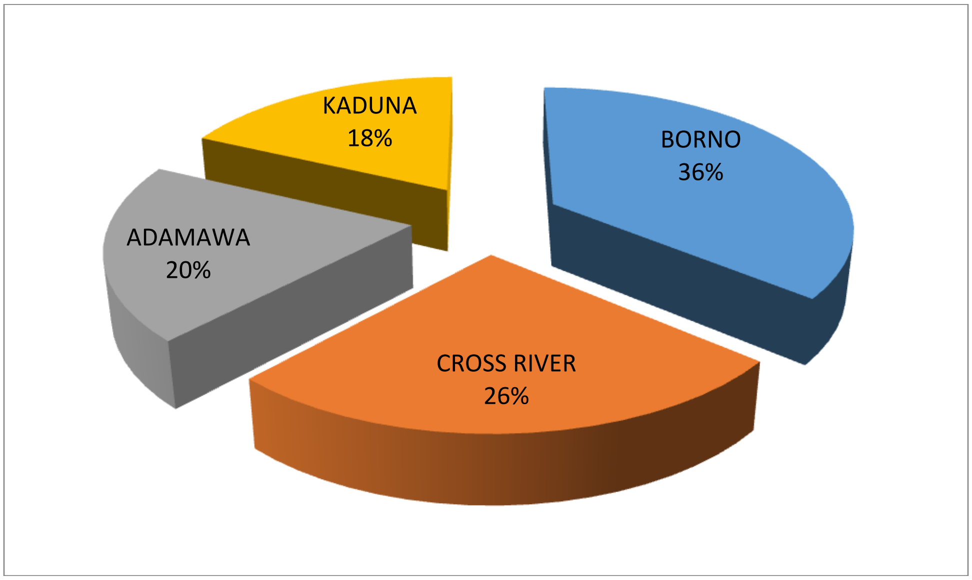

Figure 2: Sources of Bushmeat Supply to Makurdi metropolis

Bushmeat Species sold in Makurdi Markets

A total of 1452 dry carcasses of the 14 bushmeat species were encountered in the markets during the study period (Table 2). Giant rat (*Cricetomys gambianus*), representing 14.74% of the total bushmeat encountered dominated the bushmeat market while Red duiker *(Cephalophus caffer)* has the least encounter rate of 3.31%.The largest quantity of bushmeat (457) was offered for sale in Wurukum market during the study period while Fiidi market recorded the least quantity (82).

Table 2: Species encountered and their Distribution

S/NO	Species	Scientific Name	HLM	MM	NBM	WM	WRKM	FM	Total
1	Giant rat	*Cricetomy gambianus*	45	21	46	28	52	22	**214**
2	Monitorlizard	*Varanus indicus*	25	15	55	22	65	10	**192**
3	Grass cutter	*Thryonomysswinderianus*	22	24	21	14	63	14	**158**
4	Bushbuck	*Tragelaphus eurycerus*	22	14	31	20	45	10	**142**
5	Rabbit	*Sylvilagus brailiensi*	18	10	13	20	42	4	**107**
6	Alligator	*Alligator mississippinsis*	23	8	11	15	32	2	**93**
7	Civet Cat	*Civettictis civetta*	9	7	22	18	31	1	**88**
8	Squirrel	*Funiscuirus pyrrhopus*	22	6	11	12	26	4	**81**
9	Porcupine	*Hystrix cirstata*	14	7	12	15	22	9	**79**
10	Guinea fowl	*Numida meleagris*	33	18	5	8	10	2	**76**
11	Baboon	*Cercopithpus acthiops*	10	10	8	21	16	3	**68**
12	Wild dog	*Lycaon pictus*	11	2	14	12	16	0	**55**
13	Patasmonkey	*Erythrocebus patas*	6	4	8	13	20	0	**51**
14	Duiker	*Philantomba maxwellii*	2	9	11	8	15	1	**48**
			264	**155**	**268**	**226**	**457**	**82**	**1452**

HLM: High level market; **MM**: Modern Market; **NBM**: North Bank Market; **WM**: Wadata Market; **WRM**: Wurukum Market; **FM**: Fiidi Market

Table 3: Species encountered and their conservation status

S/No	Species	Scientific Name	Conservation Status
1	Giant rat	*Cricetomy gambianus*	Least Concern
2	Monitorlizard	*Varanus indicus*	Least Concern
3	Grass cutter	*Thryonomysswinderianus*	Least Concern
4	Bushbuck	*Tragelaphus eurycerus*	Least Concern
5	Rabbit	*Sylvilagus brailiensi*	Least Concern
6	Alligator	*Alligator mississippinsis*	Least Concern
7	Civet Cat	*Civettictis civetta*	Least Concern
8	Squirrel	*Funiscuirus pyrrhopus*	Least Concern
9	Porcupine	*Hystrix cirstata*	Least Concern
10	Guinea fowl	*Numida meleagris*	Least Concern
11	OliveBaboon	*Papio anubis*	Least Concern
12	Wild dog	*Lycaon pictus*	Least Concern
13	Patasmonkey	*Erythrocebus patas*	Least Concern
14	Duiker	*Philantomba maxwellii*	Least Concern

Table 4: Species encountered and their prices

S/No	Species	Scientific Name	Prices(Naira)
1	Giant rat	*Cricetomy gambianus*	1500-3000
2	Monitorlizard	*Varanus indicus*	2000-4000
3	Grasscutter	*Thryonomysswinderianus*	6000-12000
4	Bushbuck	*Tragelaphus eurycerus*	6000
5	Rabbit	*Sylvilagus brailiensi*	1500-3000
6	Alligator	*Alligator mississippinsis*	2000-4000
7	Civet Cat	*Civettictis civetta*	4000
8	Squirrel	*Funiscuirus pyrrhopus*	2000
9	Porcupine	*Hystrix cirstata*	3000
10	Guinea fowl	*Numida meleagris*	2000
11	Baboon	*Cercopithpus acthiops*	8000
12	Wild dog	*Lycaon pictus*	2000-4000
13	Patasmonkey	*Erythrocebus patas*	9000
14	Duiker	*Philantomba maxwellii*	5000

Table 5: Market interview of bushmeat traders in the study area

Characteristics	Category	Frequency	%
Who are your customers	Restaurant	40	40.8
	Drinking bars	37	37.8
	Household	18	18.4
	Traditional medicine	3	3.1
What determines the price	Species	27	27.6
	Size	46	46.9
	The season	25	25.5
What season do you have more supply	Wet	26	26.5
	Dry	72	73.5
Do Government agents inspect the bushmeat you sell?	Yes	36	36.7
	No	62	63.2
Aware that some wild animals are protected by laws?	Yes	57	58.2
	No	41	41.8

DISCUSSION

The variety of wild animal species encountered during the study agrees with the results of previous study by Tee *et.al*.,(2012). However, the species encountered during this survey differ from some of the previous research.14 bushmeat species were encountered in the markets during the study period (Table 1). Giant rat (*Cricetomys gambianus*), representing 14.74% of the total bushmeat encountered dominated the bushmeat market while Red duiker *(Cephalophus caffer)* has the least encounter rate of 3.31%. Wurukum market had the largest quantity of bushmeat (457) while Fiidi Market recorded the least quantity (82). The high numbers of giant rat carcasses were probably attribute to their high productive rate (Happold, 1987; Okiwelu *et.al*., 2009)Survey of markets across West Africa show that commonly traded bushmeats are smaller mammals and bird species which is as the result of an extinction filter with vulnerable taxa such as primates and large mammals have been historically depleted (Cowlishaw *et.al.*, 2005 and Oyegbami*et.al.*, 2018) This results indicated that traders in Makurdi get their bushmeat supply from Borno, Cross-River, Adamawa and Kaduna states which agrees with Newmark, (2008) that wildlife is rapidly disappearing from unprotected lands, due to a wide array of threats and as a result, illegal hunters are increasingly focusing their efforts on protected areas. The four states the traders source their bushmeat from have a national park. It also agrees with Tee *et.al*.,(2012) that the supply of bushmeat to Makurdi from these states means that the wildlife population in Benue state has perhaps dwindled abysmally and can no longer withstand the demand level and the protected.

The price of each bushmeat depends on the size of the bushmeat, species of bushmeat, availability and preferences by consumer and it cut across all class of people which agrees with Oyegbami *et.al*.,(2018). Since there is profit in bushmeat trade, it will encourage the traders to remain in bushmeat trade as a means of livelihood. However, as demand for bushmeat continue to increase and the traders remain in business, the pressure on wildlife resources would likely threaten their sustainability (Fa, 2000; Fa, 2003; Brown and Williams, 2003, Tee *et.al*., 2012; Oyegbami *et.al*., 2018).Regarding their conservation status, all the bushmeat species encountered during the research was listed least concern under IUCN conservation status. it is possible that there is local extinction of threatened species which is in line with Brashares *et.al*.,(2001) that bushmeat extraction in Africa is exceptionally high and West Africa in particular is noted for severe hunting of game (animals) leading to extinctions of some animal species. It could also be as a result of awareness that some wild animals are protected under law although most of the bushmeat traders said government inspection team rarely comes around

CONCLUSION AND RECOMMENDATIONS

Trade in bushmeat is a serious threat to biodiversity in Nigeria. There are so many factors that contribute to the decline. It is important to create awareness on the need for conservation to bushmeat sellers, provision of alternative livelihood and protein source, wildlife domestication should be encourage amongst bushmeat sellers to meet market demand, reviewing and enforcing the law and routine inspection of bushmeat stalls in the market. There is also need to also carry out research on bushmeat trade in other local government areas of the state.

REFERENCES

Barnett R.(1998).Food for Thought:The Utilisation of Wild Meat in Eastern and Southern Africa, TRAFFIC East/ Southern Africa, Nairobi.

Bowen-Jones E., Brown D. and Robinson, E.J.Z.(2003).Economic commodity or environmental crises? An interdisciplinary approach to analysing the bushmeat trade in central and West Africa. Area 35. 4, 390-402

Brashares, J.S. Archase P., Sam M.K.(2001). Human demography and reserve size, Predict wildlife extinction in West Africa. Proceeding of the royal society of London series B 268, 2474- 2478

Brown D and Williams A. (2003). The case for bushmeat as a component of development policy; issues and challenges. International Forestry Review 5.2: 148-155.

Brown D. (2003). Bushmeat and poverty alleviation: implications for development policy.
Technical Report 2, ODI, London.

Cowlishaw G, Mendelson S. and Rowcliffe J.M. (2004) evidence for post-depletion sustainability in a mature urban market. Journal of applied ecology 42:460-468.

Fa J.E.(2000). Hunted animals in Bioko island, West Africa: sustainability and future in Robinson

Fa, J.E., Dominic C, and Meeuwig J.(2003). Bushmeat and food security in the Congo Basi: linkages between wildlife and people’s future. Environmental Conservation 30, 1: 71-78

Fa, J.E., Peres C.A., Meeuwig J.(2002). Bushmeat exploitation in tropical forests: an intercontinental comparison. Conservation Biology 16 (1), 232-237.

Happold, D.C.D. (1987). *Mammals of Nigeria. New York:* Oxford University Press.

Lindsey P.A., Romañach S.S., Matema S., Matema C., Mupamhadzi I., Muvengwi J., (2011). Dynamics and underlying causes of illegal bushmeat trade in Zimbabwe. Oryx 45, 84.

Lindsey P., Balme G., Becker M., Begg C., Bento C., Bocchino C., Dickman A., Diggle R., Eves H.,Henschel P., Lewis D., Marnewick K., Mattheus J., Mcnutt J.W., Mcrobb R., Midlane N., Milanzi J., Morley R., Murphree M., Nyoni P., Opyene V., Phadima J., Purchase N., Rentsch D., Roche C., Shaw J., Van Der Westhuizen H., Van Vliet N., Zisadza P. (2012). Illegal Hunting and The Bush-Meat Trade in Savanna Africa: Drivers, Impacts and Solutions to Address the Problem. Panthera/Zoological Society of London/Wildlife Conservation Society Report, New York. 74 Pages.

Okiwelu S. N., Ewurum N. and Noutcha M. A. E (2009). Wildlife Harvesting and Bushmeat Trade in Rivers State, Nigeria: species Composition, Seasonal Abundance And Cost *Scientia Africana*, 8 (2),1-8.

Oldfield S. (2002). The trade in wildlife: regulation for conservation. Fauna and Flora International, Resource Africa and TRAFFIC International, Cambridge, United
Kingdom.

Oyegbami A.I,Soewu D.A,Oyatogun M.O,Ijiwade E.O. (2018). Utilization of wild animals for Bushmeat in South Western Nigeria: implications for wildlife conservation. Proceedings of 6th NSCB Biodiversity conference 155-159pp

Newmark, W.D.(2008). Isolation of African protected areas. Frontiers in Ecology and the Environment 6, 321-328

Reeve, R. (2002). Policing international trade in endangered species: the CITES treaty and compliance. The Royal Institute of International Affairs, London, United Kingdom.

Tee T.N., Ikpa T.F and Tortange V. (2012) Bushmeat trade in Makurdi Metropolis; implications for the conservation of wildlife in Nigeria Journal of Applied Biosciences 52: 3704 – 3715 ISSN 1997–5902

Wilkie D.S, Starkey M., Abernethy K, Effa, E.N., Telfer,P and Godoy R. (2005). Role of prices and wealth in consumer demand for bushmeat in Gabon, Central Africa. Conservation Biology 19.1:268-274.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Awotoye, 2019

GROWTH RESPONSE OF *Khaya senegalensis* (Desr) A. Juss. SEEDLINGS TO SELECTED ORGANIC MANURES

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ABSTRACT

The experiment on the growth response of Khaya senegalensis seedlings to selected organic manures was carried out in the Federal College of Forestry, Ibadan. The experiment was arranged in completely randomized design (CRD) with six treatments and seven replicates. Germination was observed for eight days. Assessment of growth parameters commenced two weeks after transplanting and was done weekly for 16 weeks. Total plant height, stem diameter and leaf production were measured. Data were analyzed using ANOVA at 5% probability level. Results showed that T_4 (10g of cow dung + 2000g of top soil) had the highest performance in terms of plant height (17.2cm) while T_6 (2000g of top soil) had the least height performance (14.9cm). Sources of manures had no significant influence ($p<0.05$) on the growth of Khaya senegalensis seedlings. The stem diameter growth of the seedlings was not significantly ($p<0.05$) influenced by the manures. T_5 (2.5g of Cow dung + 2.5g of Gliricidia sepium + 2000g of top soil) had the best performance with mean value 0.31mm. T_6 (control) had the least performance with 0.26mm. The highest mean leaf count was observed on the seedlings raised on 5g of Gliricidia sepium + 2000g of top soil with 9.5 while seedlings raised on 10 g of Gliricidia sepium + 2000g top soil had the least with 7.9. Manures had no significant effect ($p>0.05$) on the leaf production of the seedlings. Therefore, more research should be focused on the use of other sources of manures in raising Khaya senegalensis seedlings.

Keywords: Growth, Manure, *Khaya senegalensis*, Seedlings, *Gliricidia sepium*

INTRODUCTION

The importance of *Khaya senegalensis* both in furniture and in traditional medicines cannot be over emphasized. It has contributed immensely to our economy because of its high production of wood content in its tree species. This has enabled its use conventionally for carpentry, interior trim and construction (Lemmens *et al.*, 2008). *Khaya senegalensis* is a deciduous evergreen tree that belongs to the meliaceae family with common name African mahogany tree. *Khaya senegalensis* is a tree, 15 – 30m high up to 1m in diameter with a clean bole to 8 – 16m, buttress not prominent or absent, bark dark grey, with small thin, reddish, tinged scale, slosh dark pink to bright crimson, exuding a red sap. (Orwa *et al.,* 2009).

Khaya senegalensis comprises four (4) species in mainland Africa of which one or two of them are endemic to the Comoros and Madagascar. Khaya species strongly resemble each other in flower and fruit, and differences are more prominent in their leaflet. (Arbonnier, 2004). Some of the species in the genus of Khaya are: *Khaya senegalensis*, *Khaya grandifolia*, *Khaya ivorensis*, *Khaya anthotheca.*

Manure on the other hand, are organic materials which contain three most important substances for plant growth- Nitrogen, Phosphate and Potash. Manure is added to the soil for several reasons. It improves the physical conditions of the soil. It also keeps up the level of humus in the soil and maintains the best conditions for the activities of soil organisms (Opunni-Fimpong, 2006). In addition, it makes up for the plant nutrients which have been removed by crops or lost by leaching and soil erosion. Out of the two basic types of manures, organic manure is considered best because it is from a natural source and has no adverse effect on human being when the end product is consumed. It is therefore necessary to investigate some manures that can increase the growth of *Khaya senegalensis seedlings* for sustainable production at the nursery stage.

MATERIALS AND METHODS

Study Area

The experiment was carried out in Federal College of Forestry, Ibadan. The college is located in Ibadan North West Local Government Area of Oyo state at Latitude 7^0 23′N and $7^0$26′N and Longitude 3^0 36′E and 3^0 52′E of the Greenwich meridian. It has an annual rainfall of about 1400-1500mm and average relative humidity of about 65%. There are two distinct seasons that are notable in the area which are dry and wet (raining) season. (FRIN 2019)

Procedure

Freshly collected seeds of *Khaya senegalensis seeds* were collected from a mother tree at the Forestry Research Institute of Nigeria (FRIN) Ibadan. The seeds were then planted into the germination basket filled with sterilized river sand. Watering was done once a day to enhance seed germination. Meanwhile, *Gliricidia sepium* leaves and cow dung were collected separately and air dried for a period of 2 weeks, grinded into powdered form, mixed with topsoil and then filled into the polythene pots in different quantities. After germination (8days), the seedlings were carefully pricked from the germination basket and then transplanted into the polythene pots. The readings were taken every week.

The treatments are: T_1 =5g of *Gliricidia sepium*+ 2000g (2kg) of top soil, T_2 = 5g of cow dung+ 2000g (2kg) of top soil, T_3 = 10g of *Gliricidia sepium*+ 2000g (2kg) top soil, T_4 =10g of cow dung+ 2000g (2kg) top soil, T_5 =2.5g of *Gliricidia sepium*+ 2.5g of cow dung + 2000 g (2kg) of top soil, T_6 = 2000 g (2kg) of top soil (control**).**

Experimental design

The experiment was arranged in a Completely Randomized Design (CRD) with six (6) treatments and seven (7) replicates. Stem diameter (mm), seedlings height (cm) and leaf production were assessed.

Data Analysis

Data collected were analysed using analysis of variance (ANOVA).

RESULTS

The characteristics of soil is very vital in plant growth and development and this is determined by the nutrient composition of the soil. The result (Table 1) indicated that the total N was higher in top soil (1.35%) than in other media used for the experiment, while potassium and phosphorus was higher in cow dung with 1.0 cmol/kg and 1.5 cmol/kg respectively. This is a proof that the medium used for the study is good enough for planting as it contains the necessary nutrients needed for plant growth.

Table 1: Chemical analysis of top soil, cow dung and *Gliricidia sepium* leaves

Parameters	Top soil	Cow dung	*Gliricidia sepium*
Moisture content%	1.74	0.09	0.09
Total N%	1.35	1.34	0.78
K (Cmol/kg)	0.19	1.0	0.9
P (Cmol/kg)	1.24	1.5	1.2
Mg (Cmol/kg)	1.94	0.21	0.14

Effect of cow dung and *Gliricidia sepium* leaves on seedlings height, stem diameter and leaf production of *Khaya senegalensis* seedlings

Plant height

The result on plant height (Table 2) shows that T_1 (5 g of *Gliricidia sepium* + 2000g of top soil), T_2 (5g of cow dung + 2000g of top soil), T_4(10g of cow dung + 2000g of top soil) and T_5(2.5g of *Gliricidia sepium* + 2.5g of cow dung + 2000g of top soil) had a relatively close mean values with 16.5cm, 16.9cm, 17.2cm and 17.0cm respectively, however, T_4 had the highest performance in terms of plant height indicating that high quantity of cow dung had a positive effect on the height of *Khaya senegalensis* seedlings. T_6 (control) (2000g of top soil), however had the least performance in terms of plant height with 14.9cm. The manure had no significant influence ($p>0.05$) on the plant height of the species (Table 3).

Stem diameter

The result on stem diameter (Table 2). revealed that T_5 (2.5g of Cow dung + 2.5g of *Gliricidia sepium* + 2000g of top soil) had the best performance with mean value 0.31mm, however, 5 g of *Gliricidia sepium* + 2000 g of top soil T_4

(10 g of Cow dung + 2000 g of top soil) and T_5 (2.5 g of Cow dung + 2.5 g of *Gliricidia sepium* + 2000g of top soil)had a relatively close mean values with 0.29mm, 0.30mm, 0.31 mm respectively indicating that the mixture of both cow dung and *Gliricidia sepium* had a positive effect on the stem diameter of the seedlings. The result also revealed that plants in T_6 (control) had the least performance in stem diameter, with 0.26mm. The manure had no significant influence at p> 0.05 on stem diameter of the species (Table 3).

Leaf production

Result (Table 2) indicated that 5 g of *Gliricidia sepium* + 2000 g of top soil produced the highest number of leaves with 9.5. However, 5 g of *Gliricidia sepium* + 2000g of top soil), 5 g of cow dung + 2000g of top soil) and T_4 (10g of cow dung + 2000 g of top soil had a relatively close mean values with 9.5, 9.4 and 9.3 respectively. The result also further revealed that plants on T_3 had the least performance in terms of leaf production with mean value of 7.9. The manure had no significant influence at p> 0.05 on leaf count of the species (Table 3).

Table 2: Effect of manures on seedlings height, stem diameter and leaf production of *Khaya senegalensis* seedlings

Treatments	Plant height (Cm)	Stem diameter (Cm)	Leaf production Count (No)
1	16.5	0.29	9.5
2	16.9	0.27	9.4
3	15.6	0.28	7.9
4	17.2	0.30	9.3
5	17.0	0.31	8.9
6	14.9	0.26	9.1

Table 3: Analysis of variance for the effect of manures on the growth of *Khaya senegalensis* seedlings

Sources of variation	SS	df	MS	F	P-value	F cal
Seedlings height						
Treatments	42.708	5	8.542	0.1456	0.981	2.342
Error	4224.40	72	58.672			
Total	4267.107	77				
Stem diameter						
Treatments	1.346	5	0.269	0.264	0.932	2.342
Error	73.54	72	1.021			
Total	74.887	77				
Leaf production						
Treatments	19.008	5	3.802	0.139	0.983	2.342
Error	1970.154	72	27.363			
Total	1968.162	77				

Not significant p >0.05

DISCUSSION

Organic manure consists of three most important substances for plant growth- Nitrogen, Phosphate and Potash. Manure is added to the soil for several reasons, with ultimate aim of improving soil nutrients. Various researchers who worked on the effect of organic manures on the growth of some tropical trees species gave similar results to that of the present study {(Mbakwe and Nzekwe (2005); Baiyeri (2002)}. The result also agreed with the findings of Mbakwe and Nzekwe (2005) who observed that organic manures had effect on the growth of the seedlings of *Irvingia wombulu* (Vermeosen); this was in conformity with the observations obtained in this study. The findings by Baiyeri (2002) on two tropical tree species [*Anarcadium occidentalis* Linn (cashew) and *Treculia africana* Decne (African breadfruit)] grown on five nursery media formulated from top soil and organic manures at different ratios showed significant effect on seedling emergence of cashew. This study was also supported the findings of Orwa *et al*., (2009) that organic manure was seen to improve the growth of *Khaya senegalensis*. Furthermore, organic manure keeps up the level of humus in the soil, maintains the best conditions for the activities of soil organisms and then makes up for the plant nutrients which have been removed by crops. This was in accordance with the findings of Gideon (2012) who reported that organic manure improved soil nutrients and thus enhanced the seedling growth of *Khaya grandifolia*.

CONCLUSION

The study revealed the potentials of Cow dung and *Gliricidia sepium* at varying levels as good sources of organic manure for the enhancement of the growth of *Khaya senegalensis* most especially at the nursery stage. The treatments also reflected an excellent performance on plant height, stem diameter and leaf production of the tree species.

Recommendations

Based on the findings from this study, it is recommended that Cow dung as well as the mixture of *Gliricidia sepium* and Cow dung be adopted by the farmers in raising *Khaya senegalensis* seedlings. More so, other experiments should be carried out on the use of other sources of manures in raising *Khaya senegalensis*.

REFERENCES

Arbonnier, M., (2004). Trees, shrubs and lianas of West African dry zones. CIRAD, Margraf Publishers Gmbh, MNHN, Paris, France. 573 pp.

Baiyeri, K.P. 2002. Evaluation of nursery media for seedling emergence and early seedling growth of two tropical tree species. Proceedings of the 20th Annual Conference of Horticultural Society of Nigeria, NIHORT, Ibadan. 96-100.

FRIN (2019). Forestry Research Institute of Nigeria, Metrological Station Report.

Gideon, 2012. Effect of varying levels of vermicompost on the growth of *Khaya senegalensis.* Unpublished project in the Department of Forest resources management. University of Ibadan.

Lemmens, R.H.M.J., (2008). Khaya ivorensis A.Chev. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l’Afrique tropicale), Wageningen, Netherlands. Accessed 11 April 2019.

Mbakwe, R. and Nzekwe, U. (2005). The influence of potting media on the vigour of budded bush mango (*Irvingia wombulu* Vermeosen) rootstocks. Proceedings, National Conference on Organic Agriculture, UAAB, Abeokuta, Nigeria. 25th-28th Oct. 67-70.

Opuni-Frimpong, E., (2006). Improving productivity and conservation of African mahogany: genetic selection, propagation and silvicultural management of *Hypsipyla robusta* (Moore). PhD Forest Science degree thesis, School of Forest resources and Environmental Science, Michigan Technological University, Houghton, United States. 177 pp.

Orwa C. A. Mutua, Jamnadass R., and S. Anthony. (2009). Plant Diversity and Ethno-botanical notes on different tree species. Ethno-botanical leaflets 13:651-654.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Awotoye, 2019

GROWTH RESPONSE OF *Khaya senegalensis* (Desr) A. Juss. SEEDLINGS TO SELECTED ORGANIC MANURES

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ABSTRACT

The experiment on the growth response of Khaya senegalensis seedlings to selected organic manures was carried out in the Federal College of Forestry, Ibadan. The experiment was arranged in completely randomized design (CRD) with six treatments and seven replicates. Germination was observed for eight days. Assessment of growth parameters commenced two weeks after transplanting and was done weekly for 16 weeks. Total plant height, stem diameter and leaf production were measured. Data were analyzed using ANOVA at 5% probability level. Results showed that T_4 (10g of cow dung + 2000g of top soil) had the highest performance in terms of plant height (17.2cm) while T_6 (2000g of top soil) had the least height performance (14.9cm). Sources of manures had no significant influence ($p<0.05$) on the growth of Khaya senegalensis seedlings. The stem diameter growth of the seedlings was not significantly ($p<0.05$) influenced by the manures. T_5 (2.5g of Cow dung + 2.5g of Gliricidia sepium + 2000g of top soil) had the best performance with mean value 0.31mm. T_6 (control) had the least performance with 0.26mm. The highest mean leaf count was observed on the seedlings raised on 5g of Gliricidia sepium + 2000g of top soil with 9.5 while seedlings raised on 10 g of Gliricidia sepium + 2000g top soil had the least with 7.9. Manures had no significant effect ($p>0.05$) on the leaf production of the seedlings. Therefore, more research should be focused on the use of other sources of manures in raising Khaya senegalensis seedlings.

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INTRODUCTION

The importance of *Khaya senegalensis* both in furniture and in traditional medicines cannot be over emphasized. It has contributed immensely to our economy because of its high production of wood content in its tree species. This has enabled its use conventionally for carpentry, interior trim and construction (Lemmens *et al.*, 2008). *Khaya senegalensis* is a deciduous evergreen tree that belongs to the meliaceae family with common name African mahogany tree. *Khaya senegalensis* is a tree, 15 – 30m high up to 1m in diameter with a clean bole to 8 – 16m, buttress not prominent or absent, bark dark grey, with small thin, reddish, tinged scale, slosh dark pink to bright crimson, exuding a red sap. (Orwa *et al.,* 2009).

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Manure on the other hand, are organic materials which contain three most important substances for plant growth- Nitrogen, Phosphate and Potash. Manure is added to the soil for several reasons. It improves the physical conditions of the soil. It also keeps up the level of humus in the soil and maintains the best conditions for the activities of soil organisms (Opunni-Fimpong, 2006). In addition, it makes up for the plant nutrients which have been removed by crops or lost by leaching and soil erosion. Out of the two basic types of manures, organic manure is considered best because it is from a natural source and has no adverse effect on human being when the end product is consumed. It is therefore necessary to investigate some manures that can increase the growth of *Khaya senegalensis seedlings* for sustainable production at the nursery stage.

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The treatments are: T_1 =5g of *Gliricidia sepium*+ 2000g (2kg) of top soil, T_2 = 5g of cow dung+ 2000g (2kg) of top soil, T_3 = 10g of *Gliricidia sepium*+ 2000g (2kg) top soil, T_4 =10g of cow dung+ 2000g (2kg) top soil, T_5 =2.5g of *Gliricidia sepium*+ 2.5g of cow dung + 2000 g (2kg) of top soil, T_6 = 2000 g (2kg) of top soil (control**).**

Experimental design

The experiment was arranged in a Completely Randomized Design (CRD) with six (6) treatments and seven (7) replicates. Stem diameter (mm), seedlings height (cm) and leaf production were assessed.

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Data collected were analysed using analysis of variance (ANOVA).

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The characteristics of soil is very vital in plant growth and development and this is determined by the nutrient composition of the soil. The result (Table 1) indicated that the total N was higher in top soil (1.35%) than in other media used for the experiment, while potassium and phosphorus was higher in cow dung with 1.0 cmol/kg and 1.5 cmol/kg respectively. This is a proof that the medium used for the study is good enough for planting as it contains the necessary nutrients needed for plant growth.

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Parameters	Top soil	Cow dung	*Gliricidia sepium*
Moisture content%	1.74	0.09	0.09
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P (Cmol/kg)	1.24	1.5	1.2
Mg (Cmol/kg)	1.94	0.21	0.14

Effect of cow dung and *Gliricidia sepium* leaves on seedlings height, stem diameter and leaf production of *Khaya senegalensis* seedlings

Plant height

The result on plant height (Table 2) shows that T_1 (5 g of *Gliricidia sepium* + 2000g of top soil), T_2 (5g of cow dung + 2000g of top soil), T_4(10g of cow dung + 2000g of top soil) and T_5(2.5g of *Gliricidia sepium* + 2.5g of cow dung + 2000g of top soil) had a relatively close mean values with 16.5cm, 16.9cm, 17.2cm and 17.0cm respectively, however, T_4 had the highest performance in terms of plant height indicating that high quantity of cow dung had a positive effect on the height of *Khaya senegalensis* seedlings. T_6 (control) (2000g of top soil), however had the least performance in terms of plant height with 14.9cm. The manure had no significant influence ($p>0.05$) on the plant height of the species (Table 3).

Stem diameter

The result on stem diameter (Table 2). revealed that T_5 (2.5g of Cow dung + 2.5g of *Gliricidia sepium* + 2000g of top soil) had the best performance with mean value 0.31mm, however, 5 g of *Gliricidia sepium* + 2000 g of top soil T_4

(10 g of Cow dung + 2000 g of top soil) and T_5 (2.5 g of Cow dung + 2.5 g of *Gliricidia sepium* + 2000g of top soil)had a relatively close mean values with 0.29mm, 0.30mm, 0.31 mm respectively indicating that the mixture of both cow dung and *Gliricidia sepium* had a positive effect on the stem diameter of the seedlings. The result also revealed that plants in T_6 (control) had the least performance in stem diameter, with 0.26mm. The manure had no significant influence at p> 0.05 on stem diameter of the species (Table 3).

Leaf production

Result (Table 2) indicated that 5 g of *Gliricidia sepium* + 2000 g of top soil produced the highest number of leaves with 9.5. However, 5 g of *Gliricidia sepium* + 2000g of top soil), 5 g of cow dung + 2000g of top soil) and T_4 (10g of cow dung + 2000 g of top soil had a relatively close mean values with 9.5, 9.4 and 9.3 respectively. The result also further revealed that plants on T_3 had the least performance in terms of leaf production with mean value of 7.9. The manure had no significant influence at p> 0.05 on leaf count of the species (Table 3).

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Treatments	Plant height (Cm)	Stem diameter (Cm)	Leaf production Count (No)
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DISCUSSION

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CONCLUSION

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Recommendations

Based on the findings from this study, it is recommended that Cow dung as well as the mixture of *Gliricidia sepium* and Cow dung be adopted by the farmers in raising *Khaya senegalensis* seedlings. More so, other experiments should be carried out on the use of other sources of manures in raising *Khaya senegalensis*.

REFERENCES

Arbonnier, M., (2004). Trees, shrubs and lianas of West African dry zones. CIRAD, Margraf Publishers Gmbh, MNHN, Paris, France. 573 pp.

Baiyeri, K.P. 2002. Evaluation of nursery media for seedling emergence and early seedling growth of two tropical tree species. Proceedings of the 20th Annual Conference of Horticultural Society of Nigeria, NIHORT, Ibadan. 96-100.

FRIN (2019). Forestry Research Institute of Nigeria, Metrological Station Report.

Gideon, 2012. Effect of varying levels of vermicompost on the growth of *Khaya senegalensis*. Unpublished project in the Department of Forest resources management. University of Ibadan.

Lemmens, R.H.M.J., (2008). Khaya ivorensis A.Chev. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. Accessed 11 April 2019.

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Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adeniji et al., 2019

DRY MATTER ACCUMULATION AND GROWTH ANALYSIS OF *Jatropha curcas* L. AS INFLUENCED BY APPLICATION OF POULTRY MANURE AND COW DUNG IN NIGERIA

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ABSTRACT

Growth and yield of Jatropha curcas are low due to poor soil fertility and agronomic practices. An experiment was conducted at the Crop Garden of the Department of Crop Protection and Environmental Biology (CPEB) University of Ibadan on dry matter accumulation and growth analysis of Jatropha curcas as influenced by application of manure. Poultry Manure at 10, 20 and 40 t/ha and Cow Dung at 10, 20 and 40 t/ha (P5, P10, P20, P40 and C5, C10, C20, C40) with control (0 t/ha, M0) were evaluated (5 kg soil; 1 plant/pot)in a Completely Randomised Design. Dry weight and leaf area were obtained at monthly intervals to calculate: Relative Growth Rate, Net Assimilation Rate, Leaf Area Ratio and Leaf Area Duration using the formulae of Roderick (1978).The result showed that treatments P40, C40, P20 and C20 had the highest leaf dry weight (47.67g, 48.71g, 48.91g and 48.11g), while control had the least(23.30g), P40 had the highest stem dry weight (89.13g) which was not significantly higher than stem dry weight of C40 (86.56g), P20 (85.95g) and C20 (80.85 g) and control had the least stem dry weight of 51.78g.Treatment C40had the highest root weight (40.50g) and control had the least value of 25.41g.The net assimilation rate (NAR), relative growth rate (RGR), leaf area ration (LAR) and leaf area duration (LAD) showed that the RGR were higher between 6 and 8 weeks across all the levels. The NAR increased as the level of manure increased. Leaf area duration increased as the plant grew older across all levels while P5, C5 and control had the least. Leaf area ratio was 20.14(cm^2/g) on control and 33.49(cm^2/g) and 39.54 (cm^2/g) on P40 and C40 respectively at last observation. Application of manure up to 20t/ha increased the dry matter accumulation and growth of Jatropha curcas.

Keywords: *Jatropha curcas,* Organic manure, Biodiesel, Environmental sustainability.

INTRODUCTION

Jatropha curcas is a deciduous large shrub that can be 3-5 m tall (Tewari, 1994; El-quesni *et al., 2013*). It is known as physic nut. Species found in Nigeria is wild (Yammama, 2009) and it is called *'Botunje'* or *'Lapalapa Funfun'* in Yoruba language, '*Binidazugu'* in Hausa and *'Mpianya'* in Igbo language. *Jatropha curcas* adapts easily to various climatic and soil types, it can endure drought, salinity of soil and, thus, can be used to green up barren wastelands and also it is suitable for preventing soilerosion (Jones and Miller, 1992).Also out of all plants species that yield oil that can be used as biodiesel, *Jatropha curcas* has been recognized as being the preferred oil seed producing plant, due to high oil recovery and quality of oil (FAO, 2008). *Jatropha* oil is an important product from the plant. Biodiesel is a major substitute for mitigating greenhouse gas emissions (Lopez *et al*., 1997). In addition *Jatropha* seed oil can be used in treating some human and veterinary diseases; it also exhibits some pesticides properties (Nwosu and Okafor, 1995; Oyi *et al.*, 2007).

Growth is a vital function of any plant and is an indication of a gradual increase in number and size of cells. Growth analysis is commonly used to determine success of species in various habitats, competition among species, genetic differences in yield and effects of treatment on crops (Olaniyan, 2013). Growth analysis is the most simple and precise method to evaluate the contribution of different physiological indices of plants. Total dry matter is the spatial and temporal integration of all plant processes; rate of dry matter accumulation is the product of total incident solar radiation, the absorption of incident solar radiation by the crop canopy and the efficiency of conversion of absorbed solar radiation into plant dry matter.

Fertiliser is a major source of plant nutrients in crop production and most crops respond to fertiliser application based on need (Adediran *et al.*, 2003). A plant could benefit and manifest to its full potential if it was supplied with appropriate types and amounts of nutrients Akanbi and Togun (2002).Animal wastes have been utilised effectively as fertiliser for centuries and poultry manure and cow dung have long be recognized as perhaps the most desirable of these natural fertilisers because of their high nitrogen content (Sloan*et al.*, 2009 Adeoye *et al.,* 2004).

Plant growth and yield are to a large extent influenced by application of fertilisers (Hussein *et al*., 2012).This research work is aimed at examining the effects of organic fertiliser application on growth and yield of *Jatropha curcas.*

MATERIALS AND METHODS

Study Area

The studies were carried out at the Crop Garden of the Department of Crop Protection and Environmental Biology (CPEB) University of Ibadan. Ibadan is located between longitude7^0 234" N to 7^0 396" N and latitude 3^0 550" E to 3^0 916" E. Elevation: 231m above sea level (Wikipedia). The experiment was 2 x 5 (2 manure types at 5 levels) factorial using poultry manure (P) and cow dung (C) at five different levels. The treatments were in a Completely Randomized Design (CRD) replicated four times. The factorial combination of the treatment gave a total of 10 pots per replicate; each pot was duplicated four times to give room for monthly assessment of dry weight and leaf area. Pots of 5 liters size were filled with 5kg soil and equivalent weight of 5, 10, 20 and 40 t/ha of cured poultry manure (P5, P10, P20, P40) and cow dung (C5, C10, C20, C40) were added into each designated pot while 0t/ha served as control (M0). The manure was allowed to incubate in the soil for two weeks to give room for its stabilization. Seeds of *Jatropha curcas* were sown at two seeds per hole at a depth of 3cm. Watering was carried out to maintain the soil at field capacity. After two weeks thinning was done as required to have 1 seedling per pot. Manual weeding was carried out at 14 days interval and white flies were controlled with Cypermethrin at the rate of 2L/ha according to manufacturer recommendation, to prevent damage to the plant when infestation was noticed. At 8 WAS (weeks after sowing). Leaf Area (cm^2) was measured using Tayo and Togun (1984) method. Plant dry matter was obtained by partitioning plants into leaves, stem and root and put in the oven set at 80°C to dry to constant weight so as to calculate plant growth. This was done at monthly interval until 28weeks after sowing(WAS) when flower buds were noticed. The dry weights were used to calculate the following growth parameters: Relative Growth Rate (RGR), Net Assimilation Rate (NAR), Leaf Area Ration (LAR) and Leaf Area Duration (LAD) using the following formulae (Roderick, 1978).

$$RGR = \frac{Log\ eW_2 - LogeW_1}{T_2 - T_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$NAR = \frac{W_2 - W_1}{T_2 - T_1}\ X\ \frac{eLogeLA_2 - LogeLA_1}{LA_2 - LA_1} \ldots\ldots 2$$

$$LAR = \frac{\frac{LA1}{W1} + \frac{LA2}{W2}}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

$$LAD = \frac{LA_2 - LA_1(T_2 - T_1)}{2} \ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where:

W_1 = Weight at T_1;

W_2 = Weight at T_2;

T_1 = Time at 1st Sampling Period;

T_2 = Time at 2ndSampling Period;

LA_1 =Leaf area at T_1;

LA_2 =Leaf area at T_2

Data Analysis

Data collected were analysed using analysis of variance (ANOVA) and significant means were separated using Duncan Multiple Range Test (DMRT) at p0.05.

RESULTS

The physical and chemical properties of the manure and soil used for the experiment are shown in Tables 1 and 2. The laboratory analysis of the poultry manure and cow dung used in the experiment showed that cow dung had higher carbon (7.41%) than poultry manure (5.97%). The percentage nitrogen in poultry manure (1.66) was higher than that of cow dung (1.06).The soil used for the experiment was loamy sand by texture; the soil in the experimental pot was moderately alkaline (pH 7.10). The Cation Exchange Capacity (CEC) seemed to be adequate (21.40%) due to the high level of Calcium in the soils. Organic Carbon, total Nitrogen and available Phosphorus content were 3.78%, 0.51% and 25.35%.

Table1: Properties of manure used in the experiment on *Jatrophacurcas*

Properties	Manure	
	Poultry Manure (%)	**Cow dung (%)**
C	5.97	7.41
N	1.66	1.06
P(Avail)	2.43	0.48
K	1.98	1.97
Na	0.68	0.60
Ca	3.95	0.13
Mg	3.73	0.38

Table 2: Physical and chemical properties of pre-cropping soil used in the experiment on *Jatropha curcas*

	Properties	Pot experiment
Textural class	Sand (%)	89.80
	Clay (%)	5.40
	Silt (%)	4.80
	C (%)	3.78
	N (%)	0.51
	P(Avail, %)	25.35
	Base salt (%)	99.75
	C E C (%)	21.40
	K (%)	0.36
	Na($Cmol^1$)	0.94
	Ca ($Cmol^1$)	14.50
	Mg ($Cmol^1$)	5.54
	pH	7.10

The dry matter accumulation of *Jatropha curcas* in response to manure application is shown on Table 3.Treatments P40, C40, P20 and C20 had the highest leaf dry weight (47.67g, 48.71g, 48.91g and 48.11g).The control had the least leaf dry weight (23.30g) which was significantly lower than other treatments. Stem dry weight followed a similar trend as the leaf dry weight, P40 had the highest weight (89.13g) which was not significantly higher than C40 (86.56g), P20 (85.95g) and C20 (80.85g).Control had the least stem dry weight of 51.78g although not significantly higher than P5 and C5 (60.61g and 61.50g). In terms of root dry weight, C40had the highest root weight, (40.50g), which was not significantly different from P40 (37.61g), P20 (35.96g) and C20 (32.82g).Control still had the least value of root dry weight but not significantly lower than P5 (27.25g), P10 (29.01g), C5 (28.66g) and C10 (30.46g) at$p_{0.05}$.

Table 3: Effect of manure on *Jatropha curcas* dry weight (g)

Treatment, t/ha	Leaf dry weight(g)	Stem dry weight(g)	Root dry weight(g)
M0	323.30d	51.78c	25.41d
P5	32.10c	60.61bc	27.25cd
P10	33.48c	67.42b	29.01bcd
P20	48.91a	85.95a	35.96abc
P40	47.68ab	89.13a	37.61ab
C5	32.39c	61.50bc	28.66bcd
C10	35.46c	68.36b	30.46bcd
C20	48.11a	80.85a	32.82abc
C40	48.71a	86.56a	40.50a

Mean having different letters among treatments are different significantly at $P_{0.05}$ with DMRT
Where; Mo = Control experiment, t/ha; P = Poultry manure, t/ha; C = Cow dung manure, t/h

The effects of organic fertilizer types and rate on plant growth analysis are indicated in Table 4. The net assimilation rate (NAR), relative growth rate (RGR), leaf area ration (LAR) and leaf area duration (LAD) showed that the RGR were higher between 6 and 8 weeks across all the fertilizer level. It started decreasing as the plant grew older. The control, P5 and C5 had the least RGR. The NAR started increasing as the plant grew older from 8 to 28 weeks. It also increased with increase in the level of manure application. Poultry manure also enhanced NAR. Leaf area ratio decreased with age of the plant; it followed a similar trend as NAR by increasing as the level of fertilizer applied increased. Leaf area duration increased as the plant grew older across all the fertilizer levels while P5, C5 and control had the least.

Table 4: Plant growth analysis of *Jatropha curcas* on application of poultry manure and cow dung at different levels

Duration	TRT	RGR(g/g/wk)	NAR(g/cm^2/wk)	LAR(cm^2/g)	LAD(cm/wk)
8-12wks	M0	0.159	0.0001	32.00	1134.11
	P5	0.178	0.0001	28.55	1592.33
	P10	0.201	0.0011	61.11	2893.00
	P20	0.098	0.0013	80.54	4374.56
	P40	0.204	0.0011	86.33	4111.81
	C5	0.181	0.0001	46.88	1721.34
	C10	0.120	0.0010	52.11	2799.86
	C20	0.111	0.0012	59.82	4003.82
	C40	0.193	0.0010	74.03	4231.86
12-16wk					
	M0	0.064	0.0001	32.39	1376.24
	P5	-0.058	-0.0001	28.49	1715.50
	P10	0.088	0.0016	53.11	2969.10
	P20	0.086	0.0019	71.31	4586.82
	P40	0.081	0.0013	78.20	4248.86
	C5	0.079	0.0002	45.92	2051.72
	C10	0.080	0.0018	48.94	2986.44
	C20	0.088	0.0016	56.50	4108.44
	C40	0.090	0.0013	68.29	4471.34
16-20wk					
	M0	0.053	0.0004	28.73	1529.82
	P5	0.047	0.0001	36.66	2277.90
	P10	-0.003	0.0011	45.14	3177.02
	P20	0.019	0.0034	55.08	4854.50
	P40	0.088	0.0025	61.72	4488.64
	C5	0.008	0.0001	34.52	2013.90
	C10	0.062	0.0008	38.33	3069.26
	C20	0.071	0.0016	44.77	4352.46
	C40	0.078	0.0024	54.55	4713.38
20-28wk					
	M0	0.041	-0.0002	20.14	3157.24
	P5	0.077	0.0013	28.51	4735.68
	P10	0.070	0.0019	35.33	6269.72
	P20	0.095	0.0026	40.15	8000.70
	P40	0.078	0.0024	33.49	8143.68
	C5	0.081	0.0013	24.59	3776.96
	C10	0.121	0.0015	29.58	6172.00
	C20	0.084	0.0031	28.19	6850.20
	C40	0.095	0.0026	39.54	8023.24

Where: Mo = Control experiment; P = Poultry manure, t/ha; C = Cow dung manure, t/ha

DISCUSSION

. The dry matter accumulation potential of *Jatropha curcas* plants used in this experiment were highly enhance by application of manure as both poultry manure and cow dung at the rates of 20t/ha and 40t/ha increased dry matter accumulation potential of *Jatropha curcas.*Togun*et al.* (2003) and Akanbi*et al.* (2007) reported that organic amendments enhance plant photosynthetic activities and hence more dry matter is produced. Manhas and Gill (2010) found that increment in application of organic manure increased the growth, dry matter accumulation, yield and quality of plant.

Organic fertiliser resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity and exchangeable Ca, Mg and K which invariably enhance crop yield and productivity. Adeleye *et al.* (2010) also confirmed that organic manure improved soil organic matter, total N, available P, exchangeable Mg, Ca, K and lowered exchangeable acidity The increase observed in leaf area duration (LAD) as the plants grew older showed persistent of the leaves on older plant and accounted for the overall yield. High relative growth rate (RGR), leaf area duration (LAD) and net assimilation rate (NAR) can be said to be responsible for higher means observed on total dry weight at higher application of manure because of higher photosynthetic capacity which is responsible for yield of plants fertilized at these level.

CONCLUSION

Jatropha curcas responded positively to added fertilizer and fertilised plants were found to grow better than control plants. Organic fertilizer resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity and exchangeable Ca, Mg and K which invariably enhance crop yield and productivity. Application of manure up to 20t/ha increases the dry matter accumulation of the treated plants. Manure application improved the photosynthetic capacity of the plant by increase, leaf area duration (LAD) and net assimilation rate (NAR).High relative growth rate (RGR), leaf area duration (LAD) and net assimilation rate (NAR) can be said to be responsible for higher means observed on total dry weight at higher application of manure because of higher photosynthetic capacity which is responsible for yield of plants fertilised at these level. .

Recommendations

The following recommendation(s) are hereby advocated:

i. Application of manure should be encouraged as it enhanced yield and biomass weight.
ii. Application of up to 20t/ha of poultry manure and cow dung could be adopted in *Jatropha curcas* production as it increased the yield of the plant.

REFERENCES

Adediran, J. A., De Baets, M., Mnkeni, P. N. S., Kiekens, L., Muyiwa, N. Y. O and Thys, A. (2003).Organic waste materials for soil fertility improvement in the border region of the eastern cape, South Africa.*Biological Horticulture* 20:283 -300.

Adeleye, E.O., Ayeni, L. S. and Ojeniyi, S. O.(2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on alfisol in southwestern Nigeria. *Journal of American Science* 6:871-878.

Adeoye, G. O., Ojobor S. A. and Adeoluwa, O. O. (2004). Evaluation of potential of co-compost of rice-wastes, cow dung and poultry manure for production of rice. *In: Proceedings of the 29th Annual Conference of the Soil Science Society of Nigeria.* 213–218

Akanbi, W. B. and Togun, A. O. (2002).The influence of maize – stoves compost and nitrogen fertiliser on growth, yield and nutrient uptake of amaranth.*ScientiaHorticulturae*. 93: 1 – 8.

Akanbi, W. B., Adeboye, C .O.,Togun, A. O., Ogunrinde, J. O and Adeyẹye, S. (2007). Growth, herbage, seed yield and quality of *Telfairia occidentalis* as influenced by cassava peel compost and mineral fertilizer. *World Journal of Agricultural Sciences* (4): 508 – 516.

El-quesni, F. E. M, Hasish, K. L, Magda, M. Kandil, M. and Azza, A. M. (2013).Impact of some bio fertiliser and compost on growth and chemical composition of *Jatropha curcas* L. *World Applied Science Journal.* 21 (6) 927-932

FAO, (2008). The state of food and agriculture: Bio fuel; prospect, risk and opportunities 55-59

Jones, N. and J. H. Miller, (1992).*Jatropha curcas*: a multipurpose species for problematic sites. *Land Resources Series* No.1. Asia Technical Department, World Bank, Washington. 42 p

Hussein, M. M., Thaloot, A. T., Tawfik, M. M., Goborah, E. and Mohamed, H. (2012).Impact of mineral and organic fertiliser on vegetative growth of *Jatropha curcas*L. in sandy soil. *Elixir Appl. Botany* 49 .2012. 9714-9717

Lopez ,O.,Foidl, G. and Foidl, N. (1997). Production of biogas from *J. curcas*fruit shells. In: Biofuels and industrial products from *Jatropha curcas - Proceedings of the Symposium "Jatropha*97*", Managua, Nicaragua, Austria* pp. 118-122.

Manhas, S. S. and Gills, B. S. (2010). Effects of planting materials, mulch level and farmyard manure on growth, yield and quality of Tumeric. *The Journal of Agricultural Science* 80(6)227-233

Nwosu, M. O and Okafor, J.I, (1995).Preliminary studies of the anti-fungal activities of some medicinal plants against Basidiobolus and some other pathogenic fungi, *Mycoses*. 38, 191-195.

Olaniyan, (2013).Maize: panacea for hunger in Nigeria, *Afican Journal of Plant Science.9(3) 155-174*.

Oyi, A. R. Onaolapo, J. A. Haruna, A. K. and Morah, C. O. (2007). Antimicrobial screening and stability studies of the crude extract of J*atropha Curcas*L.latex (Euphorbiaceae) *Nigerian Journal of Pharmaceutical Sciences*, 6(2).

Roderick, H. (1978). Plant growth analysis.Arnold,E. ed, Southhampton Camelot press. pp 26-28

Sloan, D. R., Kidder, G and Jacobs, R. D. (2009). Poultry Manure as Fertiliser. Cooperative Extension Services, Department of Dairy and Poultry Science Institute of Food and Agricultural Sciences University of Florida, Gainsville. Article No 1

Tayo, T. O. and Togun, A. O. (1984). Response of Pigeon Pea (*Cajanuscajan*) to the Application of Fertiliser. *Annuals of Applied Biology* 105:293-302

Tewari, D. N, (1994). Brochure on *Jatropha* ICFRI Publication, Dehradun, India. Vol.2

Togun, A. O., Akanbi, W. B. and Dris, R.(2003). Influence of compost and nitrogen fertiliser on growth, nutrient uptake and fruit yield of tomato (Lycopercicumesculentum) *Crop Research* 26 (1):98-105

Wikipedia,http://www.oyostate.gov.ng

Yammama, K. A. (2009). *Jatropha* cultivation in Nigeria; Field experience and cultivation *jatrophaproject@yahoo.com*.26pp

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ibrahim et al., 2019

CONSTRAINTS FACING AGROFORESTRY PRACTICES AMONG FARMERS IN NEW BUSSA, NIGERIA

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ABSTRACT

The study examined agroforestry practices and its constraints among selected farmers in New Bussa, Niger State, Nigeria. Data were collected using a well-structured questionnaire, personal interview and observations from the total of one hundred and twenty respondents. Descriptive statistics were used to analyse the data collected. Findings revealed that farming was male dominated with a mean age and family size of 41years and 10 persons respectively. More than half (69.2%) of the farmers were literate with mean years of experience in farming being 14years. The most common trees on the farmlands were Vitellaria paradoxa, Mangifera indica, Parkia biglobosa, Azadirachta indica, Afzelia africana, Detarium microcarpum and Vitex doniana. Majority of the farmers were aware (70.8%) of agroforestry practices mainly through conservation education (32.5%) and forest guards (20.0%) to conserve economic trees and improve farm produce. Medicinal herbs (98.3%), Source of income (81.7%) and Source of food (80.3%) were the major benefit accrued to farmers from agroforestry in the study area. Constraints to agroforestry practices in the study area included limited use of farm machineries (75%), poor access to credit facilities (70.8%), fast growing nature of trees (68.3%), Land tenure (65.8%), Marketing channel (62.5%) and increase in population (56.7%). The study thus, recommended that extension agents from public and non-governmental organizations should enlighten farmers more on agroforestry through workshops and community awareness campaign and assistance should be given to farmers in form of credit facilities, improved seeds or varieties, and soft loans for enhanced production.

Keywords: Agroforestry, Awareness, Benefits, Constraints, Conservation, Economic trees,

INTRODUCTION

Traditional agroforestry is variously referred to as indigenous agroforestry or ethno agroforestry. Traditional agroforestry started in prehistoric times when hunters and gatherers deliberately or accidentally dispersed seeds of highly valued fruit trees in the vicinity of their campfires. These seeds later germinated and grew to produce fruits for food and were managed in mixture of naturally grown timber trees and other herbal plants (Udofia, 2010).

Agroforestry is an effort at combining trees and shrubs with crops with emphasis on their mutual benefits to enhance diversity, productivity, profitability and sustainability of the land use system and hence the farmer. Agroforestry as a land use system has been in practice for very many years and in most continents of the world. In the past century, there had been efforts to develop the concept of Agroforestry as science in order to appropriately quantify improvement in productivity of various crops and the soil as well as the cash flow in terms of profit to the farmer. However, Agroforestry is a land management system combining forest trees and food crops production with or without livestock in such a way that they are technically and financially feasible and will enable the small holder farmer to obtain high income and living standards while ensuring improvement of soil and the environment. Agroforestry is seen as a sustainable land management practice that can help to resuscitate lands and maintain live supporting practices in the farm lands of the householder farmers in the sub-humid topics. It includes all practices that deliberately combine trees and shrubs with agricultural crops and/or livestock overtime or space. It is an age long technology which several civilizations have used to sustain their food production systems (Adeola, 2015).

Almost half of the world's agricultural lands have at least 10 percent tree cover, suggesting that agroforestry, an integrated system of trees, crops and/or livestock within a managed farm or agricultural landscape, is widespread and critical to the livelihood of millions of people. In fact, agroforestry is significant in the production of both local commodities (such as fuel wood, timber, fruit and fodder) and global ones (such as coconut, coffee, tea, cocoa, rubber and gum). It can also play a strategic role in helping many countries meet key national development objectives, especially those related to poverty eradication, food security and environmental sustainability. In towns and villages, its positive outcomes can be seen in food, fuel wood and watershed management, contributing to a more resilient food system (FAO, 2011).

Agroforestry serves to improve the resilience of farmers and increase their household income through the harvesting of diverse products at different times of the year. It also brings job opportunities from the processing of tree products, expanding the economic benefits to rural communities and National Economies. Agroforestry Systems can be conceived for spaces varying from plots to farms to landscapes. At plot level, farmers may combine nitrogen fixing trees with cereal crops. At farm level, they may plant trees in woodlots or along boundaries and at landscape scale communities may rehabilitate degraded areas through trees and other vegetation. Effective agroforestry systems make the most of positive interactions between their various components, so that the final product is more valuable than in the absence of trees, while the risks of failed harvests and dependence on chemical inputs are reduced. The potential of agroforestry to contribute to sustainable development has been recognized in international policy (FAO, 2011).

The intergovernmental panel on climate change (IPCC) increasingly acknowledges it as a component of climate-smart agriculture. During the 2011 conference of the parties (COP) meetings in Durban, agroforestry was frequently mentioned as having a strong potential for climate change adaptation and mitigation (FAO, 2013). In addition, the United Nations Convention to combat Desertification (UNCCD) acknowledges agroforestry's potential to control desertification and rehabilitation. It is therefore necessary to assess or investigate agroforestry practices and its constraints among farmers in New Bussa, Niger State, Nigeria.

Specifically, the study identified the personal characteristics of respondents, economic trees commonly found/grown on the farm in the study area, determined the awareness of respondents towards agroforestry, described the benefits of agroforestry in the study area and examined the constraints to agroforestry in the study area.

MATERIALS AND METHODS

Study Area

New Bussa is a town in Niger State, Nigeria. It is the new site of Bussa after the Kainji Lake dam set the previous location underwater. As of 2007, New Bussa had an estimated population of 24,449. New Bussa is the headquarters of the Borgu Emirate and the Borgu Local Government Area. New Bussa sits at $9^0$53'N, $4^0$31'E and the original town of Bussa was located about 40km North of New Bussa at $10^0$13'51'N, $4^0$28'31"E (altitude 561ft or 170meters) (The World Gazetter, 2007). Agriculture is the main source of livelihood of the people, particularly indigenes and the town attracts non-indigenes as a result of Federal Government parastatals prevailing in the area.

Sampling technique and sample size

New Bussa was clustered into six areas: Senior camp, Main Bussa, General hospital Road, Ibadan way, Baptist Church side and Dogongeri. Snowball method was adopted to select twenty farmers from each of the clustered area. This gave a sample size of one hundred and twenty farmers (120).

Method of data collection

Primary data were used for the study. A well-structured questionnaire based on the objectives of the study was used to generate data from the respondents. (Head of households) personal interview and observations were also used to gather data from the farmers.

Method of data analysis
Data obtained from the farmers were analysed using descriptive statistics such as frequency, percentages and charts.

RESULTS

Personal characteristics of the respondents
The result entry in Table 1 indicates that the majority of the respondents (65%) were male while the remaining (35%) were female. This means that males dominated farming in the study area; this could be due to energy demand of farming, unemployment level and government campaign on back to land (Agriculture). 30% of the respondents were within the economically active age group of 31-40 years while the mean age of the respondents was 40.9years.This is similar to the mean age (41.62) of farmers recorded by Umunna *et al* (Ummuna *et al.*, 2018) in Igabi Local Government Area of Kaduna State. The greater proportion of the economically active age group could increase food security in the country. This age group according to Asiabaka (2002) is motivational, innovative and adaptive to agricultural innovations.

The majority (66.7%) of the respondents were married. The singles were about 20.8% while 8.3% and 4.2% were divorced and widowed respectively. The farmers could be expected to make rational decision towards agroforestry practices since they might be relying on the farm to provide for their family members. Onwubuya and Ajani (2012) affirmed that married people dominate agricultural production activities in Nigeria.

38.3% of the farmers had 6-10 members in their household while the average household size was 10 persons indicating a medium family size. Nwaru (2004) observed that large household size would help in reducing labour constraint in agricultural production. Most of the respondents (69.2%) were literate; they had secondary and tertiary education. United States Agency for International Development, USAID (2010) reported that the more educated a farmer is the more chances that the farmer would adopt innovations. This would help the farmers in understanding the concept of agroforestry.

4.2%of the farmers had 1-10years experience, 22.5% had 11-20years, and 33.3% had 21-30years of farming experience while the average farming experience was about 14years. This shows that appreciable proportions of the farmers were quite knowledgeable in farming and can easily perceive new improved ideas.

Table 1:- Personal Characteristics of the respondents

Variables	Frequency (n=120)	Percentage (%)	Mean	Standard Deviation
Sex				
Male	78	65		
Female	42	35		
Age				
≤30	28	23.3		
31-40	36	30.0	40.91	15.03
41-50	22	18.3		
≥51	34	28.3		
Marital Status				
Single	25	20.8		
Married	80	66.7		
Divorced	10	8.3		
Widowed	5	4.2		
Household Size (Units)				
1-5	41	34.2		
6-10	46	38.3	10.21	5.975
11-15	24	20.0		
16-20	9	7.5		
Educational Status				
No formal Education	20	16.7		
Primary Education	17	14.2		
Secondary Education	33	27.5		
Tertiary Education	50	41.7		
Years of experience				
1-10	53	44.2		
11-20	27	22.5	14.4	
21-30	40	33.3		

Source; Field Survey, 2018

Economic trees commonly found in the study area.

The results of questionnaire, personal interview and observations on the farms visited during research work revealed the following economic trees in the study area:- *Vitellaria paradoxa, Detarium microcarpum, Parkia biglobosa, Gmelina arborea, Tectona grandis, Afzelia africana, Anacardium occidentale, Mangifera indica, Lannea acida, Anogeissus leiocarpus, Azardirachta indica, Piliostigma thonningii, Nauclea latifolia, Grewia mollis, Ficus sychomorus, Leucaena leucocephala, Acacia spp, Khaya senegalensis Eucalyptus citriodora, Sterculia setigera,Terminalia mollis, Prosopis africana, Vitex doniana*.

The dominant trees are *Vitellaria paradoxa*, *Parkia biglobosa*, *Mangifera indica*, *Detarium microcarpum and Afzelia Africana*. The above result was similar to those trees identified by Etukudo (2000) in his book of forestry. These trees would serve the purpose of wind break, erosion control, soil stabilization source of food, medicine and income in the study area (Ibrahim *et al*., 2018).

Respondents Awareness towardsAgroforestry

Figure 1 revealed that 70.8% of the respondents were aware of Agroforestry practices in the study area, while 29.2% were not aware. The means of awareness (figure 2) was majorly through conservation education (32%) and forest guards (20%). This could be due to the protected area i.e., Kainji Lake National Park that surrounds the study area. In this case public enlightenment could be given to the people on the need to conserve economic trees by farmers on their farms through the forest guards and park patrol team. The high awareness level could also be as a result of the educational level of the respondents. This awareness result corroborates the report of Sulaiman *et al*, (2015) in his study of the awareness and use of information and communication technologies among extension agents in Kaduna State of Nigeria.

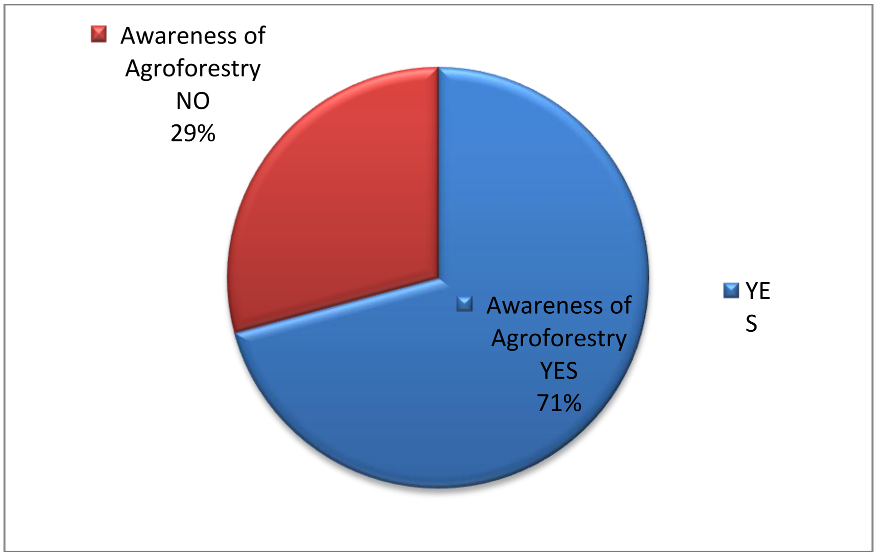

Figure 1: Awareness of Agroforestry in the study area

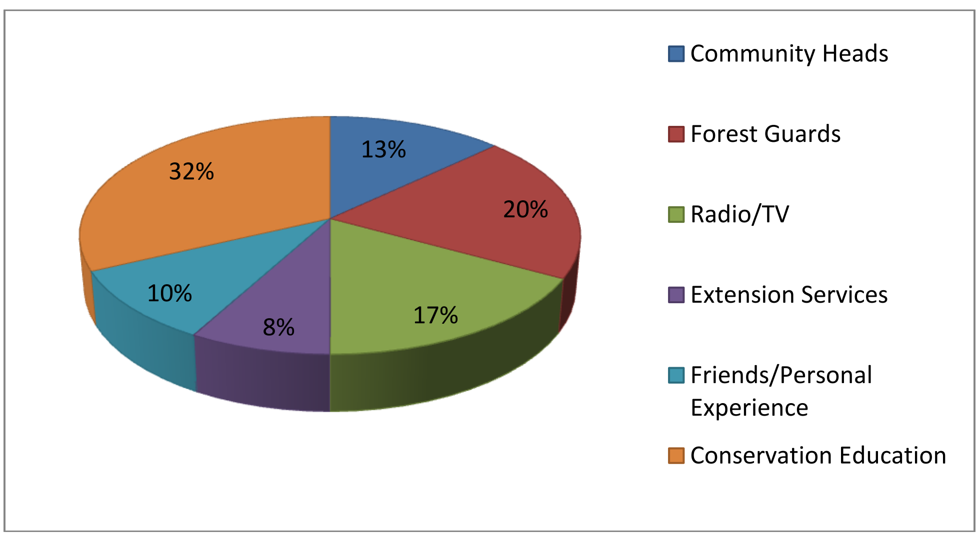

Figure 2: Means of Awareness

Benefits of Agroforestry in the study area

The results of the benefits of Agroforestry in the study area as presented in figure 3 revealed that agroforestry has several benefits to the farmers and their households as it cut across all the variables presented. Medicinal herbs had the highest percentage (98.3%), this is in line with the report of Aju and Uwalaka (2010) that "ever before the introduction of Western drugs in Nigeria the people depended solely on plants, animals and mineral recipes for their medical care.

Adekunle (2005) also added that ethno medicine has gained much acceptance as the only alternative medicine by the poor due to lack of adequate medical personnel and the unaffordable cost of orthodox medicine in the rural area. However, farmers who were involved in hunting and gathering of minor forest produce in the nearby forest for their livelihood stopped at the introduction of agroforestry and concentrated only on farming as agroforestry ensured good and cheap fodder for them which in turn increased the number of livestock. Sales from livestock and tree crops produced on home garden agroforestry system in South Eastern Nigeria accounted for over 60% of family cash income (Robert and Tim, 2004). The percentage for others (4.2%) could be benefit such as shade for the farmers to rest after work or tiredness, shade for livestock, stake for yams or boundaries on the farm.

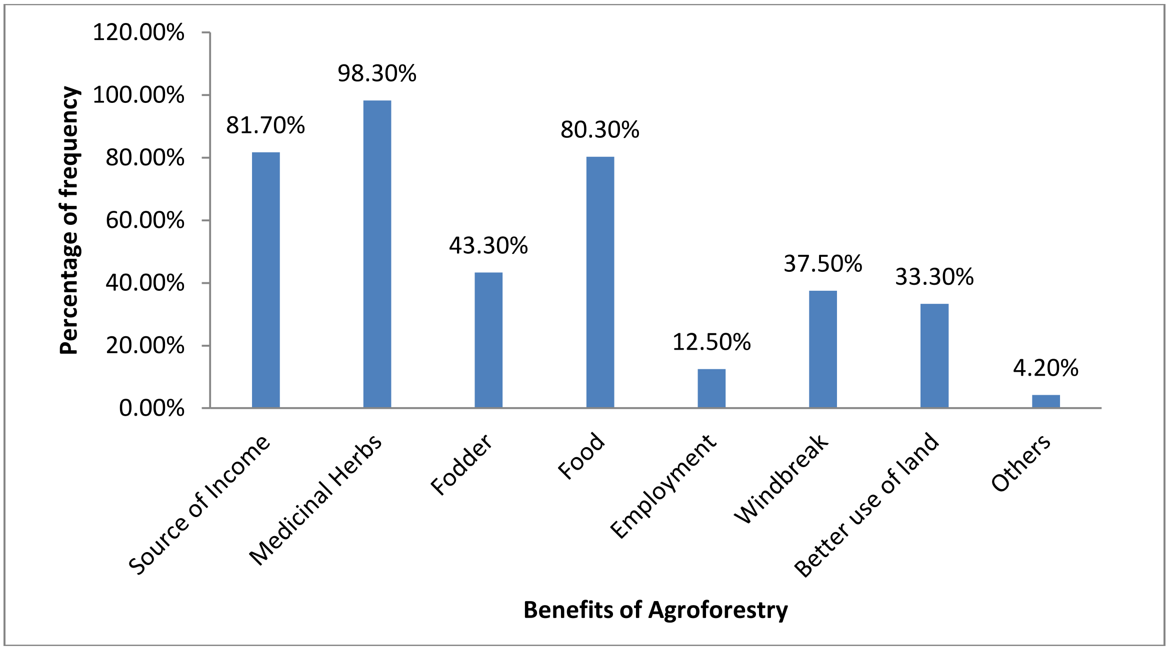

Figure 3: Benefits of Agroforestry in the study area

Constraints to Agroforestry Practices

The major constraints to agroforestry practices were limited use of machineries (75%), poor access to credit (70%), fast growing nature of trees (68.3%) land tenure (65.8%) and marketing channels (62.5%). Limited use of machineries could be due to inability of the farmers to afford the cost of purchase or hiring of machineries, hindrance from the roots of trees on the farm, small size of the farm due to land tenure system and technical know-how. Poor access to credit could be attributed to the fact that most farm households are not members of cooperative/ farm organizations and consequently may not have direct access to credit facilities and good price for products. Fast growing nature of trees form canopy or shades over arable crops planted by farmers which invariably lead to poor growth and yield. Land tenure system in our society is another challenge to farmers. Land owners a times feel reluctant to lease their land totally for farming, when released stiff conditions may be attached making it difficult for farmers to acquire land. Marketing farm products, both agricultural and forestry produce are sometimes difficult for farmers. Distance from farm to market, transportation problem, bad road network, attitude of buyers trying to cheat the farmers, processing and storage problems are all marketing challenges facing farmers. It sometimes leads to waste of agricultural produce and consequently low income accrued to farmers who has laboured for long. This result is similar to the barriers to agroforestry development identified by FAO (2013).

Other constraints include inadequate capital (58.3%), this could affect the inputs of the farm, results from poor or low yield, inaccessibility to soft loans either from the government or non-governmental bodies and reduced standard of living of the farmers. Increase in population (56.7%) increases demand for available land leading to competition, industrialization and land scarcity for agroforestry. Unavailability of labour (50.8%) is another constraint, whereby educated and well-to-do individuals who needs hired labour to farm large hectares of land are not able to get. High incidence of pests and diseases (50.8%) could be caused by incidence of climate change and the associated problem of excessive rainfall and drought. This could result to poor yield, low quality / market value and poor return to households (Mabel, 2015).

The respondents perceived that the minor constraints to agroforestry were poor yield and theft (46.7%), poor access to extension service (41.7%), poor soil fertility (32.5%) and short growing season. Poor yield and theft equally constitute constraints especially when the soil is not fertile and the stands located at unsafe places according to Mabel (2015). However, inefficient government extension services contribute to continue low yields of production in Nigeria because farmers are deprived of vital innovations that could improve their output. The above results corroborate the report of Ibrahim *et al* (2018) in assessment of Agroforestry practices in Kaiama Local Government Area of Kwara State.

Table 2:- Constraints to Agroforestry Practices

Constraints	Frequency	Percentages (%)	Ranking
Land tenure	79	65.8	4th
Inadequate Capital	70	58.3	6th
Increase in Population	68	56.7	7th
Unavailability of labour	61	50.8	8th
Poor access to extension services	50	41.7	11th
Marketing Channel	75	62.5	5th
Poor yield and theft	56	46.7	10th
Fast Growing nature of trees	82	68.3	3rd
Short Growing Season	33	27.5	13th
Limited use of Machineries	90	75.0	1st
Poor Soil fertility	39	32.5	12th
High incidence of pests and diseases	60	50.0	9th
Poor access to credit	85	70.8	2nd

CONCLUSION

The study has shown that majority of the farmers were aware of agroforestry in the study area mostly through conservation education.

Agroforestry is an alternative cultivation strategy that has been adopted by some farmers in the study area. Tress and shrub retained on the farm lands in the study area grew as wild plants, although few were consciously cultivated (such as *Gmelina arborea*, *Tectona grandis*, *Mangifera indica*, *Anarcadium occidentale Azardirachta indica* and *Khaya senegelensis*) by indigenous farmers as integral part of the rural farming systems in the study area. The practice of agroforestry tends to increase and improve forest resources, farm produce and health delivery through medicinal herbs which constitute the rural economy. Despite the benefits and goodness of agroforestry the farmers were constrained by limited use of machineries, poor access to credit facilities, fast growing nature of trees, land tenure system, Marketing difficulties, inadequate capital, poor access to extension services, high incidence of pests and diseases. These could be overcome through the following recommendations.

Recommendations

(1) Extension agents from public and non-governmental organizations should build requisite knowledge and skills of farmers on agroforestry practices.
This can be achieved through workshop, radio programmes and community awareness campaign.

(2) Land tenure system should be removed through land decree policy, enforced by the government and make land available to interested farmers.

(3) Assistance should be made available by the government and non-governmental agencies to farmers through the provision of credit facilities, exotic species, improved

seeds/varieties, improved marketing channel and rural infrastructural development.

(4) Soft loans should be put in place for farmers by government and non-governmental organizations to improve their farming and standard of living.

Acknowledgements

I appreciate the support of Mr. Adelakun, Kehinde Moruff during the typing and proof reading of this research work. Special thanks go to the Federal College of Wildlife Management for their encouragement and opportunity given to me to collect data without hindrance**.**

REFERENCES

Adekunle, V.A.J. (2005). Trends in Forest Reservation and Biodiversity Conservation in Nigeria. In Environmental Sustainability and Conservation in Nigeria: Okoko, E., Adekunle, V. A. J. and Adeduntan, S. A (eds.) Environmental Conservation in Nigeria, Research Team, Federal University of Technology Akure, Nigeria. pp. 82-90.

Adeola, A.O. (2015). *Principles and practice of Agroforesrty*.Yempet Publishers, Akure 150p.

Aju, P.C., and Uwalaka, R.E. (2010). Forest Resources and the Economy of Rural Nigerians. In Ijeomah, H.M.andAiyeloja, A.A. (eds.) *Practical Issues in Forest and Wild Life Resources Management*, Port Harcourt, Green Canopy Consultants, pp. 172-186.

Asiabaka, C.C. (2002). *Agricultural Extension*. A handbook for development practitioners.Omoku Press Rivers State, Nigeria. 230p

Etukudo I.G. (2000). *Forest our Divine Treasure*. Durand Publishers, Uyo, pp. 92-119.

FAO, (2011). Making Integrated Food Energy Systems Work for People and Climate: an overview.*FAO Environment and Natural Resource Management Working paper 45*.Written by A. Bogdanski, O. Dubois, C. Jamieson and R. Krell. Rome.

FAO, (2013). *Advancing Agroforestry on the Policy Agenda*. Agroforestry: Strategy and Policy. Agroforestry working paper No.I, Rome pp.1-10.

Ibrahim, A. O., Adeniji, O. A, Ampitan, T. A., Ogialekhe, P., Adegbola, G A. And Buochuana, A. (2018).Assessment of Agroforestry Practices in Kaiama Local Government Area of Kwara State.Proceedings of the 6th Biennial National Conference of the Forests and Forest Products Society (FFPS).Isah, A. D., Shamaki, S. B., Adekunle, V. A. J. and Bello, A. G. (eds.) pp. 234-241.

Mabel, U. D. (2015). Involvement of Farm Households in Banana and Plantain Production in Aguata Agricultural zone of Anambra State, Nigeria. *Journal of Agricultural Extension*. 19 (1), 107 -121.

Nwaru, J.C. (2004). Rural Credit Market and Arable Crop Production in Imo State, Nigeria.

Onwubuya, E A. And Ajani, E.N. (2012). Strategies for Improving Production and Processing of Cocoyam among Women in Anambra State, Nigeria. *Universal Journal of Education and General Studies* ***1****(16) 169-173.*

Robert, M. and Tim, H. (2004). Small Home-garden Plots and Sustainable Livelihoods for the Poor. In: Rural Development Institute (RDI) USA, FAO LSP working paper II. Available at *www.fao.org/docrep/007/j2545e/j254400.htm*.

Sulaiman U, Michael, W.M, Olayemi, Y.T and Rabiu, S. (2015). Awareness and Use of Information and Communication Technologies among Extension Agents in Kaduna State of Nigeria.*Journal of Agricultural Extension*. **19**(1), 69-82.

The World Gazetteer: Archived from the original on 09-02-2013. Retrieved 06-04-2007.

Udofia, S.I. (2010). Traditional Agroforestry practices in Nigeria. In Ijeomah H. M. and Aiyeloja, A. A. (eds.) *Practical Issues in Forest and Wildlife Resources Management*, Port-Harcourt Green Canopy Consultants. pp. 3-27.

Umunna, M. O., Adeeko, A., Ibrahim, O. A. Adigun, S. O., Ariyo, I. B. And A. B. S. Umar (2018). Biosecurity Measures against

Highly Pathogenic Avian Influenza used by Poultry farmers in Igabi Local Government Area of Kaduna State. *Nigerian Journal of Agricultural and Development Economics*. **8**(2), 108-118.

United States Agency for International Development (USAID), (2010). ICT to Enhance Farm Extension Services in Africa. *FACET Briefing Paper*, Washington DC. 35p

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Olomola et al., 2019

PROTOCOL DEVELOPMENT FOR IN-VITRO PROPAGATION OF *Anthocephalus cadamba*

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ABSTRACT

The objective of this study is to establish the most suitable protocol for the micro propagation of Anthocephalus catamba. The seeds of the species were collected from the wild and stored in the Seed bank until time of use. These were subjected to surface-sterilization using systemic fungicide and other disinfectants. Different media strengths of Murashige and Skoog (MS) were used to determine the most efficient nutritional requirement. The media strengths employed in this experiment were ¼, ½ and full. The culture media were supplemented with 6-Benzylamino purine (BAP), Giberrellic acid (GA3) and N-acetic acid (NAA). The generated plantlets had no contamination in the growth room due to the methods employed in the disinfection. In almost all the results obtained, both the ¼ and ½ strength media produced better result than plantlets growing on full strength media. Treatment D (¼ strength, 0.1mg/L BAP, 0.2mg/L GA3 & 0.1mg/L produced the best results in all. From the results obtained from this study, it is recommended that lower basal salts will be required for the in-vitro propagation of A.cadamba.

Keywords: *Anthocephalus cadamba*, growth hormone, media strength, micro-propagation, plantlets.

INTRODUCTION

Anthocephalus cadamba (Roxb) Miq) is a famous tropical large tree with straight cylindrical bole. The tree may reach a height of 45 m with trunk diameters of between 100cm and 160 cm. It has small buttresses and a broad crown. It is generally known as *Kadamb* or *Jabon* in South Asia and Southeast Asia (Asgar and Baharuddin 2017). *Anthocephalus cadamba* is an early-succession species which grows best on deep, moist, alluvial sites. It grows also often in secondary forests along riverbanks and in the transitional zone between swampy, permanently flooded and periodically flooded areas. (Jeyalalitha, 2015).

Anthocephalus cadamba wood is very easy to preserve and it is used for plywood, light construction, pulp and paper, boxes and crates, dug-out canoes, and furniture components. The wood can be easily impregnated with synthetic resins to increase its density and compressive strength (Joshi and Mathur, 2014). Some scientific studies carried out revealed its anti malarial (Slkar et. al., 1996, Sianne and Fanie 2002) and antihepatotoxic activities (Kapil, *et al.*, 1995). *Anthocephalus cadamba* has the prospect in establishment of forest plantations as it is a fast growing species with high production. *Anthocephalus cadamba* being a fast growing species has the prospect of been used in establishment of forest plantations. It can potentially regulate the water system in the soil and Prevent soil erosion (Asgar *and* Baharuddin, 2017).

Despite its usefulness and importance, little work has been done on its cultivation and depletion of natural population. Plantations of this species have not been successfully established due to poor seed germination, seed dormancy and poor efficacy of rooting through conventional method of propagation, making the conservation of *A. cadamba* serious concern (Bose and Choudhary, 1991).
Conventional methods of propagation of *A. cadamba* by seed and cuttings have not been successful this leading to limitation of the distribution of this sacred tree (Anjali and Nishi,

2015). To overcome these challenges and meet up with demand, it is necessary to have this plant in large numbers supported by seed stocks which are superior in both quality and quantity (Asgar and Baharuddin 2017). Tissue culture technique is one of the alternatives that can be used for the supply of seedlings of *A.cadamba* for large-scale propagation and conservation. The aim of this study is to determine the most appropriate media strength and optimum hormonal concentration for the *in-vitro* propagation of *A. cadamba*. Information from the in-vitro propagation of this species will help in mass propagation for possible plantation establishment and sustainable usage.

MATERIALS AND METHODS

Collection of explants: Viable seeds of *A. cadamba* were obtained from the seed bank of the Forestry Research Institute of Nigeria, Ibadan, Nigeria.

Explants disinfection

The seeds were first subjected to antifungal treatment by treating them with 3%w/v systemic fungicide. They were then rinsed using sterile distilled water. The seeds were disinfected by the use of 70% alcohol on the seeds for 5 mins. They were rinsed after with sterile distilled water and 10% hypochloride was added with few drops of Tween20 and allowed to stay for 15mins. These were then rinsed thrice with sterile distilled water in the laminar airflow hood for inoculation.

Culture Media preparation

The culture medium used for this experiment was Murashige and Skoog basal medium. This medium was prepared in quarter, half and full strengths respectively making the sucrose content to be 0.75%, 1.5% and 3% sucrose respectively. All media strength was fortified with different combinations and concentrations of Plant growth regulators (PGRs). These growth regulators included Benzyl amino purine (BAP), N-acetic acid (NAA), and Giberellic acid (G3). They were combined in the concentrations highlighted in Table 1 below.

Table 1: Media Strength and Plant Growth regulators Concentration

Media strength	Treatments	BAP (mg/L)	G3(mg/L)	NAA (mg/L)
Quarter Strength	A	0.0	0.0	0.0
	B	0.1	0.0	0.1
	C	0.2	0.1	0.2
	D	0.1	0.2	0.1
	E	0.0	0.1	0.2
Half strength	F	0.0	0.0	0.0
	G	0.1	0.0	0.1
	H	0.2	0.1	0.2
	I	0.1	0.2	0.1
	J	0.0	0.1	0.2
Full strength	K	0.0	0.0	0.0
	L	0.1	0.0	0.1
	M	0.2	0.1	0.2
	N	0.1	0.2	0.1
	O	0.0	0.1	0.2

A= control for Quarter strength, F= control for Half strength, K= control for full strength media.

This experiment was done to determine the effects different media strengths and different hormonal concentrations on the in-vitro propagation of *Anthocephalus cadamba*. It is a balanced three-factor factorial design (3x2) with ten replicates for each treatment. The comparism test was done using Statistical Product and Service Solution (SPSS) 16.0 software. Analysis of variance was done to determine significant difference.

Shoot initiation:
The seeds of the species were inoculated into culture tubes with the various media strengths under aseptic conditions, sealed with Parafilm and taken to the growth room with 16h photo period and 8 h dark period. Observations were made at intervals of 2 days till the first radical emergence. Subsequent readings were taken at 7 days intervals. The shoot heights, root lengths and number of leaves were taken.

RESULTS

Treatment C (¼ strength, 0.2 mg/L BAP, 0.1 mg/L GA3 and 0.2 mg/L NAA), gave the longest shoot length after 3 weeks of inoculation while treatment O (full strength, 0.1mg/L GA3 and 0.2mg/L NAA), gave the shortest with height of 0.25 cm among the tubes that had growths in them. Treatment C gave the longest shoot length of 4.0cm five weeks after inoculation while treatment M (Full strength, 0.2mg/L BAP, 0.1mg/L GA3 and 0.2 mg/L NAA) gave the shortest shoot length. Treatment D (¼ strength, 0.1mg/L BAP, 0.2mg/L GA3 and 0.1 mg/L) produced the highest shoot at 5.6cm after 7 weeks of inoculation while treatment N (Full strength, 0.1 mg/L BAP, 0.2 mg/L GA3 and 0.1 mg/L NAA) gave the shortest shoot length.

From Table 2, the mean shoot height in plantlets raised in full strength media is lower than those inoculated in both ¼ and ½ strength media. Treatment A (full strength, no PGR) produced the longest root length while treatment O gave the shortest root length (0.25cm) 3 weeks after inoculation. At 5 weeks after inoculation, treatment M produced the highest root length while treatment O gave the shortest (0.7cm). At 7 weeks after inoculation, treatment M gave the longest root length of 5.2, but the shortest root length was produced by treatment O (0.2cm).

Table 2: mean shoot height of *A. cadamba*, 3, 5 and 7 weeks after inoculation.

	Shoot Height		
Treatments	**3 WAI**	**5 WAI**	**7 WAI**
Control	1.23b	1.56a	1.89a
Full Strength	0.27a	1.15a	1.45a
Half Strength	2.06c	2.51b	3.59b
Quarter Strength	1.93c	2.83b	3.83b

P< 0.05, WAI = Week after inoculation.

Table 3: Mean Root length of *A. cadamba*, 3, 5 and 7 weeks after inoculation.

	Root length		
Treatments	**3 WAI**	**5 WAI**	**7 WAI**
Control	1.20b	1.52a	1.79a
Full Strength	0.41a	1.28a	1.91a
Half Strength*	1.31b	1.76a	3.42b
Quarter Strength	1.19b	2.54b	3.54b

P< 0.05,WAI = Week after inoculation.

Table 4: Mean number of leaves of *A. cadamba*, 3, 5 and 7 weeks after inoculation.

	Number Leaves		
Treatments	**3 WAI**	**5 WAI**	**7 WAI**
Control	5.13bc	5.73b	5.67a
Full Strength	1.03a	3.50a	4.75a
Half Strength	4.05b	8.21c	9.38b
Quarter Strength	6.38c	7.05bc	8.75b

P< 0.05, WAI = Week after inoculation.

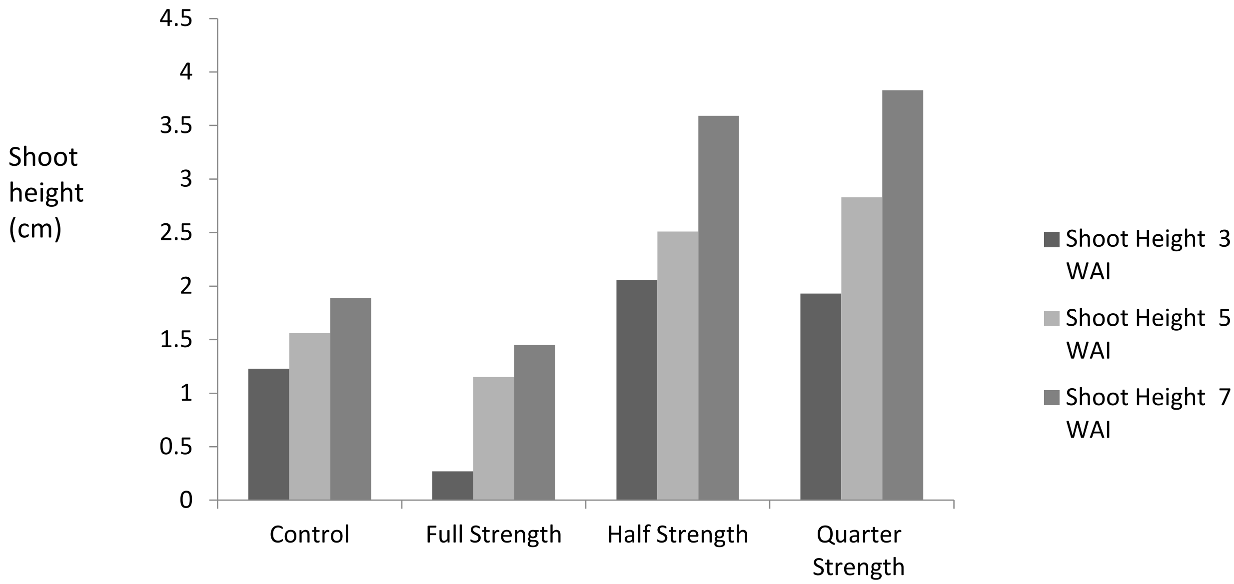

Figure 1: Mean Shoot length, 3 WAI, 5 WAI and 7 WAI.

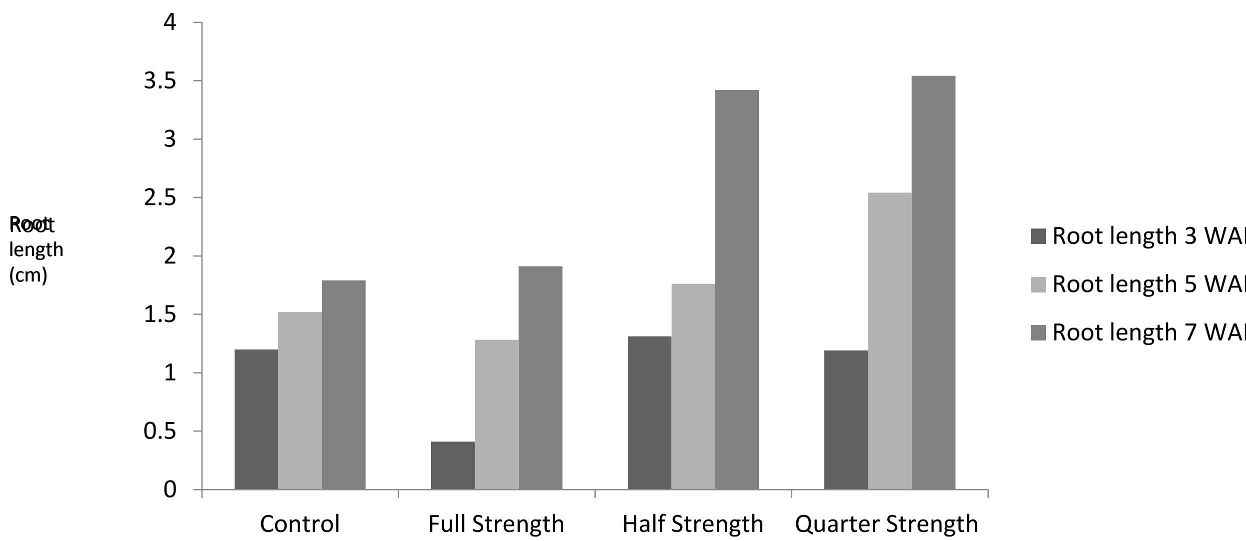

Figure 2: Mean of root length, 3WAI, 5WAI & 7WAI.

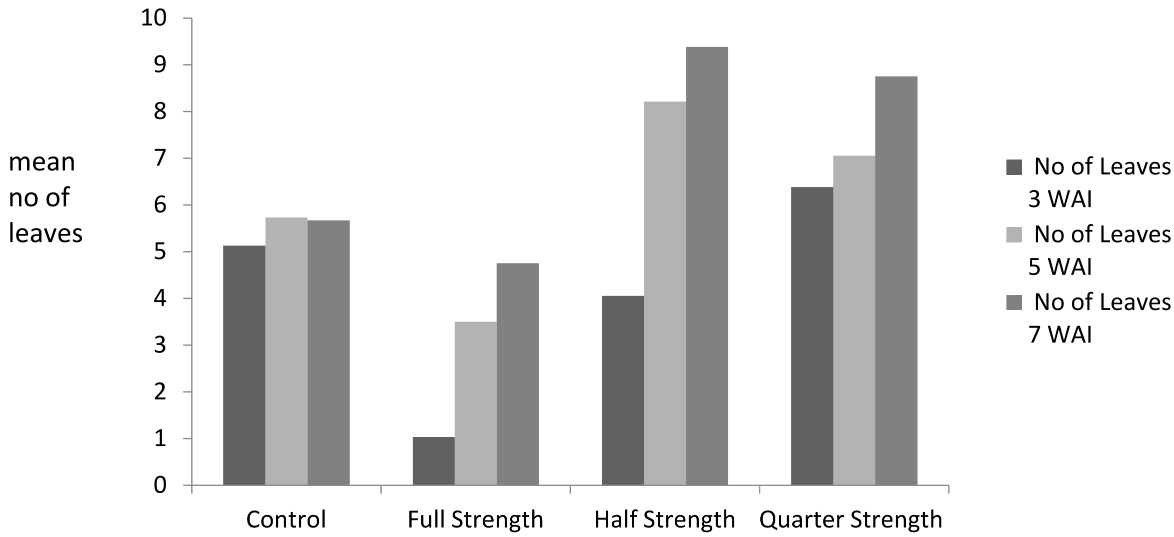

Figure 3: Mean number of leaves

Plate 1: Plantlets of *A.cadamba* in different treatments 3 WAI.

Plate1: Plantlets of *A.cadamba* in different treatments 5WAI.

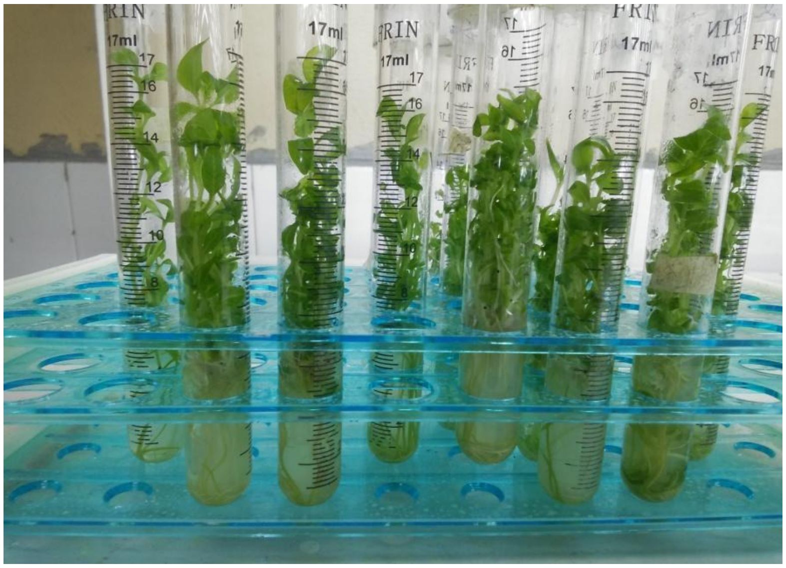

Plate 3: Plantlets of *A .cadamba* in different treatments 7WAI.

DISCUSSION

The mean root length is higher in both ¼ and ½ strength media (Table 3) than the full strength media, this is in line with similar work done by Sarropoulos *et al*. 2015, both ½ and ¼ strengths media gave the optimum results. Treatments N.D and I have the same PGR concentrations but different media strength, ¼ and ½ gave better results than full strength, Figures 1, 2 and 3, this is to validate the claim that lesser basal salts are required for the *in-vitro* propagation of *A. cadamba*. Even without PGRs, ½ strength supported the proliferation of the shoots and roots of the species (Bhalla *et al*.2009).

The full strength and control media which contain maximum basal salt requirement gave the worst results in terms of growth, this is in line with certain study carried out that some plant require lesser concentration of basal salt medium for maximum, growth Fadel *et al*., 2010 – explants inoculated on half strength media had the best results on the organogenesis of *Methana spicata* I.There was no significant difference between the mean shoot lengths of plantlets 3 weeks after inoculation in the media with half and quarter strengths MS media. Plates 1,2, & 3 shows growth of the species at 3WAI, 5WAI and 7WAI. At 5WAI and 7WAI, there was no significant difference in the mean shoot length of the control and full strength media. There was also no significant difference in the mean shoot lengths of the plantlets with quarter and half strengths (Table 2). The mean shoot lengths are higher in both quarter and strength MS media showing that lower nutritional requirement is needed for shoot proliferation of *A. cadamba*, this is in line with the work by Bidarigh and Azarpour, 2013 in which ¼ strength MS media gave one of the best results in shoot and root elongation. Husain *et al*,. 2007, half strength MS media supplemented with growth regulators produced the best results in the *in-vitro* propagation of of Indian Kino (*Pterocarpus marsupium* Roxb.) obtained similar results obtained in this study.

CONCLUSION

According to Okafor *et al*.2010, some tree species like *Treculia Africana* and others will require full strength media for their in-vitro propagation; such cannot be said of other species of all trees especially the Rubiaceae family. It will be therefore recommended that full strength media should not be employed in the *in-vitro* propagation of *Anthocephalus cadamba*.

REFERENCE

Anjali ,J. and Nishi, M.(2015).In vitro propagation and conservation of *Anthocephalus cadamba* through apical bud and nodal explants– A valuable medicinal plant CIBTech Journal of Biotechnology Vol. 4 (3), pp.8-18.

Asgar, T. and Baharuddin,I. (2017). In vitro multiplication of jabon (*Anthocephalus cadamba* (roxb)) on various concentrations of BAP and IAA. The *Agriculture Science Journal*, 4 (2) 60 - 65

Bhalla, S., Ong Abdullah J., Sreeramanan S. and Karuthan, C. 2009. Shoots Induction from *Hibiscus Rosa-sinensis* Nodal Explant Using *N* 6-benzylaminopurine (BAP). *Research Journal of Agriculture and Biological Sciences*, 5(4): 403-410, 2009. © 2009, INSInet Publication.

Bidarigh S and Azarpour E. (2013). Evaluation of the Effect of Ms Medium Levels on Rooting in Micro Cuttings of Tea (*Camellia sinensis* L.) Under In-vitro Culture Condition. *Journal of Agricultural and Biological Science*,8(1) 1990-6145.

Bose, T.K. and Chaudhary, B. (1991). Tropical garden plants in colour, (Horticulture and allied publishers, Kolkata.) 13-14

Fadel, D,Kintzios, S., Economou1,A.S, Moschopoulou, G., and Constantinidou, H.A. (2010).. Effect of Different Strength of Medium on Organogenesis, Phenolic Accumulation and Antioxidant Activity of Spearmint (*Mentha spicata* l.) *The Open Horticulture Journal*, *3*, 31-35,

Husain M. K. & M. Anis M and A. Shahzad. A. (2007). In vitro propagation of Indian Kino (*Pterocarpus marsupium* Roxb.) using Thidiazuron.*In Vitro Cellular and Developmental Biology*, 43:59–64. DOI 10.1007/s11627-006-9011-8

Jeyalalitha, T., Murugan, K. and Umayavalli, M.(2015). Preliminary Phytochemical Screening of Leaf Extracts of *Anthocephalus Cadamba*. *International Journal of Recent Scientific Research*. 6(10): 6608-6611.

Joshi, A. and Mathur, N. 2014. In vitro Propagation and Conservation of *Anthocephalus cadamba* Through Apical Bud and Nodal Explants– A Valuable Medicinal Plant. CIBTech Journal of Biotechnology, 319 – 3859.

Kapil, A., Koul, I. and Suri, O. P. (1995). Antihepatotoxic effects of chlorogenic acid from *Anthocephalus cadamba*. *Phytotherapy Research*. 9(3): 189-193. 92

Okafor C. Uche, Agbo P. Ejiofor, Okezie C. Eziuche.2010. Comparative Growth Rates of *Treculia Africana* Decne: Embryo in Varied Strengths of Murashige and Skoog Basal MediumSarropoulou V., Dimassi-Theriou K., Therios I. 2015. Medium strength in inorganics and PVP concentration effects on cherry rootstocks *in vitro* rooting. *Horticultural Science.* (*Prague*) 42(4): 185–192. doi: 10.17221/359/2014-HORTSCI

Sianne, S. and Fanie, R. Van, H. (2002). Antimalarial activity of plant metabolite. *Natural Products Research*. 19: 675?692.

Slkar, I.V., Kakkar, K.K., Chakre, O. J. (1992). Glossary of Indian Medicinal Plants with Active Principles. CSIR, New Delhi, Part I, pp 75.

World Academy of Science, Engineering and Technology (2016). *International Journal of Agricultural and Biosystems Engineering*,10(9), *www.arpnjournals.com*

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adebayo et al., 2019

WILLINGNESS TO ESTABLISH PRIVATE FOREST PLANTATION AMONG DWELLERS IN SOME SELECTED LOCAL GOVERNMENT AREA OF OSUN STATE, NIGERIA

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ABSTRACT

This study was carried out to investigate the willingness to establish private forest plantations among dwellers in Ife North, Ede South and Osogbo Local Government Areas of Osun State. One hundred and seventeen (117) questionnaires were administered randomly to selected respondents from nine (9) selected communities in the study areas, while ninety-three (93) copies of questionnaire were retrieved. Multi-stage sampling technique was used to select respondents from the study area. The willingness of the respondents to private forest plantation establishment showed that 64.5% of the respondents agreed on establishment of private forest plantation. Chi-square analysis indicated that a significant relationship exist between respondents' sex, level of education, source of labour and secondary occupation on willingness to establish private forest plantation. Many of the dwellers faced some problems which influenced their willingness in establishing private forest plantations such as poor extension service, land tenure system, small land holding, non-availability of seed/seedlings, lack of technical know-how, Government policies, trees casting shadow on crops, etc. More dwellers can be encouraged in willingness to participate in private forest plantation through extension service to farmers, government institutions' involvement at various levels of activities that will encourage individuals and organizations to establish private forest plantations. Government policies on land tenure system should be reviewed to encourage individual or private organisations to invest and actively participate more in forest plantation establishment.

Keywords: Willingness, Private Forests, Plantation Establishment

INTRODUCTION

The forest plays an important role in protecting the soil, ameliorating the environment and protecting biodiversity and conserve soil and water. Forests are the main carbon reservoirs as well as the most efficient ecosystems to capture CO2 from the atmosphere. Adedokun et al. (2011), reported that one of the most important resources of the earth is the forest and it is believed that man cannot survive without trees, especially those that are fruit producing. Ogunwusi (2011) reported that the role of forests in industrial development and in carbon sequestration is becoming very topical, and emphasis should be placed on increasing the area under forest cover through plantation establishment. Therefore, the continuing dependency of the poor living in the rural and urban settings in the developing countries on fuel wood for cooking and heating has seriously degenerated to environmental degradation (Arowosoge and Oyerinde, 2011). Therefore, the rapid growth of populations and the higher expectations of the people which have been generated throughout the State have led to an increase in the use of forests to such an extent that forests in the State have become degraded if they have not been razed to the ground, while the community involvement in forestry activities has also been ignored by planners and policy makers not only in Nigeria but also all over Africa (Adedayo and Oyun, 2010). However, very little progress has been made over the years in building on this foundation to transform the economy of the state using agriculture and forestry as a driver. Due to a lack of focus in the agriculture sector, the gains achieved by the Western Region government have been gradually eroded (Ministry of Information, Osun State, 2009). Hence, local people have an important role in agriculture, their involvement in forestry activities varies between cultures, they have names for many different kinds of plants, ways to diagnose and treat human and animal diseases and methods to cultivating fertile and infertile soils. The agroforestry practices adopted by farmers include retention of trees on farmland, planting of trees on boundaries, scattered trees on farmland, shifting cultivation and home gardening (Akinbile *et al*., 2007)

The forest provides household food and shelter for the people (Omorodion and Ebana, 1994). Precisely, forest plantations around the world provide important source of livelihood for many of the rural poor, although people necessarily make use of the forest. In a matter of fact, forest dwellers do represent the group with the highest level of forest dependency (Arnold, 2001). Forest dwellers are most often indigenous population groups that live in and with the forest according to their own traditions, making the forest also an important part of their social and cultural systems (Arnold and Bird, 1999).

It has been demonstrated that the private sector in forest plantation establishment is probably less than 1.0% of the total forest plantation in the country, although FORMECU (1999) identified a growing interest by the private sector in establishing forest plantations. This study therefore focused on the assessment of the willingness to establish private forest plantation among dwellers in Osun state.

MATERIALS AND METHODS

Study Area

The study was carried out in Osun State in 2018, Nigeria. The State was carved out of the old Oyo State on the 27th August 1991, it is located between longitudes 040301E and 4051E and latitude 70301N and 70501N, South-western Nigeria. It covers an area of approximately 14,875 square kilometres. It is also divided into three Federal senatorial districts, each of which is composed of two administrative zones. The 1991 census puts the population of the State at 2.2 million, SEEDS (2007). The State is made up of 30 Local Government Areas (LGAs) with over 200 towns, villages and other settlements. The State has a considerable number of highly urbanized settlements, some of which are Osogbo, Ile-ife, Ipetumodu, Ilesa, Ikirun, Iwo, Ede, Ila Orangun and Ikire. Others include Ejigbo, Ilobu, Gbongan, Okuku, Inisa, Ijebu-Ijesa, Ipetu-Ijesa etc. The people of the State are mainly traders, artisans and farmers. Their other occupations include hand-woven textiles, tie and dye, leather work, calabash carving and mat weaving. Osun State is bounded in the west by Oyo State, Ondo and Ekiti States in the East, Kwara State in the North and Ogun in the south. The state runs an agrarian economy with a vast majority of the populace taking to farming, SEEDS (2007).

Experimental Design

The population of this study comprised of the people in three LGAs selected from three Senatorial District of Osun state. Target population of this study comprised the households of some selected communities in the three local governments. Multi-stage sampling was used to select the respondents in the study area. One (1) Local Government Area was randomly selected from each of the three (3) Senatorial Districts to give a total number of three (3) Local Government Areas in the study area. Three (3) communities were selected in each local government area using random sampling techniques to make a total of nine (9) communities. In each of the nine (9) sampled communities, thirteen (13) household heads were systematically selected in each community to make a total number of one hundred and seventeen (117) respondents and semi structured questionnaire were administered to them. While ninety-three (93) copies questionnaires were retrieved. The selected local government areas and the sampled communities are presented in Table 1.

Senatorial District	Local Government	Communities
Osun East	Ife North	Ipoye, Olobo, Oyere- aborishade.
Osun West	Ede South	Olodan, Ararimu, Elewure.
Osun Central	Osogbo	Boredun, Onigboyi, Owode.

Data Analysis

The data was analysed using frequency distribution and percentages. The hypotheses of the study were tested using chi-square and Pearson product moment correlation (PPMC).

RESULTS

Table 2 shows there were more males (92.5%) to establishing of private forest plantation than females (7.5%) in the study area. The age distribution shows that, the age of most respondents was within the range 40-49years which has the highest percentage of 53.8%.The marital status of the respondents showed that married (88.2%) were more willing to be involved in private forest plantation establishment than single (11.8%) people, due to the fact that married people have more responsibilities and cautious of their decisions. Therefore, their participation would improve their standard of living which will also have major impact for their future. The result further showed that there were more Muslims (55.9%) than Christians (43%) in the study area. The household sizes of the respondents showed that majority (72.0%) of them have family size between 0-4. The educational background of the respondents revealed that majority (80.6%) had secondary education followed by primary and tertiary educations were 15.1% and 4.4%, respectively. The table further shows that respondents with 12 years of formal education had the highest percentage of (81.7%).

Table 2: Socio-economic characteristics of the study respondents in Osun State

Variable	Frequency	Percentage (%)
Sex		
Male	86	92.5
Female	07	07.5
Age(Years)		
21-29	02	02.2
30-39	15	16.1
40-49	50	53.8
50-59	25	26.9
60 Above	01	01.1
Marital status		
Married	82	88.2
Single	11	11.8
Religion		
Christianity	40	43.0
Islamic	52	55.9
Traditional	01	01.1
Household size		
0-4	67	72.0
5-8	26	28.0
Level of education		
Primary education	14	15.1
Secondary education	75	80.6
Tertiary education	04	04.4
Years of Formal Education		
6 years	14	15.1
12 years	76	81.7
16 years	03	03.2
Total	**93**	**100.0**

Table 3 shows that 65.6% of the respondents haven't heard about private forest plantation establishment. This result implies that majority of the respondents were ignorant about private forest plantation establishment which may contribute to low involvement in private forest plantation establishment in the study area. Also 50.5% of the respondents were not practicing agroforestry. While 49.5% were practicing it. Most of the 62.4% respondents didn't know that individuals or private organizations can establish forest plantations but 37.6% of the respondents know that individual or private organization can establish forest plantation. Most of the 53.8% respondents don't have any relationship with forest staff while 46.2% of the respondents have relationship with forest staff. From the table, it shows that 65.6% of the respondents have difficulty coping with tree tending. This result implies that majority of the respondents were having difficulty in coping with tree care and monitoring. Table 3 also show that 48.4% of the respondents have heard about the policy guiding forestry activities, this result implies that majority of the respondents have no knowledge about the policy guiding forestry activities. Most of the respondents (62.4%) don't know how to plant trees while 37.6% of the respondents know how to plant tree. Most of the 62.4% doesn't have knowledge on management activities involved in forest plantation establishment. Furthermore, 87.1% of the respondents know that trees or forest plantation establishment takes several years to mature and also 86.0% of the respondents agreed that exotic species in private forest plantation establishment are better than indigenous species, this result is in agreement with the findings of Udofia *et al*., (2011), that vast areas of forest are being converted into plantation of exotic tree species, due to the fact that they grow faster than the indigenous species.

Table 3: Knowledge of respondents on private forest plantation establishment practices in Osun State

S/No.	Knowledge on forest plantation establishment	Yes F (%)	No F (%)
1	Have you heard about PFP?	32 (34.4)	61 (65.6)
2	Are you practicing Agroforestry?	46 (49.5)	47 (50.5)
3	Do you know that individual or private organization can establish forest plantation?	35 (37.6)	58 (62.4)
4	Do you have any relationship with forest staff?	43 (46.2)	50 (53.8)
5	Difficult coping with tree tending?	61 (65.6)	32 (34.4)
6	Have you heard about policy guiding forestry activities?	45 (48.4)	48 (51.6)
7	Do you know how to plant trees?	35 (37.6)	58 (62.4)
8	Do you have knowledge on management activities involves forest plantation establishment?	35 (37.6)	58 (62.4)
9	Trees/forest plantation establishment takes several years to mature?	81 (87.1)	12 (12.9)
10	Indigenous species are better than exotic species in PFP establishment?	13(14.0)	80(86.0)

Table 4 revealed that only 81.7% of the respondents identified fire outbreak as not a constraint, which is quite reasonable because forest plantation establishment will combat excessive fire outbreak. Inadequate forest extension worker was also identified as a major constraint with (92.5%) of the respondents affirmed that forest extension workers were not enough to sensitize them on the need to establish forest plantation. The result is in agreement with the finding of Dezoysa (2002) who pointed out that extension sometimes is successful in creating awareness and promoting trees, but the extensions effort often fails with no provision for follow-up visits. Another major constraints identified by the respondents is land tenure system which accounted for (83.9%). It was observed that the land use act of 1978 vested the ownership of land on government. The table further revealed that (95.7%) of the respondents identified government policies on forestry as a major constraint. The table also shows that lack of technical know-how which accounted for (66.7%) is one of the main constraints to forest plantation establishment. Above average (53.8%) of the respondents also identified private forest establishment as long term investment which involves capital tie down investment. Most finance houses in Nigeria believe in short term, highly predictable and profitable investments..

Table 4 also shows that 50.6% of the respondents had low response based on perceived constraints to private forest plantation establishment in the study area. This implies that some of the perceived constraints are not directional to what can affect respondents' willingness to participate in establishment of private forest plantation.

Table 4: Perceived constraints of respondents to private forest plantation establishment in Osun State

S/No.	Constraints plantation establishment	Major F(%)	Minor F(%)	Not constraint F(%)
1	Fire outbreak	4 (4.30)	13 (14.0)	76 (81.7)
2	Poor extension service	86 (92.5)	7 (7.5)	0(0.00)
3	Land tenure system	78 (83.9)	14 (15.1)	1 (1.1)
4	Small land holding	79 (84.9)	13 (14.0)	1 (1.1)
5	Non availability of seed/seedlings	89 (95.7)	4 (4.3)	0(0.00)
6	Lack of technical know-how	62 (66.7)	29 (31.2)	2 (2.2)
7	Long term investment	50 (53.8)	8 (8.6)	35 (37.6)
8	Lack of finance	84 (90.3)	8 (8.6)	1 (1.1)
9	Government policies	89 (95.7)	4 (4.3)	0(0.00)
10	Shortage of labour supply	77 (82.8)	16 (17.2)	0(0.00)
11	Poor transportation during raining season	81 (87.1)	12 (12.9)	0(0.00)
12	Trees casting shadow on crops	72 (77.4)	15 (16.1)	6(6.5)
13	Unnecessary competition for soil nutrient with arable crops	71 (76.3)	13 (14.0)	9 (9.7)

Table 5 indicates the willingness of the respondents to support private forest plantation establishment. The table revealed that most of the respondents (65%) agreed on willingness to private forest plantation establishment, some were undecided (15%) while 20% disagreed on willingness to private forest plantation establishment. This may be due to the perceived benefits they stand to gain if they establish the plantation.

Table 5: Willingness of the respondents to private forest plantation establishment in Osun State

S/No.	Willingness to forest plantation establishment	Agree F(%)	Undecided F(%)	Disagree F(%)
1	I will like to establish PFP?	60 (64.5)	6 (6.5)	27 (29.0)
2	Economy diversification will make me to invest in establishment of PFP.	56 (60.2)	10 (10.8)	27 (29.0)
3	I will establish PFP if there is availability of land.	62 (66.7)	11 (11.8)	20 (21.5)
4	Climate change can make me to establish PFP to mitigate its effect	59 (63.4)	15 (16.1)	19 (20.4)
5	If i have access to loan, i will establish PFP.	61 (65.6)	11 (11.8)	21 (22.6)
6	I will establish PFP as a means of income generation.	62 (66.7)	16 (17.2)	15 (16.1)
7	Arable crops can be interplant with trees known as Agroforestry practice.	61 (65.6)	13 (14.0)	19 (20.4)
8	I will involve and establish PFP to encourage urban forest development	61 (65.6)	15 (16.1)	17 (18.3)
9	I will establish PFP for the community benefit	61 (65.6)	14 (15.1)	18 (19.4)
10	If land acts are reformed, I will engage in PFP establishment	61 (65.6)	14 (15.1)	18 (19.4)
11	Establishment of PFP will improve the sustainability of forestry sector	61 (65.6)	14 (15.1)	18 (19.4)
12	Government involvement at various level of activities will encourage individual and organisation to establish PFP	61 (65.6)	13 (14.0)	19 (20.4)
13	Awareness creation by stakeholders will enable individual to participate in establishment of PFP	61 (65.6)	11 (11.8)	21 (22.6)

Chi-square analysis (Table 6) revealed that, significant relationship exist between the sex, level of education, source of labour and secondary occupation on willingness to establish private forest plantation, sex (X^2 = 23.038, P = 0.000), level of education (X^2 = 18.476, P = 0.001), source of labour (X^2 = 10.073, P = 0.006) and secondary occupation (X^2 = 12.458, P = 0.052). This implies that the sex, level of education, source of labour and secondary occupation of the respondents influenced their level of willingness to establish private forest plantation. However, age (X^2 = 12.615, P = 0.126), marital status (X^2 = 2.005, P = 0.367) religion (X^2 = 2.340, P = 0.674) and household size (X^2 = 0.065, P = 0.968) of respondents were found to have no significant relationships with their level of willingness to establish private forest plantation.

Table 6: Chi-square analysis of socio-economic characteristics of the respondents and their willingness to establish private forest plantation in Osun State

Variables	X^2-value	P-value	Decision
Sex	23.038	0.000	S
Age	12.615	0.126	NS
Marital	02.005	0.367	NS
Religion	02.340	0.674	NS
Household size	00.065	0.968	NS
Level of education	18.476	0.001	S
Source of labour	10.073	0.006	S
Secondary occupation	12.458	0.052	S

S = (P ≤ 0.05)

The result as presented in Table 7 revealed that there was significant relationship between knowledge and willingness to establish private forest plantation (P < 0.05). This means that knowledge is power and the more knowledgeable the respondents has on activities involves in establishment of forest plantation the more their willingness to establish private forest plantation.

Table 7: Pearson Product Moment Correlation analysis showing relationship between knowledge and willingness to establish private forest plantation in Osun State

Variable	r-value	P-value	Decision
Knowledge and Willingness	0.854	0.000	S

The result on the table below showed that there was significant relationship between perceived constraints of the respondents' and their willingness to establish private forest plantation (P < 0.05). This implies that constraints perceived or faced by individuals will determine their willingness to engage in private forest plantation. The negative sign on the r-value indicates that there was an imbalance relationship between the perceived constraints and willingness to establish private forest plantation among the respondents.

Table 8: Pearson Product Moment Correlation analysis showing relationship between perceived constraints and willingness to establish private forest plantation in Osun State

Variable	r-value	P-value	Decision
Perceived constraints and Willingness	-0.213	0.040	S

DISCUSSION

The result showed that most of the respondents were still within the age range of forties which confirmed the report of Adekunle, (2009) which stated that people in this age group (40-49 years) are agile and gainfully employed in farming, hence the importance of their involvement on decision making process of farmers with respect to adoption of improved agricultural technologies and other production related decisions to establishment of forest plantation. The result is attributed to the fact that most of the households are headed by males and establishment of forest plantation with other forestry activities might be tedious and could be done by men than women.

It was revealed from the result that respondents' household size is not large, because every household head is cautious and considers their economy status. The result further showed that the literate level of the respondents in the study area was above 80% which has enhanced their willingness to establish private forest plantations. Therefore, it is in agreement with the findings of Adejoba and Oyewale, (2012) which says as the level of education attainment increases, the level of willingness also increases.

The result also agrees with the findings of Banjo and Abu (2014) who reported that formal education is an essential socio-economic factor that influences farmers' decision because of its effect on the knowledge, perception, perceived constraints and the willingness in establishing forest plantation that can increase productivity.

The result revealed that knowledge of agroforestry practices is low; this is contrary to the findings of Akinbile *et al*., (2007) that agroforestry has a way of instituting sustainable agricultural development in Nigeria. This is because agroforestry has the ability to combat the various environmental problems by assisting farmers to maintain the fertility of their soils, ensure diversification of crops, wood and timber species and to stabilize, improve and conserve the environment. The result also revealed that policies on forestry were identified as a major problem; this is in line with the report of Onyekwelu (2001), that there is need to reform government policies, incentives, extension service, and provision of seed/seedlings. Also tackling other problems like long gestation period, land tenure, shortage of labour supplies and logging problem due to poor transportation during the raining season.

The result also revealed that majority of the respondents believed that establishment of forest plantation is a long time investment; this is in line with the findings of Dezoysa et al (2002) that over 46% of the participants in the programme consider the investment in forest plantation as an investment for the future especially for their children

CONCLUSION

The establishment of forest plantation is a key to sustainable harvest of wood products in order to support human society. Incessant deforestation has been a major problem which is resulting to uncertainty of weather conditions which is gradually transforming to climate change and variability. Therefore, our environment needs to be managed in such a way that we will have a balance the ecosystem and its services. Thus, respondents' knowledge on forest plantation enables them to show willingness in participating in trees planting. This is as a result of the perceived benefits associated with forest plantations.

Recommendation

Therefore, if Forest Research Institute of Nigeria and all stakeholders at all levels in forestry activities should initiate and sustain programmes that will enlighten and encourage the individual participation in forest plantation establishment. It will serve as benefits for the participants in private forest plantation.

REFERENCES

Adedayo, A.G., and Oyun, M.B., (2010). The involvement of Rural Women in Forest Resources exploitation in Ondo State, Nigeria. In: Onyekwelu, J. C, Adekunle, V.A.J and Oke, D.O (Editors) climate change and forest resources management; the way forward. Proceedings of the 2nd Biennal National Conference of the Forest and Forest Products Society, Pp. 140 -144.

Adedokun, M. O., Soaga, J. A. O., Olawumi, A. T., Oyebanji, O. O., Oluwalana, S. A. and Sijuwade,
A. (2011). Utilization pattern and physiochemical properties of chrysophyllum albidum In Odeda
Local Government Area of Ogun State, Nigeria. *Nigeria Journal of Forestry*, 42(2) 43-47

Adekunle, A.A. (2009). Integrated Agricultural Research for Development (IAR4D). A concept paper prepared for Forum for Agricultural Research in Africa (FARA), Sub-Saharan Africa Challenge Programme (SSA CP).

Adejoba, O. R and Oyewale, O. O (2012). Community Involvement in Forestry and Rural Development in Ejigbo and Ola-Oluwa Local Government Areas of Osun State. Forestry Research Institute of Nigeria, Ibadan, Nigeria Department of Forest Product Development and Utilization. 42p.

Akinbile LA, Salimonu KK, Yekinni OT (2007). Farmers Participation in Agroforestry Practices in Ondo State, Nigeria. *Research Journal of Applied Sciences* 2: 229-232

Arnold, J.E.M. (2001). Forestry, Poverty and Aid. Occasional Paper No. 33. Centre for International Forestry Research (CIFOR), Jakarta, Indonesia. 17p.

Arnold, J.E.M. and Bird, P. (1999). Forests and the Poverty Nexus Prepared for the UNDP/EC Expert Workshop on Poverty and the Environment, Brussels, Belgium. Pp 1-2.

Arowosoge, O. G. E. and Oyerinde, O. V. (2011). Assessment of fuelwood trade in Ekiti State Nigeria: Issues on fuelwood sustainability. *Nigeria Journal of forestry*, 42(2): 63-66

Banjo, A.A. and Abu, J.E. (2014). Community Involvement in Forest Management. Proceedings of the 37th annual conference of the Forestry Association of Nigeria, held in Minna, Niger State, Nigeria. 9th-14th November, 2014.

Burgers, P., Ketterings, Q.M. and Dennis, P. G. (2005) Fallow Management Strategies and Issues in Southeast Asia. Agriculture, Ecosystems and Environment, Vol. 10, Pp.1-13.

FORMECU, (1999). Forest resource study, Nigeria. Revised National Report, Vol. 2.prepared for FORMECU by Beak and Geomantic international, 224 pp.

Ministry of Information, Osun state (2009). File: Osun State, Nigeria. Available. *www.osunstateorg/ministries/mininfowmen.htm 22/6/2009*.

Ogunwusi, A. A.(2011). Strategies for promoting private sector investment in plantation Establishment in Nigeria. *Nigeria Journal of forestry*, 40(1): 8-16

Omorodion, F.I. and Ebana, R. (1994). The Impact of Deforestation in Cross River State of Nigeria. 16p. Report Prepared for Cross River State. Forestry Project (ODA Assisted).

Onyekwelu, J.C. (2001). Growth Characteristics and Management Scenarios for plantation grown Gmelina arborea and Nauclea diderrichii in south-western Nigeria. Published Ph.D. Thesis; Hieronymus Publishers, Germany; ISBN 3-89791-235-X., 201 pp.

SEEDS (2007). State Economic Empowerment and Development Strategy (SEEDS). Osun State Government.

Udofia, S.I., Jacob, D.E., Owoh, P.W. and Samuel, N.S. (2011). Stemming environmental degradation: The afforestation approach. *Nigerian Journal of Agriculture, Food and Environment* 7(1): 22-27.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Aderounmu et al., 2019

CONTRIBUTION OF LOCUST BEAN SEED PROCESSING TO THE HOUSEHOLD OF RURAL WOMEN IN OYO STATE, NIGERIA

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ABSTRACT

This study was carried out to assess the contribution of locust bean seed processing to the household of rural women in Oyo State Nigeria. Means of livelihood, existing processing techniques, level of income, contribution of locust bean and constraints hindering locust bean processing by women in the study area were examined. Multi stage sampling technique was used to select 12l women processors as respondents. Questionnaires were administered to the sampled respondents of which 120 were retrieved. The data were subjected to descriptive (frequency, percentage, mean) and inferential statistics. The results revealed that 33.3%% of processors were between the ages of 51 years and above. Majority (76.7%) of the respondents relied on locust bean processing as means of livelihood. All the respondents used traditional method of processing. The result revealed that there is no significant (p>0.05) relationship between the selected socioeconomic characteristic variables and contributions of locust bean seed processing. The result also showed positive and significant (p<0.05) relationship between livelihood income, perceived constraints and contributions of locust bean seed processing to the household of rural women. Difficult in locust bean processing (35.8%), scarcity of water/flowing river (18.3%) and inadequate capital (11.7%) were reported as most important constraints to locust lean processing in the study area. It was concluded that locust bean processing has the potential to improve the processors' household economy thus allowing agricultural development and sustainability provided the constraints are adequately addressed.

Keywords: Locust bean, Processing, Rural Women, Oyo State, Livelihood

INTRODUCTION

A major concern of developing countries in Africa and other regions has been to significantly reduce poverty among the masses. Poverty is still a common feature of rural communities that constitute the dominant population in developing countries, According to International Fund for Agricultural Development (IFAD, 2009), rural people constitute about 72 percent of the people living in extreme poverty (Less than 1.25 USD per day) in developing countries, down from about 80 percent ten years ago. About 51 percent of all the people in developing countries live in poverty (Less than USD 2.00/day), while 27 percent live in extreme poverty. At the macro, community, and household levels, the necessity to combat poverty and its effects in African countries has become compelling over the past few decades (Clempson, 2012).

Exploitation of the usefulness of the African locust bean tree (*Parkia biglobosa*) has been an age-long income- generating venture among rural households in Nigeria and other African countries (Shao, 2002). Its relatively low input requirements have made the tree a veritable means of rural household poverty alleviation. Its seeds are used as a coffee substitute and in making local doughnuts, while its leaves serve as vegetable in combination with other foods. The bark of the African Locust Bean (ALB) tree is used medicinally and its young flowers are mixed with salads, the fruit pulp and seed residues are used in making animal feeds.

The most important part of the tree is found in its seeds and the processed seed is used as a condiment for soup. It is a source of natural nutritious condiment which features frequently in the traditional diet of the people (Akande *et al*., 2010). Apart from the flavoring attribute of the processed locust bean "iru", it also contributes significantly to the intake of protein, essential fatty acids, particularly Vitamin B, riboflavin and Vitamin A (Oguntola, 2007). Locust bean is native to West Africa and it is also called different local names in different localities; for instance, it is referred to as "kinda" in Sierra Leone, "Kapalugu" among the inhabitants of Northern Ghana, "Nere" in Burkina Faso, "igi igba" in Yoruba land, and "worku" in Ghana (Diawara *et al*., 2000).
Also in the dry area, locust bean tree serve as potential sources of food, edible oil, fodder, lumber, fire wood and green manure. It was estimated that about 200,000 tonnes of Africa locust bean seeds are gathered each year in Nigeria alone, as well as large quantities are produced in the savannah region of South West, Nigeria (Diawara *et al*., 2000). The seeds are most valued product of the tree. It generates reliable and dependable income for the farmers and women who are involved in its processing and marketing. It is estimated that the total national demand for various types of food condiments and seasonings in Nigeria is 5,475 Tonnes per annum (FIIRO, 2013).

Forest- based activities in developing countries Nigeria inclusive, which are mostly in NTFPs area, provide an equivalent of 17 million frill- time jobs in the formal sector and another 30 million in the informal sector, as well as 13- 35% of all rural nonfarm employment (Duong 2008). Locust bean is an important forest product especially in the formal sector and another 30 million in the informal sector, as well as 13- 35% of all rural non- farm employment (Duong, 2008). Locust bean is an important forest product especially in dry land areas where it forms alternative sources of livelihoods. It also contributes to poverty alleviation through generation of income providing food and improved nutrition, medicine and foreign exchange earnings (Chikanai and Kagombe, 2002). There is therefore a growing awareness of the contributions of locust bean to household economy, food security, national economy and conservation of biodiversity (Okafor *et al*., 1994).
The main objective of this study is to assess the contributions of locust bean seed processing to the household economy of rural women in Oyo state, Nigeria.

The personal characteristics of the respondents identify their other means of livelihood, existing processing techniques; ways by which locust bean business contributes to the income and of course the constraints encountered by the respondents.

MATERIALS AND METHODS

Study area

The study area is Oluyole Local Government Area of Oyo state. Ibadan Is the capital of Oyo state, situated in the South- western part of Nigeria, 128 km inland northeast of Lagos and 53 0km southwest, of Abuja. It is the third largest metropolitan area by population in Nigeria after Lagos and Kano, with a population of l, 338,659 according to 2006 census. It has boundaries with Ogun in the south, Kwara state in the North, Republic of Benin in the west and Osun state in the East. Ibadan is 228rn above sea level and has a rainfall of average distribution of about 1250 mm and 1800 mm. it is located on the latitude 7°45"N of the equator and longitude 3°45"E of the Greenwich meridian. Ibadan is blessed with two seasons; dry season which begins from November to April while rainy season from April to October. It also has a temperature that ranges between 27°c and 32°c with relative humidity of about 25% to 90% (Alabi and Ibiyemi, 2002). Oluyole is a home for small, medium and large scale industries.

Sampling Procedure

Multi-stage sampling technique was used for the study.

1. First stage: Oyo State was purposively selected for the study due to the availability of locust bean processors in the area.
2. Second stage: Four Agricultural zones which are Oyo, Saki, Ibadan-Ibarapa, and Ogbomoso were selected
3. Third stage: Four (4) local government areas were purposively selected. These includes Ibarapa North, Iseyin, Surulere and Saki east

representing agricultural block of the Agricultural Development Programme (ADP)

4. Thirty five (35) locust bean processors were selected from each of the selected Local Government representing the ADPs. Therefore, a total of 140 were administered while only 120 were retrieved and useful for analysis for this study.

Data analysis

Descriptive statistics such as frequency, percentage and 5 point Likert-type scale was used to analyse the objectives of the study

RESULTS

Table 1 revealed that the respondents' ages ranged from 21 years with Majority (38.3%) were from 51years and above while only 5.0% were between the ages of 21-30years. Also 58.3% were married, 12.5% were divorced while 29.2% of the respondents were widow. The table further revealed that the majority (50.8%) of the processors and marketers were Christians, 46.7% were into Islamic religion while 2.5% of them were traditional worshippers. Most of the respondents (68.3%) have family size below 5 persons within the household while 31.7% have family size between 6-10 persons (Table 1). The result further shows that majority of *P. biglobosa* processors and marketers in the study area had primary education (56.7%) as much as 34.2% had no formal education, 7.5% had secondary education while only 1.7% had tertiary education. Apart from the major livelihood activity, 28.3% and 9.2% of the respondents engaged in trading and arable farming respectively as supplementary livelihood activities (Table 2). In table 3, 2.5% of the respondents had income range of less than ₦1, 000 daily, 51.7% had income range between ₦1000 - ₦2000, and 41.7% had income range between ₦2, 000 – ₦3, 000 while only 4.2% have above ₦3, 000 per day. The result revealed in table 4 shows that majority (100.0%) of the respondents use the traditional processing method. Table 5 revealed that rural women highly benefited from marketing of processed locust-bean and cracking of locust bean pod as they ranked 1st and 2nd respectively. An investigation of the constraints encountered by the respondents yielded the data contained in table 6. Eight constraints identified during the field survey were presented on a 5 point Likert-type scale. The table showed that the respondents' greatest constraint was that, processing of locust bean is strenuous which was ranked first.

Table 1: Socio-Economic Characteristics of Respondents

Variable	(N= 120)	Frequency	Percentage (%)
Age			
21-30		6	5.0
31-40		26	21.7
41-50		41	34.2
51 Years And Above		47	39.1
Total		**120**	**100**
Marital status			
Married		70	58.3
Divorced		15	12.5
Widowed		35	29.2
Total		**120**	**100**
Religion			
Christianity		61	50.8
Islam		56	46.7
Traditional		3	2.5
Total		**120**	**100**
Household Size			
Below 5		82	68.3
6-10		38	31.7
Total		**120**	**100**
Educational Status			
No Formal Education		41	34.2
Primary Education		64	56.7
Secondary Education		9	7.5
Tertiary Education		2	1.7
Total		**120**	**100**

Table 2: Other means of Livelihood Activities by sampled Respondents

Livelihood Activities	No	Yes
Trading	86(71.7)	34(28.3)
Tailoring	120(100.0)	–
Arable Farming	109(90.8)	11(9.2)
Yam Flour	120(100.0)	–
Fish processing	120(100.0)	–

Table 3: Distribution of respondents according to Income

Income	Frequency	Percentage
<1000	3	2.5
1000-2000	62	51.7
2000-3000	50	41.7
>3000	5	4.1
Total	**120**	**100.0**

Table 4: Existing technique in Processing Locust bean

Technique (N= 120)	Frequency	Percentage
Traditional	120	100.0
Mechanical	–	–
Both	–	–

Table 5: Ways by which locust bean contribute to the income of the respondents

Contributions	SA	A	U	D	SD	Rank
Cracking of locust bean pod	1.7	0.0	1.8	42.5	55.0	2nd
Marketing of processed locust bean	76.7	19.2	1.8	2.5	1.8	1st

Note: SA= Strongly agreed, A=Agreed, U= Undecided, D=Disagreed, SD= Strongly disagreed
Source: Field Survey, 2018

Table 6: Perceived Constraints Encountered by the Respondents

Contributions	SA	A	U	D	SD	Rank
Inadequate capital	11.7	9.2	0.8	33.3	45.0	3rd
Processing of locust bean is strenuous	35.8	24.2	0.8	35.0	4.2	1st
Low demand of locust bean (*Iru pete* or *woro*)	2.5	2.5	1.7	56.7	36.7	8th
Inadequate market for the processed locust bean	9.2	5.0	1.7	32.5	51.7	4th
Scarcity of water/ flowing River	18.3	40.8	4.2	20.0	16.7	2nd
Lack of modern processing facilities	5.8	3.3	1.7	40.0	48.3	5th
Lack of technical know-how	4.2	5.8	1.7	40.0	48.3	6th
Competition from other seasoning	2.5	3.3	2.5	27.5	64.2	7th

Note: SA= Strongly agreed, A=Agreed, U= Undecided, D=Disagreed, SD= Strongly disagreed
Source: Field Survey, 2018

DISCUSSION

The result of this study therefore showed that majority (39.1%) of the processors was from 51 years old and above. This implies that *P. biglobosa* processors and marketers were middle aged. This is in agreement with the findings of Okunmadewa *et al*., (2000) and Afolabi (2007) that most of these marketers were in their active and productive years who can easily adopt new innovations that could enhance *P. biglobosa* processing and marketing, most (58.3) of the respondents were married and depend on processing and marketing of *P. biglobosa* to attend to their needs and be responsible for the needs of their household. This is supported by Akinbile (2007) who stated that marriage confers responsibility. The majority (68.3) with small family sizes of less than 5 could be attributed to the practice of modern family size which is now extended to the rural areas, especially when people knew the implications and then adopt family planning method to control the size of their families. Oruboye (1995) reported that since Nigeria is still largely agrarian and due to low level of technology prevailing in agriculture and communal land tenure practices, especially in the rural areas, emphasis has been strongly on large family size.

There is a reasonable level of literacy among the processors as majority (56.7) of them had primary education but higher education is important as this is likely to lead to quick access and adoption of new processing and marketing innovations and would immensely influence their income. Low level of educational attainment would limit respondents' access of information which might be of immense assistance to the processors especially in the adoption of new processing techniques and exploitation of market opportunities (Adams, 1982).

Information on other means of livelihood practiced by women in the study, it was observed that processing and marketing of *P. biglobosa* is the major livelihood activity of women in the area.

Little percentage (28.3% and 9.2%) of the women also combined other activities for a living. Since the processors were mostly involved in *P. biglobosa* production, this signifies high prospect for *P. biglobosa* production and the tendency to promote agricultural production and sustainability in Nigeria through efficient *P. biglobosa* processing and marketing. The findings support the observation by Olawoye (2002), that the concept of occupation involving one activity by which livelihood needs are met as used in the western world is not relevant to the experience of most mud dwellers in developing countries.

The daily income generated by the respondents indicated that majority (51.7%) had income range between ₦1000 - ₦2000. The implication of this is that respondents need to engage themselves in other income generating activities in order to increase their economic status. This in accordance with the findings of FAQ (2001) that rural dwellers are characterized with meager income. This is also supported by the report of Fagbemi, (2002) that large percentage 87% of the respondents had less than or equal to ₦135, 000 income per annum. All (100.0%) of the respondents use the traditional processing method which may be due to the fact that they have no knowledge about the modem method and this justifies the points said earlier on that the product is unsuitable for exportation as a result of lots of impurities and are rather consumed locally thereby fetching low income for the processors.

It was also shown that locust bean has contributed immensely to household income of the rural women because majority (76.7%) of them benefited from marketing of processed locust-bean. This is in line with Oyerinde and Daramola, (2004) who had earlier reported that production of locust bean is of the great potentials for increased income and expanding of opportunities among rural women. Those aspects that are of least contribution to rural women include selling of the seeds to other processors, harvesting of locust bean fruit and growing of locust bean tree. This could probably be attributed to the fact that they are not always bringing more income compared to the other ones. This implies that *P. biglobosa* processing and marketing could serve as livelihood activity for the rural women in the study area and it is expected to have positive influence on the household income of the rural women in the area. This is in line with the study of Carr and Hart (2008) that Non- Timber Forest Products e.g. *P. biglobosa* is a sector that offers great promise for women, hut to enhance the effectiveness of poverty reduction programmes, opportunities for the greater involvement of women are essential.

An investigation to the constraints encountered by the 'respondents showed that the respondents' greatest constraint was that, processing of locust bean is strenuous which was ranked first. This might not be unexpected because the majority of processors still make use of traditional method in processing their locust bean and this traditional processing procedures adopted by respondents were arduous, time-consuming, and gener1ly devoid of any modem technology and still have small family size. Respondents generally identified scarcity of water/flowing river as the second most important problem they faced. This might be attributed to too much of agricultural practices on the little rivers available in the area. Inadequate operating capital and inadequate market •for the processed locust bean were also among the problems faced by the processors. These problems could not only limit their scale of operation, but could also perpetuate household poverty among the processors. Despite widespread demand, historically, consumers are not willing to pay a 'good' price for the product, probably due to the fact that the processors still use traditional processing and packaging methods (Yusuf and Rahji, 2012). While modern processing facilities and lack of technical know-how are the, least of the constraints according to the respondents, the other constraints were competition from other (industrially manufactured) seasonings and low demand which may be attributed to the age of civilization and increase in the production of modem condiments like maggi, curry, time etc. This result agreed with the findings of FIIRO, (2013).

CONCLUSION

Based on the study on contribution of locust bean seed processing and marketing to the household economy of rural women in Oluyole Local Government Area of Oyo State, it was concluded that rural women were fully engaged in locust bean processing and marketing especially those aspects that have economic relevance and it had contributed to their household economy. The study revealed no significant relationship between some selected socioeconomic characteristic variables and contributions of locust bean seed processing and marketing; there is positive and significant relationship between livelihood income, perceived constraints and contribution of locust bean seed processing and marketing to the household economy of rural women.

Recommendations

It was therefore recommended that:

i. Rural women locust bean processors can increase the quantity of locust-bean processed by the use of modern technique if available; also incorporate other means at which locust bean seed itself can boost their standard of living.
ii. Since older people women still dominate locust bean seed processing, it is a signal that there is an opportunity for the involvement of younger people. It is therefore worthwhile for governments (local, state, and Federal) and non-governmental organizations to encourage greater youth participation in locust bean seed processing and marketing as a way of arresting youth unemployment, particularly in rural communities.

REFERENCES

Adams, M. E., (1982): "Agricultural Extension in Developing Countries", Longman Group Ltd. Singapore, pp. 108. In Fabiyi, E. F. Danladi B. 11, Akande, K. E and Mahmood, Y. (2007): "Role of Women in Agricultural. Development and Their Constraints; A Case Study of Biliri Local Area, Gombe State, Nigeria". *Pakistan Journal of Nutrition*, 6 (6): 676-680.

Afolabi, J.A., (2007): Evaluation of Poultry Egg Marketing in South-Western Nigeria. *International Journal of Poultry Science*, 6: 362-366.

Akande F.B, Adejumo, O.A., Adamade C,A and Bodunde, J., (2010). Processing of Locust bean Fruits: Challenges of Prospects. *African Journal of Agricultural Research* Vol. 5(17), Pp. 2268-2271

Akinbile, L., (2007): Social Impact of Limestone Exploitation in Yewa North, Local Government of Ogun State. *Parkistan Journal of Social Sciences* 1:107-111.

Alabi, R.T., and Ibiyemi, AG., (2002): Rainfall and Crop Production in Nigeria. Agronomy of Nigeria. University of Ibadan. Pp. 63- 66.

Carr, M. and Harti, M. (2008): Mountain Forum: Digital Repository; Gender and Non-Timber Forest Products (NTFPs): Publication of International Fund for Agricultural Development (IFAD): Promoting Food Security and Economic Empowerment, http://www.ifad.org/gender/pub/tirnber.pdf

Chikamai, B.N and Kagombe, J., (2002): Review and Synthesis on The State of Knowledge of Boswelia Spp. and Commercialization Of Frankincense In The Dry Lands of Eastern Africa. KEFRI, Nairobi.

Clempson, R. (2012). Combating Poverty in Sub-Saharan African. Retrieved from Sub-Saharan-African Http://www.E-Ir.Info/2012/04/25/Combating-Poverty-In-Sub-Saharan-Africa/

Diawara, B., Sawadogo, L., Jacobson, M., and Awug, W.K., (2000): HACCP System for Traditional Fermented Food (Sombala) Capacity Building for Research and Quality Assurance in Food Fermentation Technology for African Fermented Foods. WAITRO Journal, 26: Pp 11-62.

Duong, N.H., (2008): The Role of Non-Timber Forest Products In Livelihood Strategies And Household Economics In A Remote Upland Village In The Upper River Basin, Nghe The Phuong. Journal of Science and Development 1:88-98

Fagbemi, T. (2002): Investment opportunities in renewable resources Industry-forestry. 1st Edn. Belodan, Nigeria.

Federal Institute of Industrial Research, Oshodi (FIIRO), (2013): Industrial Profile of Soy Dawadawa Production Http:/Www.Fiiro.Gov.Ng Accessed On 6th January, 2015.

Food Agricultural Organization, FAO (2001): Experiencing of Implementing National Forest Programme in Nigeria (Electronic version) *www.fao.org/forestry/journal Retrieved 26/6/2015*

Oguntola S., (20075: A Diet Rich In Locust Bean Benefits The Body. Nigerian Tribune

Okafor, J.C., Omoradion, F.I and Amaja, C (1994): Non Timber Forest Products (Nigeria): Consultancy Paper Prepared By The Tropical Forest Actions Program (TFAP) Forest Management, Evaluation And Co-Ordination Units (FORMECU) And Federal Department Of Forestry (FDF) Abuja, Nigeria. Pp.8.

Okunmadewa, I.Y., Adebayo, S.K., and Mafimisebi, O,E., (2000): Structure, Conduct and Performance of Sun-dried meat trade in Ibadan ‘Metropolis. *Journal of Technology and Education in Nigeria*. 5(2: 68-75

Olawoye, J. E., (2002): Giving a voice to the rural population. An inaugural lecture presented at the Faculty of Education, University of Ibadan. 11th April.

Oruboye, I. O., (1995): “The Demographic Situation in Nigeria and Prospects of for Fertility Transition” *Journal of International Development*”. In Wusu, O. and Isiugo-Abanihe, U.C. (2006):”Interconnections among change family structure, childrearing and fertility behaviour among Ogun, Southwestern, Nigeria”. Demographic Research, 14(8), 139-155.

Oyerinde, O.V. and Daramola, A.G., (2004): Socioeconomic characteristic of African locust bean South-western Nigeria. *Pakistan Journal of Social Science* 2: 291 – 294.

Shao, M., (2002): *Parkia biglobosa*: Changes in Resource Allocation In Kandiga, Ghana (Unpublished Master’s Thesis). Michigan Technological University, Michian, Retrieved From *www.Forest.Mtu.Edu/Shao.Pdf*

Yusuf O. I. S., and Rahji, M. A.Y., (2012): The processing and preference for locust bean products (*Parkia biglobosa*) in Lagos, Nigeria. *Journal of Biology, Agriculture and Healthcare*, 2(11), 105 – 112.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Cheikyula et al., 2019

HAEMATOLOGICAL INDICES OF *Heterobranchus longifilis* JUVENILES VAL. (PISCES: 1840) EXPOSED TO AQUEOUS BARK EXTRACT OF *Tephrosia vogelii*

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ABSTRACT

This study was carried out to assess the changes in haematological indices in Heterobranchus longifilis juveniles exposed to aqueous bark extract of Tephrosia vogelii. The experimental fish were obtained from the wild and transported to the Department of Fisheries and Aquaculture, University of Agriculture, Makurdi, Nigeria for two weeks acclimatization. Ten (10) fish of average weight 115.25± 25.00g were selected randomly, injected intramuscularly (IM) with aqueous bark extract of T. vogelli using five concentrations of 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06 g/l with replicates. Control fish were injected with distilled water. Blood was collected and analyzed for changes in some haematological indices. Result obtained showed no significant (P>0.05) changes in the Haematological indices considered.

Key words: Haematological changes, *T. vogelii*. *Heterobranchus longifilis*

INTRODUCTION

The rapid growth of the aquaculture industry has placed an increasing demand on the various inputs such as feeds, drugs, chemicals and anesthetics. Anesthetics have been used to immobilize fish in the management of fish stocks to minimize stress and physical damage during tagging, weighing, measuring, clipping and collection of scales and in aquaculture during egg and milt stripping, and to calm brood fish during transportation in order to reduce mortality from excitement and hyperactivity under confinement (Agoke *et al.*,2010; Omoniyi *et al*.,2002; Ramanayaka and Atapatu,2006; Ayuba and Ofejekwu,2004; FAO,1997).

Chemical substances currently in use as fish anesthetics have several disadvantages: poor solubility in water, long induction time, acute toxicological effects at high concentrations, bioaccumulation in tissues (Marking, and Meyer, 1985; Oshode *et al.,* 2008; Solomon and Amali, 2004). The use of natural plant extracts as anesthetics is cheaper, safer and is biodegradable. For these reasons, there has been an increase in the exploration of various plant extracts as anesthetics in aquaculture. Some of these plants include clove oil from clove plant *Eugenia caryophylla* (Soto and Burhanuddin 1995),*Datura innoxia ugenia aniophylun*, *Clotalaria sp*, *Derriss candens*, *Barringtonia raecemosa*, *Eryagau npoetidany*, *Anamirla cucculus*, *Caryphaambra culifera* (Ramanayaka and Atapatu, 2006). *Lepidogathisa lopecuriodes*, *Nicotiana tobaccum* (Agokei and Adebisi, 2010; Jegede (2014), *Acorus calamus* (Agokei and Adebisi, 2010); *Ocimum gratissumum* (Jegede, 2014).

The use of the Fish Poison Bean, *T. vogelii* vary from one part of the world to another. The leaves of *T. ephrosia vogelii* have long been used by the Tiv people of Benue State and in other parts of Nigeria to sedate fish when fishing in natural water bodies. The leaves are also used for the treatment of dyspepsia and are highly toxic to cold blooded animals like mollusks, frogs, toads, worms and insects. They are highly effective fish poison for killing fish (Michael, 2002; Lungu, 1987). In Southern and Eastern Africa, it is widely cultivated for its use in crop protection, soil enrichment and as pesticide (Stevenson, *et al*., 2012). This study aims to determine hematological changes in *Heterobranchus longifilis* exposed to aqueous bark extract of *T. vogelii*

Materials and Methods

The plant was collected at Tofi village in Mbagen, Buruku Local Government Area, Benue State of Nigeria. The fresh, wet samples of *T. vogelii* bark were air-dried for 21 days to remove the moisture content, then oven-dried to crisp dry at 60˚C for 3-4 hours to constant weight to make them pliable. The dried samples were crushed to powder using an electric kitchen blender and stored in air-tight bottles.

The experimental fish, *H. longifilis* were purchased from fishermen of the River Benue and taken to the General Purpose Laboratory of the Department of Fisheries and Aquaculture of the University of Agriculture, Makurdi for two weeks acclimatization. During the period of acclimatization, the fish were fed once daily at 09.00 hours at 4% of their body weight with a commercial fish diet.

Preparation of aqueous bark extract

Known weights of the dry bark of *T. vogelii* were dissolved in 1 liter of de-ionzed water in 2.5 litre air-tight laboratory bottles at 27.0±0.4˚C room temperature. The mixture was shaken to ensure that they were properly mixed with the water allowed to stand for 24 hours. The settled portion was decanted and filtered through No.1 Whatman filter paper. The filtrate was kept in air tight bottles and used for exposure.

The Aadministration of *T. vogelii* Aaqueous Bark Extract.

The fish were starved for 24hours before the exposure. Ten (10) fish of average weight 115.25± 25.00 g were placed in tanks and each injected intramuscularly (IM) with the aqueous bark extract of *T. vogelli* using 0.5ml of the extract corresponding to five concentrations of 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06 g/l with replicates in 20-liter capacity tanks. Control fish were injected with distilled water**.** The injection was done with a No 23 needle and a 2 mL syringe. Water was changed daily. Water quality parameters of temperature, dissolved oxygen, pH, and alkalinity were measured using a Hanna multi-parameter water tester model HI98129.

Collection of Blood Samples

Blood was collected from the heart of a stunned fish with a No 23 needle and a heparinized syringe and placed into EDTA bottles. They were then taken to the PERFAR Laboratory of Federal Medical Center, Makurdi where they were analyzed for the haematological indices of White blood cell count(WBC), Red blood cell count(RBC),Haemoglobin(HGB), Haeamatocrit (HCT),Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin(MCH) and Mean Corpuscular Haemoglobin concentration (MCHC) using a Mindray Auto HeamatologyAnalizer.

Statistical Analysis

The statistical analysis was carried out using Genstat Discovery Edition 4 for one-way Analysis of variance (ANOVA).

RESULTS

The haematological indices of *H. longifilis* injected with various concentrations of *T. vogelii* aqueous bark extract. The values of RBC, Hb and Hct were below the control, but they did not do not differ significantly ($P<0.05$) among the treatments with the control (Table 1).

The water quality parameters measured were not significantly different with the control and among the treatments (Table 2).

Table 1: Mean Haematological indices of H. longifilis injected various concentrations of *T.* vogelii aqueous bark

Conc. . (g/ℓ)	Fish Weight (g)	Haematological Indices					MCH (Pg)	MCHC g/dL
		WBC (x10^{11}/L)	RBC (X10^{12}/L)	Hg g/Dl	HCT (%)	MCV (FL)		
0.00 (Control)	77.50±2.50^{a}	1.608±8.0x10$^{9\ a}$	1.525±6.50x10$^{10\ a}$	7.50±1.10^{a}	22.60±4.20^{a}	115.40±0.30^{a}	42.35±3.95^{a}	36.55±1.75^{a}
0.01	74.00±1.00^{a}	1.588±1.32x10$^{10\ a}$	1.485±6.50x10$^{10\ a}$	6.500±0.40^{a}	18.30±1.10^{a}	112.90±1.90^{a}	40.10±0.70^{a}	35.55±0.05^{a}
0.02	77.50±2.50^{a}	1.452±1.64x10$^{10\ a}$	1.395±1.65x10$^{11\ a}$	7.300±0.90^{a}	20.25±2.95^{a}	136.00±0.70^{a}	40.10±8.10^{a}	35.350±0.05^{a}
0.03	83.50±3.50^{a}	1.295±3.79x10$^{10\ a}$	1.310±4.50x10$^{11\ a}$	6.20±1.80^{a}	21.15±1.35^{a}	137.20±0.30^{a}	39.10±6.30^{a}	34.35±1.15^{a}
0.04	71.50±3.50^{a}	1.323±1.53x10$^{10\ a}$	1.255±1.50x10$^{10\ a}$	6.000±0.90^{a}	22.650±0.45^{a}	138.60±24.0^{a}	37.45±2.75^{a}	33.25±2.95 a
0.05	72.50±2.50^{a}	1.442±1.85x10$^{10\ a}$	1.330±2.10x10$^{11\ a}$	5.250±0.85^{a}	23.400±0.20^{a}	140.90±23.3^{a}	35.95±6.30^{a}	31.90±1.80^{a}
0.06	77.50±2.50^{a}	1.597±1.14x10$^{10\ a}$	1.485±5.50x10$^{10\ a}$	6.750±0.45^{a}	24.20±3.40^{a}	142.40±4.20^{a}	40.40±6.30^{a}	31.40±3.20^{a}

Means in the same Colum with the same superscript are not significantly different ($P<0.05$)
WBC - White Blood Cells, MCV - Mean Corpuscular Volume, HC – Haematocrit; RBC - Red Blood Cells; MCH - Mean Corpuscular Haemoglobin
Hg – Haemoglobin; MCHC - Mean Corpuscular Haemoglobin Concentration

Table 2: Mean Water Quality Parameters in exposure of *H. longifilis* to *T. vogelii* Aqueous Bark Extract

Conc. (G/ℓ)	Water Quality Parameters			
	Temperature ˚C	Dissolved Oxygen (MG/ ℓ)	PH	Alkalinity (MG/ ℓ)
0.00	25.41±0.02^{a}	6.81±0.02^{b}	7.05±0.50^{c}	30.18±0.01^{d}
0.01	25.38±0.02^{a}	6.82±0.02^{b}	7.17±0.02^{c}	30.21±0.03^{d}
0.02	25.36±0.02^{a}	6.88±0.01^{b}	7.24±0.01^{c}	30.34±0.01^{d}
0.03	25.35±0.01^{a}	6.90±0.91^{b}	7.30±0.01^{c}	30.38±0.02^{d}
0.04	25.33±0.01^{a}	6.91±0.01^{b}	7.29±0.01^{c}	30.42±0.02^{d}
0.05	25.34±0.00^{a}	6.95±0.02^{b}	7.32±0.01^{c}	30.39±0.02^{d}
0.06	25.32±0.01^{a}	6.93±0.02^{b}	7.30±0.03^{c}	30.45±0.03^{d}

Means in the same colum with the same superscript not significantly different (P<0.05)

DISCUSSION

Similar reductions in RBC and Hg values have been reported by (Tilak,*et al*.,2006; Sudagara *et al* 2009; Atamanalp *et al*., 2008) also reported decrease in the values of RBC in Sheatfish (*Silurus glanis)* immediately after treatment with 2-phenoxyethanol anesthetic without significant differences. It is known that plant-derived toxins cause changes in blood variables associated with oxygen transport (Agbon *et al*.2002; Omoniyi *et al* 2002). In some cases, this may lead to anaemia which could result from the lysis of erythrocytes by the active ingredients (Brown, 1980). Gabriel *et al.,* (2009) reported the absence of significant changes in the blood variables associated with oxygen transport when catfish hybrids were exposed to aqueous leaf extract of *Lepidagathisa lopecuroides* and suggested that the levels of toxicant used did not interfere with erythropoiesis nor cause heamolysis. Consequently, in the present investigation the absence of changes in the haematological variables associated with oxygen transport in *H. longifilis* following treatment with the different concentrations of aqueous bark extracts of *T. vogelii* could be attributed to absence of negative impact of the anesthetic substance on the experimental fish which did not lead to erythropoiesis or heamolysis.

MCV values obtained with the aqueous bark extracts declined with increasing concentration without significant differences. The MCH values obtained with aqueous bark extracts did not assume a definite pattern but rather showed fluctuations without significant changes. Mean values of MCHC obtained with aqueous bark extract all declined with increasing concentration of anesthetic extracts without significant differences (P>0.05). This result is similar to the finding of (Gabriel *et al* 2011) in *Clarias gariepinus* following anesthesia with metomidate where neither a definite pattern nor significant differences were found in values of MCH and MCHC. Ucar and Atamanalp (2010) reported that no significant differences were recorded in the values of MCV, MCH and MCHC in Rainbow trout (*Onchorynchus mykiss*) and Brown trout (*Salmo trutta furio*) treated with clove oil anesthetic. Similarly, in (Sudagara *et al* 2009) Roach (*Rutilus rutilus*) anesthetized with clove powder did not show significant differences (P>0.05) in the values of MCV, MCH and MCHC in both experimental subjects' groups B (after 7 minutes of anesthesia at concentrations 175, 225, 275 and 350mgL^{-1}) and experiment subjects group C (24hours after 7 minutes of anesthesia at the same concentrations). Significant increase in the values of MCV and MCH were reported in Siberian sturgeon (*Acipenser baerii*) treated with both eugenol and MS-222 immediately after anesthesia compared with controls (Imanpoor. *et al*.,2012) In this case, the researchers suggested erythrocyte swelling due to significant increase in MCV. Ayuba and Ofojekwu (2004) reported significant decrease in MCV in *Clarias gariepinus* exposed to *Datura innoxia* extract and attributed the result to anaemic condition resulting from erythrocyte destruction. Therefore, the absence of significant changes in the absolute red blood indices (MCV, MCH and MCHC) obtained with the aqueous bark extract of *T. vogelii* seems to.

CONCLUSION

This research work investigated the effect of the aqueous bark extract of *T. vogelii* on the haematological indices in *H. longifilis* juveniles.

The result obtained revealed that all the haematological indices studied had no signicant difference (P>0.05). This implies that the use of aqueous bark extract of *T. vogelii* did not impact negatively on the experimental subjects.

REFERENCES

Adolazizi, S, Ghaderi, E, Naghdi, N and Kamanggaaar, B.B (2011). Effects of clove oil as an anaesthetic on some haematological parameters of *Carassius auratus*. Journal of Aquactic Resources and Development 2:108:2155-9546.

Adewale, A. Y., Adesna, I. and Yusuf, O. Y. (2017). Anaesthetic effect of *Ocimum gratissimum* extract on *Oreochromis niloticus*. European Journal of Experimental Biology 2017, 7:7.

Agbon, A.O., Omoniyi, I.T., Teko, A.A (2002). Acute toxicity of tobacco (Nicotianatobaccum) leaf dust in Oreochromis niloticus and haematological change resulting from sub-lethal exposure. Journal of Aquatic Sciences 17 (1)*:* 5-8

Agokei, O.E and Adebisi, A.A (2010). Tabacco as an anaesthetic fish handling procedures. Journal of medical plant research 4:1396-1399.

Agrawal S. J. and Srivastaava, A. K. (1980). Haematological responses in a freshwater fish to experimental manganese poisoning. Toxicology 17: 97-100.

Bagheri, T and Imanpoor, M.R (2011). The efficacy, physiological responses and haematology of Persian sturgeon *Acipenser persicus* to clove oil as an anaesthetic agent. Turkish journal of fisheries and aquatic sciences. *11:477-483.*

Blommaert, K.L.J. (1950). The plant *Tephrosia vogelii* Houker, As a fresh water fish poison. Royal Society of South Africa Transactions 32:247-263

Bourne, P.R (1984). The use of MS-222 (tricaine methane sulphonate) as an anesthetic for routine blood
sampling in three species of marine teleosts.
Aquaculture *36:313-321*.

Bhuvaneswari, R., Manickam, N. and Bhavan, P. S. (2015). Calamus oil an anesthetic for *Cyprinus carpio* (onarmental koo). International journal pure applied biosciences 3(1): 18-26.

Farahi, A., Kasiri, M., Taleli., A, Sudagar, M. (2011). Effects of clove extracts as an anesthetic on sperm motility traits and some haematological parameters in Prussian Carp (*Carassius gibelio*). Advances in Environmental Biology 5 (6): 1406 – 4010

Gabriel, U.U, Obomanu, F.G and Edori, O.S (2009). Haematology, plasma enzymes and organ indices of *Clarias gariepinus* after intramuscular injection with aqueous leaves extracts of *Lepidagathis alopecuroides.* African journal of biochemistry research 3(9): 312-316

Gabriel, U.U, Obomanu, F.G, Orlu, E.E and Oreh, O.D (2010). Fulton's condition organ indices and *heamotological response of catfish hybrid (Heterobranchus longifilis, Clarias gariepinus) aqueous* extract of leaves of *Lepidagathis alopecuroides.* Ethiopian Journal of environmental studies and management 3(1):30-36.

Gabriel, U.U., Deelae, S. N, Akenrotimi, O.A., Orokotan, O. O (2011). Haematological responses of *Clarias gariepinus* exposed to anesthetic metonidate. Continental Journal Pharmacology and toxicology research 4 (1); 18-29.

Gadzirayi, C.T, Mutandwa, E., Mivale, M and Chindundu, M (2009). Utilization of *Tephrosia vogelii* in controlling ticks in dairy cows by small scale commercial farmers in Zimbabwe. African journal of Biotechnology 9(17): 4134 – 4136.

Gomulka P, Wlasow T, Velisek J, Svobodova Z, Chemielinska, E. (2008). Effects of Eugenol and MS–222 anaesthesia on Siberian Sturgeon *Acipenser baerii* Brandt. ACTA Veteranary. BRNO 77: 447 – 453.

Imanpoor, M.R, Bagheri, T and Hedayati, S.A.A (2010). The anesthetic effects of clove essence in Persian sturgeon, *Acipenser percius.* World journal of fish and marine sciences 2:29-36.

Jegede T. (2014). Anesthetic potential of Tobabacco (*Nicotiana tobaccum*) on *Clarias gariepinus* (Burchell:1822) fingerlings. Journal of Agriculture Science; Vol. 6 No.5.

Marking, L.L, Meyer, F.P, (1985). Are better anesthetics needed in fisheries. Fisheries 10 (6): 2–5

Olufayo, M.O (2009). Heamatological characteristics of C*larias gariepinus* (Burchell1822). Juveniles exposed to Derris euptica Root powder. AJFAN Online 9(3):921- 933.

Omoniyi, I., Agbon, A.O and Sodunke, S.A (2002). Effect of lethat and sublethalconcentrationsoftabocco (*Nicotiana tobaccum)* leaf dust extract on weight and heamatological changes on *Clarias gariepinus* (Burch). Journal of Applied Science 2(4):382-387

Oshode, O. A, Bakara, A.A, Adeogun, A.O, Eluntoye, M.O, Sowunmi, A.A. (2008). Ecotoxicological assessment using *Clarias gariepinus* and microbial characterization of leachate from municipal solid waste land hill. International Journal of Environmental Research 2 (4): 391 – 400

Ramanayaka, J.C and Atapatu, N.S.B.M (2006). Fish anaesthetic properties of some local plant materials. Tropical Agricultural Research Extension 9.http://www.agri.ruhrac.UC/tare/pdf/v-9/A.G.9.14pdf: Accessed:24.03.2011.

Soto, C. G and Burhanuddin (1995). Clove oil as a fish anaesthetic for measuring length and weight of Rabbitfish, *Signus lineaus*. Aquaculture, 135:149-150

Stevenson, P.C, Kite, G.C, Lewis, G.P., Forest, F., Nyirenda, S.P., Belmain, S.R, Sileshi, G.W and Veitch, N.C (2012). Distinct Chemotypes of *Tephrosia vogelii* and implications for their use in pest control and soil enrichment. Phytochemisty. 78:135- 146

Sudagara, M., Mohammdizarejabada, A., Mazandarania, R and Pooralimotlagha, S (2009). The efficacy of clove powder as an anaesthetic and its effect on heamatological parameters on roach (*Rutilusrutilus). Journal of aquaculture feed science and nutrition 1(1):Pp 1-5.*

Tilak, K.S, Veeraiah, K and Butchiram, M.S (2007). Effect pf phenol on haematological components of Indian major carps *Catlacatla*, *Labeo rohita and Cirrhinus mrigala.* Journal of environmental biology, 28: 177-179

Ucar, A. and Atamanalp, M. (2010). The effects of Natural (clove oil) and synthetical (2 – phenoxyethanol) Anaesthetic substances on haematology parameters of Rainbow Trout (*Onchorynchus mykiss*) and Brown Trout (*Salmo trutta fario*). Journal of Veterinary Advances. 9 (4) 1925 – 1933

Velisek J, Svobodova Z, Piackova V, Groch, L and Nepejchalova, L. (2005a). Effects of clove oil anaesthetic in common carp (*Cyprinus carpio).* Veterinary medicine Czech 50: 269-275

[29] Velisek J, Svobodova, Z, Piackova, V. (2005b). Effects of clove oil anaesthesia on rainbow trout (*Onchorynchus mykiss*). Acta Veterinaria. Brno 74: 139-146

Velisek, J, Wlasow T, Gomulka, P, Svobodova Z, Novotnyi, L (2007). Effects of 2– phenoxy ethanol anaesthesia on Sheat fish (*Silurus glanis* L.). *Veterinary*). Veterinary Medicina, 52 (3): 103 – 110

Yanar, M. and Kumijj, M. (2001). The anaesthetic effects of quinaldine sulphate and/or Diazepam on sea Bass (*Dicentrarchus labrax*) juveniles Turkish Journal of Veterinary and Animal Sciences 25: 85-89

APHA/WPCF: American Public Health Association, American Water Works Association, and Water Pollution Control Federation (1985). *Standard methods for the examination of water and wastewater*, 16thEdn.,APHA, Washington D. C., USA, 1265P.

Brown, B. (1980). Haematological: Principles and procedures. Lea and Fabiger Philadelphia. Pp 319.

Fernades, M.N. and Mason A.F. (2003). Environmental pollution and fish gill morphogy. In: Val AL, Rapoor B.G, (eds). Fish adaptation, science publishers.pp 203-231

Masopust, J (2000). Haematological and biochemical profile of blood. Clinical biochemistry. Karolinumpara (In: Czech) Pp 832.

Michael, M. (2002). Trees, Shrubs and Lianas of West African Dry Zones.CIRAD: Centre de cooperation international en recherché agronomique pour le development. Margraph Publishers.GMBH p 328.

Lungu, S. (1987). An Ecological Evaluation of Zambia Trees and Shrubs in Relation to Their Potential uses for Agroforestry in Zambia.Masters Thesis, University of Zambia,

Ayuba,V.O; and Ofojekwu, P.C (2004). Effects of extracts of dried seeds of toloache, *Datura innoxia* as anaesthetic on the African catfish *Clarias gariepinus* fingerlings. In: 18th annual conference of the fisheries society of Nigeria (FISSON), 8-12h December, 2003.Pp 25-29.

Solomon, S.G and Amali, E.I (2004). Preliminary investigation into the use of a local plant, *Datura innoxia* as tranquilizer for Mudfish, *Clarias gariepinus* Burchell (1822). In: 18th Annual Conference of the Fisheries Society of Nigeria (FISON) 8-12th December, 2003. Pp 43-47.

FAO (1997). Towards safe and effective use of chemicals in coastal Aquaculture. Joint Group of experts on the scientific aspect of Marine environmental protection(GESAMP) report and studies, GESAMP NO. 65, FAO 1997. P. 40.

http//www.ijppr.com/PDF%20all%20edition%20IJPPR/IJPPR–2010 Vol. 12, Issue 3/IJPPR.Accessed: 23.05.2017.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adelani, 2019

EFFECT OF WATERING REGIMES ON THE GROWTH AND NUTRIENT UPTAKE OF CITRUS TANGELO J. W. SEEDLINGS GROWN IN A MIXTURE OF SAND AND PULVERIZED *Jacaranda mimosifolia* D. Don LEAVES

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ABSTRACT

There is dearth of quantified information on water requirement of crops growth in the soil amended with leaf litters of agro-forestry trees. In this light, a completely randomized design with five replicates was laid down to assess the effect of watering regimes on the growth of Citrus tangelo seedlings in the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna State. C. tangelo seedlings were subjected to 200 mL of water at five watering regimes (1, 2, 3, 4 and 5 day's interval). Tissue analysis was carried out to determine the nutrient uptake in seedlings. Watering significantly (P<0.05) influences seedling growth and nutrient uptake. Significant height (9cm), number of leaves (8), leaf area-(22.65 cm^2) and phosphorus uptake (18.11 mg/100 g) were recorded for C. tangelo planted in Jacaranda mimosifolia soil and subjected to daily watering regime. Daily watering of C. tangelo enhances its growth and nutrient uptake. Daily watering of C. tangelo is recommended for its mass production for agro-forestry programmes.

Key words: Watering regimes, leaf litters, seedling growth, nutrient uptake, Agro-forestry

INTRODUCTION

Agro-forestry system is an aspect of farm forestry that encourages the deliberate integration of woody perennials with agricultural crops and/or animals on the same management unit, with the aim of enhancing soil fertility and increasing farmers' income through the use of economic trees (Akubuili, 2013). Successful integration of trees and crops in an agro-forestry system which manifest through excellent nutrient uptake that leads to growth and development does not depend only on the present of nutrient, species types, age of the plant, soil rhizosphere, (Capps and Wolf, 2000, Raţić *et al.*, 2005 and Brataševec, 2013) but also on soil-pH and the availability of water (Keller, 2005).

Water is an important natural resource that supports life and growth of plants, but there is a growing concern on water availability (Goyne and McIntyre, 2003). The availability of permanent water supply has been one of the major challenges in fruit tree nursery establishment and management, especially in the drier regions of the tropics and sub-tropics (Daba and Tadese, 2017). There is growing concern about water availability particularly in dry land forestry and nursery raised seedlings (Oboh and Igharo, 2017). Water is the major constituent of any living organisms which is involved in the important biochemical processes (Oboh and Igharo, 2017). Water is of great importance to the growth of plants because it controls the rate of transpiration which in turn, has effect on the inflow nutrient solutions (Aderounmu *et al.*, 2017). Growth and biomass production is directly proportional to the supply and use of water in plant (Cao, 2000; Olajuyigbe *et al.*, 2012). Water is an important factor in the growth, development and productivity of plant (Gbadamosi, 2014; Ogidan *et al.*, 2018). Water availability is the most important environmental factor known to have strong influence on tree species and distribution in the tropics (Bongers *et al.*, 2004).

Isah *et al.* (2013) and Gbadamosi (2014) stated that water is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements. Hence water is vital to success of seedling production especially when large quantities are required for afforestation and reforestation programmes (Oboh and Igharo, 2017). Daba and Tadese (2017) stated that sufficient quantity and quality of water is extremely important for the production of tree seedlings at nursery site. Mng'omba *et al.* (2011) stated that for tree nurseries, regular watering is necessary to produce good quality seedlings. This is because any stagnation in seedling growth or subsequent mortality translates into economic loss to a nursery operator (Mhango *et al.*, 2008, Mng'omba *et al.*, 2011, Oboh and Igharo, 2017). Mng'omba *et al.* (2011) reported that this loss can be huge because seedlings take long to reach appropriate size for grafting and transplanting or for sale. Scarcity of water leads to economic loss but the plant water requirement also varies.

Aderounmu *et al.* (2017) mentioned that water has significant effects on growth of plants though watering requirements of different species differ. Bargali and Tewari (2004) reported that water use requirements depend on tree species, growth stage and time of the year and the prevailing climatic condition of the growing site (Oboh and Igharo, 2017) and hence, it is necessary to establish this for each tree species as there are differences in growth rates. Our knowledge on optimal water requirements of most indigenous and exotic fruit tree seedlings that thrive in semi arid environments are limited (Mng'omba *et al.,* 2011). This gap in knowledge, constrains ability of nursery operators to make informed management decision about their operation (Mng'omba *et al.*, 2011). There have been limited research studies accomplished to establish the optimal water requirements for fruit tree seedlings as *C. tangelo* to sustain their growth and survival. *Citrus tangelo* productivity needs to be improved for the benefits of Nigerians by subjecting it to appropriate watering regimes. Tangelos are a specific hybrid of mandarin orange and grapefruit or pummelo.

Yuma (2018) stated that tangelos are a hybrid of *Citrus paradisi* and *Citrus reticulate.* Yuma (2018) reported that tangelo trees indicate that the fruit is a cross between the Duncan grapefruit and the Dancy tangerine of the family Rutaceae. Yuma (2018) stated that not only the tangelos are packed with flavour, they are also a great source of vitamins C and A. They are more substantial than tangerines, and this make them a great snack choice (Yuma, 2018). In spite of enormous potentials of *C. tangelo,* the optimal water requirement of it needs to be investigated for sustainable growth and development so as to make Nigerians to have access to its ample benefits. In order to promote sustainable use of water in the nurseries, it is paramount to establish optimal water requirements for tree seedlings growth (Mukhtar *et al.,* 2016) which will help in reducing the cost of planting stock production in commercial nurseries (Mng'omba *et al.*, 2011). In this light, investigation was conducted on watering regimes and nutrient uptake of *C. tangelo* seedlings.

MATERIALS AND METHODS

Study Area

The research was conducted in the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna. The college is located in the Northern Guinea Savannah ecological zones of Nigeria. The college lies within latitude10^{o} 35′and 10^{o}34′and longitude 7^{o}21′and 7^{0} 20′ (Adelani, 2015). The vegetation is open woodland with tall broad trees, usually with small boles and broad leaves (Otegbeye *et al.*, 2001).

Experimental Design

Pot experiment was conducted in a screen house. A completely randomized design was laid down to assess the effect of watering regimes (1, 2, 3, 4 and 5 day's interval) on the growth of *C. tangelo* seedlings. Seedling assessment was carried out after two weeks of transplanting into 4cm depth of soil to allow the seedlings to be subjected to early establishment. Parameters assessed include: seedling height (using meter rule), number of leaves and collar girth (using Vernier caliper). The number of leaves was counted manually. Leaf area was obtained by linear measurement of leaf length and leaf width as described by Ugese *et al*. (2008) in the formula below:

LA=4.41 +1.14LW …….. 1

Where:

LA = Leaf area

LW= Product of linear dimension of the length and width at the broadest part of the leaf.

Leaf area index was calculated as:

Leaf area index = leaf area/ land area …… 2

The fresh and dry weight of seedlings of *C. tangelo* were determined by the use of Mettler Top Loading Weighing Balance, but dry weight was taken after oven dried the seedlings at $70^{o}C$ for 72hours according to Umar and Gwaram (2006).

Tissue analysis was done for *C. tangelo* seedlings to determine nutrient uptake

Experimental procedure for the effect of watering regimes on the growth and nutrient uptake of *C. tangelo* seedlings grown in a mixture of sand and pulverized *Jacaranda mimosifolia*

Biomass transfer method that involves the collections of wet leaves was used. The sample of *Jacaranda mimosifolia* leaves was air dried and pulverized. The sample of *J. mimosifolia* leaves weighed (10g) was used. Highest value of nitrogen recorded in *J. mimosifolia* among the litters of nitrogen fixing tree species investigated according to Adelani *et al.* (2018) accounted for the choice of this species. River sand was collected from floor of the dam of Federal College of Forestry Mechanization, Afaka, Kaduna State and sieved with 2mm sieve and soaked in 10% hydrochloric acid for 24hours to remove impurities, organic matter and nutrient residue according to the recommendation of Adelani *et al.* (2014). The sample of sterilized sand was thoroughly mixed with the leaves of *J. mimosifolia* tree (10g) and then packed into polypots of $20x10x10cm^3$ dimensions. Sample of pulverized leaves of *J. mimosifolia* was analyzed chemically for nitrogen, phosphorus and potassium (NPK). Distil water was used to water the seedlings. A month old seedlings of *Citrus tangelo* was transplanted into the pots with the prepared mixture of leaf litter of *J. mimosifolia* and sand.

Data Analysis

Data were collected and subjected to analysis of variance (ANOVA) using SAS (2003). A comparison of significant means was accomplished using Fishers' Least Difference LSD at 5% level of significance.

RESULT

Effect of Watering Regimes on the Height of *C. tangelo* Seedlings

The result of the effect of watering regime on the height of *C. tangelo* is presented in Table 1. Highest height of 9cm was recorded in seedlings subjected to daily watering.

Table 1: Effect of watering regimes on the height of *C. tangelo* seedlings

NFT Species	Watering regime	Weeks					
		2	4	6	8	10	12
J. mimosifolia	1	7.00^{b}	8.00^{ab}	9.00^{a}	9.00^{a}	9.00^{a}	9.00^{a}
	2	$6.6\ 0^{a}$	6.80^{a}	7.40^{a}	7.40^{a}	7.40^{a}	7.40^{a}
	3	5.80^{ab}	6.40^{a}	7.40^{a}	7.40^{a}	7.40^{a}	7.40^{a}
	4	4.80^{b}	5.60^{ab}	6.60^{a}	6.60^{a}	6.60^{a}	6.60^{a}
	5	6.80^{ab}	7.00^{a}	7.80^{a}	7.80^{a}	7.80^{a}	7.80^{a}
SE±		0.80	0.80	0.80	0.80	0.80	0.80

**Means on the same row having different superscripts are significantly different (P<0.05)*

****NFT -** means nitrogen fixing trees*

Effect of Watering Regimes on the Girth of *C. tangelo* Seedlings

The result of the effect of watering regimes on the girth of *C. tangelo* seedlings is presented in Table 2. There was no significant difference (P <0.05) among the girths of seedlings predisposed to different watering regimes.

Table 2: Effect of watering regimes on the girth of *C. tangelo* seedlings

NFT Species	Watering regime	Weeks					
		2	4	6	8	10	12
J. mimosifolia	1	0.70[a]	0.90[a]	0.90[a]	1.00[a]	1.00[a]	1.00[a]
	2	0.70[a]	0.90[a]	0.90[a]	1.00[a]	1.00[a]	1.00[a]
	3	0.70[a]	0.90[a]	0.90[a]	1.00[a]	1.00[a]	1.00[a]
	4	0.70[a]	0.90[a]	0.90[a]	1.00[a]	1.00[a]	1.00[a]
	5	0.70[a]	0.90[a]	0.90[a]	1.00[a]	1.00[a]	1.00[a]
SE±		0.00	0.00	0.00	0.00	0.00	0.00

**Means on the same row having different superscripts are significantly different (P<0.05)*
****NFT** - means nitrogen fixing trees*

Effect of Watering Regimes on the Number of leaves of *C. tangelo* Seedlings

The result of the effect of watering regimes on the number of leaves of *C. tangelo* seedlings is showed in Table 3. Highest number of leaves of 8 was recorded in seedlings watered daily.

Table 3: Effect of watering regimes on the number of leaves of *C. tangelo* seedlings

NFT Species	Watering regimes	Weeks					
		2	4	6	8	10	12
J.mimosifolia	1	6.00[b]	8.00[a]	8.00[a]	8.00[a]	8.00[a]	8.00[a]
	2	2.20[b]	3.00[ab]	3.20[ab]	4.20[a]	4.40[a]	4.40[a]
	3	2.40[b]	3.40[ab]	3.40[ab]	4.40[a]	4.40[a]	4.40[a]
	4	2.40[b]	3.40[ab]	3.40[ab]	4.40[a]	4.40[a]	4.40[a]
	5	3.00[b]	3.80[ab]	3.80[ab]	4.80[a]	4.80[a]	4.80[a]
SE±		0.34	0.41	0.43	0.44	0.44	0.44

**Means on the same row having different superscripts are significantly different (P<0.05)*
****NFT** - means nitrogen fixing trees*

Effect of Watering Regimes on the Leaf Area of *C. tangelo* Seedlings

The result of the effect of watering regimes on the leaf area of *C. tangelo* seedlings is represented in Table 4. A significant leaf area of 22.65cm^2 was recorded in seedlings subjected to daily watering regimes.

Table 4: Effect of watering regimes on the leaf area of *C. tangelo* seedlings

N.FT Species	Watering regimes	Weeks					
		2	4	6	8	10	12
J. mimosifolia	1	18.10[b]	16.83[b]	20.87[ab]	22.65[a]	22.65[a]	22.65[a]
	2	7.49[a]	7.49[a]	9.65[a]	9.88[a]	9.88[a]	9.88[a]
	3	6.80[b]	6.80[b]	8.74[ab]	10.56[a]	10.56[a]	10.56[a]
	4	6.23[a]	6.23[a]	7.83[a]	9.20[a]	9.20[a]	9.20[a]
	5	6.23[a]	7.97[a]	7.97[a]	8.74[a]	8.74[a]	8.74[a]
SE±		0.78	0.66	0.78	1.13	1.13	1.13

**Means on the same row having different superscripts are significantly different (P<0.05)*
****NFT** - means nitrogen fixing trees*

Effect of Watering Regimes on the Leaf Area Index of *C. tangelo* Seedlings

The result of the effect of watering regimes on the leaf area index of *C. tangelo* seedlings is presented in Table 5. Highest leaf area index of 1.54 was recorded in seedlings watered at 4 days' interval.

Table 5: Effect of watering regimes on the leaf area index of *C. tangelo* seedlings

NFT Species	Watering Regimes	Weeks 2	4	6	8	10	12
J.mimosifolia	1	0.76^a	0.76^a	0.73^a	0.71^a	0.71^a	0.71^a
	2	1.42^a	1.42^a	1.06^a	0.96^a	0.96^a	0.96^a
	3	1.75^a	1.75^a	1.19^a	0.98^a	0.98^a	0.98^a
	4	1.97^a	1.97^a	1.20^a	1.54^a	1.54^a	1.54^a
	5	1.52^a	1.52^a	1.09^a	1.24^a	1.24^a	1.24^a
SE±		0.43	0.33	0.29	0.24	0.24	0.24

**Means on the same row having different superscripts are significantly different (P<0.05)*

***NFT** - means nitrogen fixing trees*

Effect of Watering Regimes on the Fresh and Dry Weight of *C. tangelo* Seedlings

The result of effect of watering regimes on the fresh and dry weight of *C. tangelo* seedlings is presented in Table 6. A significant fresh weight and dry weight of 5.55g and 1.75g respectively were recorded in seedlings subjected to 5 days' watering interval.

Table 6: Effect of watering regimes on the fresh and dry weight of *C. tangelo* seedlings

NFT Species	Watering regimes	Fresh weight L	S	R	T FW	Dry weight L	S	R	TDW
J. mimosifolia	1	0.40^b	0.10^c	0.70^a	1.20^e	0.10^b	0.10^c	0.20^a	0.30^d
	2	0.85^b	0.35^c	1.45^a	2.65^d	0.20^b	0.10^c	0.30^a	0.60^c
	3	0.95^b	0.30^c	1.85^a	3.10^c	0.20^b	0.10^c	0.45^a	0.75^c
	4	1.60^b	0.55^c	2.20^a	4.35^b	0.60^b	0.20^c	0.60^a	1.40^b
	5	2.10^b	0.45^c	3.00^a	5.55^a	0.60^b	0.20^c	0.95^a	1.75^a
SE±		0.10	0.10	0.10	0.31	0.07	0.07	0.07	0.21

**Means on the same row having different superscripts are significantly different (P<0.05) for plant parts*

**Means on the same column having different superscripts are significantly different (P<0.05) for total fresh weight and total dry weight*

Key: NFT-Nitrogen fixing trees; L –leaf, S – stem, R – root, TDW –Total dry weight, TFW –Total fresh weight

Nutrient Uptake in the Watered *C. tangelo*

The nutrient uptake in the watered seedlings of *C. tangelo* is presented in Table 7. Highest nitrogen, phosphorus and potassium uptake of 1.96%, 18.11mg/ 100g and 345mg/ 100g were recorded in seedlings subjected to 4days, 1 day and 5 days' watering intervals, respectively.

Table 7: Nutrient uptake in the watered *C. tangelo*

NFT Species	Watering Regimes	Nutrient N%	Pmg/100g	Kmg/100g
J. mimosifolia	1	1.92	18.11	328.63
	2	1.88	14.32	341.78
	3	1.86	16.83	329.67
	4	1.96	12.73	312.45
	5	1.91	15.67	345.63

***NFT** - means nitrogen fixing trees*

P mg/100g - milligram of phosphorus in 100g of *J. mimosifolia*; Kmg/100g- milligram of potassium in 100g of *J. mimosifolia*

DISCUSSION

Highest number of leaves of *C. tangelo* was recorded in seedlings watered daily. Similar observation has been made by Dauda *et al.* (2009) who stated that the rate of increase in leaf number of vegetables (such as Okra, *Chocorus olitorus, Telferia* spp and *Amaranthus* spp) can be said to be directly proportional to the frequency of watering regime as seedlings watered everyday produced the highest number of leaves (6.75) and the lowest was obtained in seedlings watered once a week (5.75). Various investigators have reported the highest growth parameters in seedlings exposed to regular watering. This is consistent with the reports of Akinyele (2007) on *Buchholzia coreacea* and Oboho and Igharo (2017) on *Pycnanthus angolensis.,* Gbadamosi (2014) on *Persea americana* and Ogidan *et al.* (2018) on *Kigelia africana.* This is in consonance with reports of Antunez *et al.* (2001) as well as that of Asaolu and Asaolu (2002).

Highest number of leaves was recorded in seedlings watered daily can also be traced to nitrogen present in *J. mimosifolia* which easily dissolve in the presence of regular watering and this facilitate the uptake of nutrient than other species investigated. This result is corroborated with the reports of Olubode *et al.* (2018) who stated that there was a corresponding increase in plant nutrient uptake with increase in applied moisture content and vice versa.

A significant leaf area recorded in seedlings subjected to daily watering regimes. Regular watering enhanced the leaf area of the *C. tangelo* seedlings. This is in conformity with the report of Ogunrotimi and Kayode (2018) who stated that *Solanum macrocarpon* might require much water as seedlings watered everyday had the highest leaf area. Regular watering enhanced the leaf area of *C. tangelo* seedlings. This is consonance with the reports of Oboho and Igharo (2017) who stated that leaf size is very crucial in photosynthesis and protoplasm build up hence the higher biomass under the higher watering regime. This is in agreement with the submission of Gonzales *et al*. (2009). The regular watering allows nutrient to dissolve and transport to appropriate area for leaf expansion for photosynthesis. Regular watering also enhanced the nutrient uptake of phosphorus. This is corroborated by the documentation of Olubode *et al.* (2018).

CONCLUSION

Of all the factors affecting nutrient uptake, growth and development of the plant, water is most critical. The success of nutrient up take in agro-forestry that leads to growth and development does not depend alone on present of nutrient, species types, age of the plant, soil rhizosphere, but also on soil ph and the availability of water. Irrespective of the quality and quantity of nutrient present in the soil, only water helps the nutrient to dissolve and form ions for the absorption of the root for plant growth and development. The essentiality of water cannot be over emphasized as its helps in biochemical, physiological and hormonal process in the plants as *C. tangelo*. The result of the investigation on the effect of watering regimes on the growth of *C. tangelo* revealed that daily watering enhances the growth parameters and nutrient uptake of *C. tangelo* except in the dry and fresh weight.

REFERENCES

Adelani, D.O., Luka, G.L and Adedapo, J.O. (2018). Effect of sources and periods of organo-priming on the germination of *Canarium schweinfurthii* Engl (African Elemi seeds). *Journal of Sustainable Environmental management* 10: 73-89.

Adelani, D.O., Suleiman, R.A. Aduradola M. A and Akesode, H.A. (2014). Assessment of leaf litters of some tree species on growth of *Zea mays* (L) in Northern Guinea Savanna ecology. *Journal of Organic Agriculture and Environment* 2:117-130.

Adelani, D.O. (2015). Effects of pre-germination treatments and sowing depths on early growth of sesban (*Sesbania sesban*). *Applied Tropical Agriculture*, 20(1): 31-36.

Aderounmu, A.F., Adenuga, D.A., Ogidan, O.A and Alonge, O.O. (2017). Effect of different watering regimes on the early growth of *Terminalia superba* ENGL and DIELS. In: Adekunle, V.A.J., Ogunsanwo, O.Y and Akinwole, A.O (Eds). *Harnessing the Uniqueness of Forest for Sustainable*

Development in a Diversifying Economy. Proceedings of the 39th Annual Conference of the Forestry Association of Nigeria. Pp183-189.

Akinyele A.O. (2007). *Silvicultural Requirement of Seedlings of Buchholzia coriacea* Engler. Unpublished PhD Thesis, Dept. of Forest Resources Management, University of Ibadan, 20-34

Akubuili, H. (2013). "Gender play a key role for sustainable farming in Africa" EU news and policy debates across languages. http:// www.curative.com/ development-policy/researcher-eu-aid-education-afriinterview 517158. Accessed on 1st May, 2013. 2pp.

Antunez, I., Retamosa, E.C and Villar, R. (2001). Relative growth rate in phylogenetically related deciduous and evergreen woody species. *Oecologia*, 128: 172-180.

Asaolu, M.F and Asaolu, S.S. (2002). Proximate and mineral composition of cooked and uncooked *Solanum melongena*. *International Journal* of *Food Sciences* and *Nutrition* 53: 103-107.

Bargali, K and Tewari, A. (2004). Growth and water relation parameters in drought-stressed *Coriaria nepalensis* seedlings. *Journal of Arid Environment*, 58:505-512.

Bongers, F., Pooter, L and Hawthorne, W. D. (2004). The forest of upper Guinea gradients in large species composition, In Pooter, L. (ed.) *Biodiversity of West African Forests: An Ecological Atlas of Woody Plant Species.* CABI Wallingford, United Kingdom, pp. 41-52.

Brataševec, K. (2013). *Determination of the Actual Uptake of Essential Nutrients by Different Parts of Vitis Vinifera L. Cv. 'Rebula*. Dissertation of University of Nova Gorica Graduate School, Nova Gorica. Pp 136.

Capps, E. R and Wolf, T. K. (2000). Reduction of bunch stem necrosis of Cabernet Sauvignon by increased tissue nitrogen concentration. *American Journal of Enology and Viticulture*, 51: 319-328.

Cao, K. F. (2000). Water relations and gas exchange of tropical saplings during a prolonged drought in a Bornean Health Forest, with reference to root architecture. *Journal of Tropical Ecology* 16:101-116.

Dauda, T.O., Asiribo, O.E., Akinbode, S.O., Saka, J.O and Salahu, B.F. (2009). An assessment of the roles of irrigation farming in the millennium development goals. *African Journal of Agricultural Research* 4:445-450.

Daba, M. H and Tadese, A. E. (2017). Estimation of optimum water requirement and frequency of watering for different tree seedlings at Bako Agricultural Research Center nursery site. *Journal of Health and Environmental Research*, 3 (6): 90-97.

Gbadamosi, A. E. (2014). Effect of watering regimes and water quantity on the early seedling growth of *Picralima nitida* (Stapf). *Sustainable Agriculture Research,* 3 (2): 35-42.

Gonzales, J. A., Gallardo, M., Hilal, M., Rosa, M and Prade, F. E. (2009). Physiological responses of quinoa (*Chenopodium quinoa* Willd.) to drought and water logging stresses: dry matter partitioning. *Botanical Studies, 50*: 35-42.

Goyne, P. J and McIntyre, G.T. (2003). Stretching water-Queensland's water use efficiency cotton and grains adoption program. *Water SA*, 48(7):191-196.

Isah, A. D., Bello A. G., Maishanu H. M. and Abdullahi, S. (2013). Effect of watering regime on the early growth of *Acacia senegal* (Linn) wild provenances. *International Journal of Plant, Animal and Environmental Sciences,* 3(1): 52-56.

Keller, M. (2005). Deficit irrigation and vine mineral nutrition. *American Journal of Enology and Viticulture,* 56: 267-283.

Mhango, J., Akinnifesi, F.K, Mng'omba, S.A and Sileshi, G. (2008). Effect of growing medium on early growth and survival of *Uapaca kirkiana* Müell Arg. seedlings in Malawi. *African Journal of Biotechnology* 7(13): 2197-2202

Mng'omba, S. A., Akinnifesi, F. K., Sileshi, G., Ajayi, O. C., Nyoka, B. I. and Jamnadass, R. (2011). Water application rate and frequency affect seedling survival and growth *of Vangueria infausta* and *Persea* *americana. African Journal of Biotechnology*, 10(9): 1593-1599.

Mukhtar, R.B., Mansur, M.A., Abdullahi, S., and Bunza, M.S. (2016). The growth of *Balanites aegyptiaca* (L.) seedlings under varied watering intervals in the nursery. *Journal of Tropical Agriculture, Food, Environment and Extension* 15(3): 30-33.

Oboho, E. G. and Igharo, B. (2017). Effect of pre-germination treatments on germination and watering regimes on the early growth of *Pycnanthus angolensis* (Welw) Warb. *Journal of Agriculture and Veterinary Science* 10 (3): 62-68.

Ogidan, O. A., Olajire-Ajayi, B. L and Adenuga, D. A. (2018). Assessment of watering regimes on seedling growth performance of *Kigelia africana* (Lam) Benth. *Biodiversity Conservation and National Development Potentials and Challenges*. In: Gabriel, S.U., Folaranmi, D.B and Edem, A.E (eds). Proceedings of 6th Nigeria Chapter of Society for Conservation Biology (NSCB) *Biodiversity Conference*. pp 341-345.

Ogunrotimi, D. G and Kayode, J. (2018). Effect of watering regimes on early seedling growth of *Solanum macrocarpon* L. (Solanaceae). *Journal of Applied Sciences, 18: 79-85.*

Olajuyigbe, S.O., Jimoh, S.O., Adegeye, A.O and Mukhtar, R.B. (2013). Drought stress on early growth of *Diospyros mespiliformis* Hochst ex A. Rich in Jega, Northern Nigeria. *Nigerian Journal of Ecology* 12(1):71-76.

Olubode, O.O., Hammed, L.A., Odeyemi, O.M., Adekoya, F.J., Meroyi, F.M and Ogunlade, O.I. (2018).Influence of moisture regimes and organic manure on nutrient dynamic and growth of cashew. *Horticulture For improved livelihoods*. In: Aiyelaagbe, I.O.O., Adeoye, I.B and Akintoye, H.A (eds). *Proceedings of III All Africa Horticultural Congress*. Pp 125.

Otegbeye, G.O., Owonubi, J. J and Oviasauyi, P.K. (2001). Interspecific variation growth of Eucal yptus growing in northern Nigeria. *In*: Popoola, L, Abu J.E and Oni, P.I (Eds). *Procee dings of 27th Annual Conference of the Forestry Association of Nigeria*, pp 12 – 16.

Raţić S., Onjia A., Đogo S., Slavković L., Popović A. (2005). Determination of metal content in some herbal drugs – Empirical and chemometric approach. *Talanta*, 67: 233-239.

SAS (2003). *Statistical analysis system*. SAS release 9. 1 for windows, SAS Institute Inc. cary, NC, USA.

Ugese, F. D, Baiyeri, K. P and Mbah, B. N. (2008). Leaf area determination of sheabutter tree (*Vitellaria paradoxa* C.F Gaertn). *International Agrophysics*, 22:167-170.

Umar, T and Gwaram, A. B. (2006). Foliar nutrient contents of four indigenous trees of the Sudan savanna. In: Popoola, L. (Eds). *Proceedings of 31st Annual Conference of Forestry Association of Nigeria* 131-139.

Yuma, Y. (2018). Natural, considerations and propagation techniques of citrus. Yuma cooperative extension. https://extension.arizona.edu/yuma; Accessed on 31/03/2018. Pp2.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ariwaodo, 2019

SYSTEMATIC EVALUATION OF SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT OF *Monodora myristica* (GAERTN) DUNAL AND *M. tenuifolia* BENTH (ANNONACEAE)

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ABSTRACT

An evaluation of seed germination and early seedling development pattern of Monodora myristica and M. tenuifolia were investigated at the nursery, to provide useful classificatory tool to aid in the taxonomic identification of the species. Results showed epigeal cryptocotylar/durian germination types, with all possible germination occurring before 84 days after sowing (Rapid germination). The study is expected to provide additional morphological clue in the identification of seedlings of Monodora species during forest regeneration studies.

Keywords: Taxonomic, Classification, Epigeal Cryptocotylar, Durian, Regeneration.

INTRODUCTION

Traditional taxonomic practice have long recognized the role of employing a full range of characters from flowers, fruits, seed, seedlings and vegetative shoots in resolving taxonomic relationship at species level and improve classification systems. Seed germination and seedling development studies have been reported for many dicotlyedons (Onyeachusim, 1985; Okali and Onyeachusim, 1991; Ng, 1991; Essig, 1991; Umbere and Omolokum, 1998; Nwadinigwe and Onyekwelu, 2009), including a limited number in Annonaceae (Hayat, 1963; Corner, 1976; De Vogel, 1980; Mohana Rao, 1982; Finneseth *et al.*, 1998; Folorunsho and Olorode, 2008). However, no detailed study on seedling morphology has been recorded for most Annonaceous genera in Nigeria (Folorunsho and Olorode, 2008) particularly the genus Monodora. The two tree species under investigation; *Monodora tenuifolia* Benth and *M. myristic*a (Gaertn) Dunal are widely known with the common name ‘African Nutmeg’ or ‘False Nutmeg’. These species are sympatric taxa in their natural distribution range within the Nigeria high forest ecosystem. They are noted to be of high economic value, as the embedded seed is used as spices amongst several other uses of the plant parts. Keay (1989) recorded five tree species belonging to the genus: *M. myristica* (Gaertn) Dunal; *M. tenuifolia* Benth; *M. crispata* Engl & Diels, *M. unwnii* Hutch & Dalz and *M. brevipes* Benth.

Seedling morphology is often studied in conjunction with other systematic lines of investigation to provide insight into additional valuable taxonomic characters of species under investigation. Its practical relevance, however, in the field of forestry is providing clue to the correct identification of species during regeneration studies especially for plant species that exhibit dimorphic features at the seedling stage as reported for the small smooth seeds and the large non-smooth seeds of *Carapa procera* (Okali and Onyechusim, 1991).The purpose of this study therefore, is to compare the seedling development state of congeneric species group (*Monodora* spp) in a common environment where plastic responses to environment are minimized. This is to provide for easy identification and a useful classificatory tool in the delimitation of the taxa

MATERIALS AND METHODS

Study Area

Fruits of the respective Monodora species were collected from growing trees during their fruiting season in a secondary forest vegetation within the Forestry Research Institute of Nigeria, Ibadan (latitude 7^{o} 23’ 15’’ to 7^{o} 24’ 00’’N and longitude 3^{o} 51’ 00’’ N to 3^{o} 52’15’’E). The rainfall pattern of the area of fruit collection is bimodal with peak around (June and July) and September to October. Mean total annual rainfall is 420.00mm in about 109 days. Mean maximum and minimum temperatures is about 34^{o}C and 24^{o}c respectively. Mean relative humidity ranges from 82% between June and September to approximately 60% between December and February (Adio *et al.*, 2011).

The fruit sizes averages 14cm by 12cm with about 205 seeds for *Monodora myristica* (Shape: Globose) and 4cm by 5 cm with about 41 seeds for *Monodora tenuifolia* (Shape: globose, non-apiculate). Seeds were extracted from matured and ripened (yellow) fruits. Seeds sizes averages 0.8cm by 1.4cm (dark brown) for *M. tenuifolia* and 1.3cm by 2.0cm (light brown) for *M. myristica* respectively. The seed size of *M. tenuifolia* is small relative to the large seed size of *M. myristica*. Fruits and seed sizes were measured using a digimatic electronic caliper. Extracted seeds were sown in washed sterilized river sand in batches of 25 seeds per plastic container. Sown seeds were placed under nursery shade (uniform environment and watered daily for observation of seed germination. Physiologically seeds are assumed to have germinated with the protrusion or emergence of the radicle but are not considered completed until the formation of the eophyll or primary leaves. Detailed description of germination type and morphology of early seedling development follows: De Vogel (1980) and Ng (1976, 1991). The authors described the various forms of germination patterns for vascular plant species. The epigeal crytocotylar germination pattern occurred when the cotyledon were shed within the remaining part of the seeds before seed coat abscission. While other variants, such as Durian germination pattern occurred for non-emerged seed coats. Ng (1976, 1991) described rapid germination as condition when all viable seeds of the species in question complete germination within 84 days (12 weeks) of seed fall or after sowing.

RESULTS

The result of the study of early seedling development of the *Monodora* species studied are presented in Table 1 and Plate 1A and B. Radicle emergence was observed between 14 – 21 days after sowing for *Monodora tenuifolia* Benth and 21 – 35 days for *Monodora myristica* (Geartn) Dunal. After penetrating the soil surface, the hypocotyl hook (green) elongated for both species. In a few numbers of cases, the seed coat containing the cotyledon remained subterranean (on the soil surface) but most often, the non-emergent cotyledons with possible remaining endosperm (enclosed within seed coat) was lifted up above the soil surface by the elongating hypocotyl. The raised seed coat remained for between 20-30days before seed coat abscission (Plate 1A). The first true leaves appeared at 40days after sowing for *Monodora tenuifolia*, at 50-60days after sowing for *Monodora myristica*.

The epigeal pattern of germination was recorded for the *Monodora* species examined as shown on Table 1. This pattern of germination has been classified as epigealcryptocotylar. Germination follows four developmental phases beginning from radical protrusion, hypotcotyl emergence, epicotyl elongation, seed abscission to seedling. However, a rare occurrence of a retained seed coat with developed exposed primary leaf was observed for a single *M. tenuifolia* seedling (Plate 1B). This phenomenon is known as durian germination type.

Germination rate observed for the *Monodora* species studied has been termed rapid germination. At three months, the seedling height differed significantly ($P \geq 0.05$) for the *Monodora* species studied. The species *M. myristica* was found to attain a mean seedling height of 13.6 ± 1.6cm compared to 9.3 ± 0.6cm for *M. tenuifolia*.

Table 1: Seedling Morphological Characters of *Monodora* Species Studied

Characters	*Monodora myristica*	*Monodora tenuifolia*
Germination rate	Rapid germination (76 DAS)	Rapid germination (54DAS)
Germination type	Epigeal	Epigeal
Hypocotyl	Well-developed enlongated hypocotyls	Well-developed enlongated hypocotyl
Root system	Well-developed root systems (tap/lateral roots) before opening of eophyll	Well-developed root system (tap/lateral roots) before opening of eophyll
Eophyll/ primary leaf	Simple, alternate, entire, petiolate (inflated), glabrous, unicostate-reticulate, Apex-acuminate to mucronate, base rounded, shape elliptic to obovate	Simple, alternate, entire, petiolate, glabrous, unicostate-reticulate, Apex-acuminate, base cuneate, shape elliptic.
Leaf Margin symmetry	Symmetrical	Symmetrical
Phylotaxy of seedling foliage	Distichous	Distichous
Growth form	Woody/sympodial	Woody/ sympodial
Average seedling height at 3months	13.6±1.6cm*	9.3±0.6cm

DAS: Days after sowing; *significant ($p \leq 0.05$)

Plate 1A: Raised seed coat of *Monodora* species before seed abscission.
1B: Rare occurrence of non-emerged seed coat of *M.tenuifolia* Benth
Source: Forestry Research Institute of Nigeria (FRIN) Nursery

DISCUSSION

Monodora seeds had ruminate endosperm and small embryo (Sharma, 1993). This feature had earlier been recorded for other Annonaceous species (Hayat, 1963). The embryo is small relative to the large endosperm and seeds with this feature can be described as morphologically dormant. The cotyledon in such seeds often develops within the seeds prior to significant radicle growth (Finneseth *et al*., 1998).

Generally, the *Monodora* species studied exhibited more or less uniformity in their taxonomic morphological characters. Little variation may however be attributed to the genetic make-up and phylogeny of the respective species.

As recorded, the epigeal cryptocotylar germination pattern (De Vogel, 1980) occurred when the cotyledons were shed within the remaining part of the seeds. This germination was also been recorded for *Asimina triloba* (Annonaceae), the North American pawpaw species (Finneseth, *et al*., 1998). Similarly, the developmental stages of studied *Monodora* species also followed the same pattern as recorded for the North American species (pawpaw). Ng (1976, 1991) stated that rapid germination as observed, occurs when all viable seeds of the species in question complete germination within 84 days (12 weeks) of seed fall or after sowing. This is a common feature among rainforest tree species. Okali and Onyeachism (1991) reported that 80% of the 25 tree species sown germinated rapidly in the sense that all the germination that could occur was within 84 days.

As observed, a well-developed root system in both species may present some ecological advantage at the establishment phase. The ecological significance of height variation at the seedling stage (Table 1) may be attributed to differences in seed size, with *M. myristica* having a larger mean seed size (1.3cm x 2.0cm) compared to the small mean seed size (0.8cm x1.3cm) for *M. tenuifolia*. The wide differences in seed size among species however, was related to the ecological conditions in which plant establish, with species from open habitats having lower average seed mass than species from more closed habitats (Mazer, 1989; Kelly and Purvis, 1993). The differences in height beyond seedling stage have been reported (Nyananyo, 2006) to exist between the taxa. At field condition, *M. tenuifolia* was shorter (about 15m) relative to *M. myristica* (about 20m). Several other studies (Ng, 1976; Long and Jones, 1996; Bonfil, 1998) had confirmed that larger mean seed size confers advantage in terms of seedling growth (height) than small mean seed size for congeneric species group. Furthermore, the influence of seed size on seedling growth has been reported to hold more for mesic and hydric species than for xeric species (Long and Jones, 1996). Being a sympatric taxa (High forest species), the studied *Monodora* species can be inferred to belong to the mesic and hydric species group and thus, their difference in terms of height may be greatly influenced by variation in seed sizes than any other ecological factor.

CONCLUSION

Correct identification of plant species at seedling stage is imperative in enumeration work involving regeneration studies of undergrowth in any tropical forest ecosystems. This study provides insight into the taxonomic features and germination pattern of this taxonomic group (Monodora) in Nigeria. It is suggested that breeding experiment should be carried out in this important genus to further explore its economic potentials and resolve taxonomic problems to aid classification.

REFERENCES

Adio, A. F., Adegbagbo, C. A., Gbadebo, J. O., Adedokun, A. and Asinwa, I. O. (2011). Preliminary study of espacement trials of *Jatropha curcas* intercropped with maize and cassava. *Journal of Sustainable Environmental Management*; 3:24-32.

Bonfil, C. (1998). The effect of seed size, cotyledon reserves and herbivory on seedling survival and growth in *Quercu srugosa* and *Quercus laurina* (Fagaceae).*American Journal of Botany*, 85(1), 79-87.

Corner, E.H.J. (1976).Annonaceae. In: *The Seeds of Dicotyledons, vol. 1*. United Kingdom: Cambridge University Press. Pp 68-86.

De Vogel, E.F. (1980). Annonaceae. In: *Seedlings of Dicotyledons*. Centre for Agric. Publishing and Documentation, PUDOC, Wegeningen, The Netherlands, Pp 168-181.

Essig, F.B. (1991). Seedling morphology in *Clematis* (Ranunculaceae) and its taxonomic implications. *SIDA:* 14(3), 377-390.

Finneseth, C.H., Layne, D. R. and Geneve, R. L. (1998). Morphological development of the North-American pawpaw during germination and seedling emergence. *Hortscience*, 33(5), 802-805.

Folorunsho, A. E. and Olorode, O. (2008). Biosystematics studies in Annonaceae II. Vegetative and floral morphological studies of some Genera of Annonaceae in Nigeria. *Research Journal of Botany*, 3 (1), 1 – 8.

Hayat, M.A. (1963). Morphology of seed germination and seedling in *Annona squamosa*. *Botanical Gazette*, 124, 360-362.

Keay, R. W. J. (1989). *Trees of Nigeria*, London: Clarendon Press, 476pp.

Kelly, C. K. and Purvis, A. (1993).Seed size and establishment conditions in tropical trees. *Oecologia*, 94, 356-360.

Long, T.J. and Jones, R.H. (1996). Seedling growth strategies and seed size effects in fourteen oak species native to different soil moisture habitats. *Trees*, 11:1-8.

Mazer, S. J. (1989). Ecological, taxonomic and life history correlates of seed mass among Indiana dune angiosperms. *Ecological Monographs*, 59, 153-175.

Mohana Rao, P.R. (1982).Seeds and fruit anatomy in *Asiminatriloba*, with a discussion of the affinities of Annonaceae. *Botanical Jahrb System*, 103-47-57.

Ng, F.S.P. (1976). Strategies of establishment in Malayan forest trees. In: Tomlinson P. B. and Zimmermann M.H.(eds). *Tropical Trees as Living Systems*. Cambridge: Cambridge University Press, Pp129- 162.

Ng. F.S.P. (1991). *Manual of Forest Fruits, Seeds and Seedlings. Malayan Forest Record no 34,* Forest Research Institute of Malaysia.

Nwadinigwe, A.O. & Onyekwelu, S.C. (2009). Cryptogeal germination and seedling morphology of *Parinari curatellifolia* Planch. Ex. Benth (Rosaceae). *Nigerian Journal of Botany*, 22(2), 223-228.

Nyananyo, B. L. (2006). *Plants from the Niger Delta*. Onyoma Research Publications, Port-Harcourt, Nigeria. 403pp.

Okali, D.U.U. and Onyeachusim, H.D. (1991).The groundflora and rainforest regeneration at Omo Forest Reserve, Nigeria. In: Rainforest regeneration and management. (Ed Gomez-Pompa, A.; whitemore, T.C. & Hadley, M.); *Man & the Biosphere series*, the Parthenon Publishing group.273-283.

Onyeachusim, H.D. (1985). Ecological studies in Omo Forest Research, South-western Nigeria with Particular reference to the tree seed germination patterns, Ground Flora dynamics and Litter standing crops. M.Phil Dissertation, Dept of Forest resources mgt., University of Ibadan, 494pp.

Sharma, O. P. (1993*). Plant Taxonomy*. New Delhi: Tata McGraw Hill Publishers,482pp.

Umbere, C.E. and Omolokun O.E. (1998).Phenotypic plasticity in edaphically different populations of *Spigella anthelma*. *Nigerian Journal of Botany*, 11, 59-66.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adelani et al., 2019

EFFECT OF PERIODS OF HYDRO-PRIMING AND SEED WEIGHTS ON THE GERMINATION OF *VITEX DONIANA* SWEET SEEDS

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ABSTRACT

There is paucity of information on breaking the dormancy of Vitex doniana through hydro-priming. Hydro-priming is the method of ensuring uniform and high germination percentage, by soaking seeds in water and follow by drying of seeds, while the emergence of radicle is prevented. There is need to determine the appropriate periods of hydropriming to prevent over or under hydro-priming of seeds. In light of this, investigation was conducted on the effect of periods of hydro-priming and seed weights on the germination of V.doniana seeds. To assess the effect of periods of hydropriming (0, 6, 12, 18, 24 and 36hrs) *and three seed weights (1.2, 1.4 and 3.3g)* ***on the germination of V.doniana seeds, a split-plot experimental design with five replications was employed. Result revealed that periods of hydropriming significantly (P<0.05) enhanced the germination of V.doniana. A significant germination percentage value of 50% was recorded in seeds hydro-primed for 36hours. Germination percentage of seeds increased with the increasing periods of hydro-priming. Highest germination percentage value of 40% was recorded in average seed size of 1.4g A significant germination percentage of 100% was recorded in 1.4g seeds hydro-primed for 36hours. Least mean germination time of 8days was recorded for 1.4 and 3.3g seeds. Hydro-priming of 1.4g for 36hours enhances the germination percentage of V.doniana seeds. The study therefore recommends hydro-primng of 1.4g seeds for 36hours for mass production of its seedlings for agro-forestry systems.***

Key words: Dormancy, Soaking and drying of seeds, Pre-sowing treatment, Germination, Agro-forestry species.

INTRODUCTION

Nigeria is rich in floristic composition and biodiversity with over 4,600 species out of which 205 are endemic, while another 476 species are threatened (FAO, 2000). The forest has productive, protective and social function (Olajide, 2003), however, this important resources are undergoing serious genetic depletion arising from various anthropogenic forces (FAO, 2004).Sale and Olujobi (2014) stated that the increase pressure on Nigeria's forest natural resources owing to population growth and economic pressure has drastically affected available land area for natural resources development. Nigeria is one of the developing countries in Sub-Sharan Africa (Osugiri *et al.*, 2012), which is blessed with a large expanse of land and variable vegetation, that is not sustainably managed (Olajide, 2010).

Oboh and Igharo (2017) reported that the ever increasing rate of forest loss all over the world makes it necessary to plan for and establish plantations and private tree plantings (small scale) of important forest species with a view to meeting the demands for forest products by the people. Okunlola and Akinyele (2017) stated that developing nations including Nigeria are endowed with many indigenous fruits that are of great importance to the rural communities. Such fruits contribute to the diet and economy of rural communities. These forest plants are important and cheap sources of vitamins, minerals, protein, carbohydrates and fats (Okunlola and Akinyele, 2017). One of such plant is *Vitex doniana*.

Vitex doniana is called Black plum; Dinya; Ucha koro and Oori-nla in English, Hausa, Igbo and Yoruba respectively (Orwa *et al.*, 2009). The blackish pulp of the matured fruits is sweet and edible, and is eaten fresh. This pulp also serves in jam preparation. A beverage is made from the fruit juice, whereas boiled fruits are the basis for an alcoholic liquor and wine (Ky, 2008). The *V. doniana* is an important indigenous fruit or leafy vegetable in Africa (Burkill, 2000; Maundu *et al.*, 2009) for food, medicine and other purposes (Dadjo *et al.*, 2012). Hounkpèvi *et al.* (2018) stated that its leaves are used as fodder for livestock and the young leaves as leafy vegetables in sauces preparation. The blackish pulp of its ripened fruits is edible and used in preparation of some sweet drinks (Hounkpèvi *et al.*, 2018).

In traditional medicine, *V. doniana* have several applications (Ladeji *et al.*, 2005; Ky, 2008; Padmalatha *et al.*, 2009). For instance the leaf, the bark, dried and fresh fruit serve as ingredients in many preparations to treat or heal diseases including conjunctivitis, headache, stiffness, measles, rash, fever, chickenpox, hemiplegia, respiratory diseases, ankylostomiasis, rachitis, gastro-intestinal disorders, jaundice, kidney troubles, leprosy, liver diseases, bleeding after childbirth and diarrhoea. The mature leaves, the bark and the roots have phytotherapeutic properties and are used to heal several diseases (Iwueke *et al.*, 2006, Kilani, 2006, Padmalatha *et al.*, 2009).

V.doniana (Verbenaceae) has numerous utilisations with promising economic potential for poverty alleviation in rural and peri-urban areas in Africa. Mapongmetsem *et al.* (2005) reported that the species contributes to the improvement of soil fertility by litter production and is a good candidate in agroforestry systems. The wood of *V.doniana* is variously used in house construction, furniture, tools and agricultural implements making; it is suitable as firewood and for charcoal production (Arbonnier 2002, Arbonnier, 2004, Ky, 2008, Louppe *et al.*, 2008, Orwa *et al.*, 2009, Dadjo *et al.*, 2012). Hounkpèvi *et al.* (2018) stated based on its socio-economic importance, its integration into the farm production systems could foster domestication strategies and reduce anthropogenic pressures on its natural populations.

The seeds of *V. doniana* are dormant (Oboh and Igharo, 2017). Dormancy is a state where seeds do not germinate when placed under conditions which are normally regarded as favourable for germination (Ajiboye, 2010). Baskin and Baskin (2004) defined a dormant seed (or other germination unit) as one that does not have the capacity to germinate in a specified period of time under any combination of normal physical environmental factors (temperature, light/dark, etc.) that otherwise is favourable for its germination, i.e. after the seed becomes non-dormant.

Seed dormancy remains a bottleneck to the propagation of many forest species of economic importance, since about 70% of all major taxonomic groups of seed plants have dormant seeds (Baskin and Baskin, 2003). Oboho and Igharo (2017) stated that dormancy and other seed factors mitigate against easy propagation of many forest tree species. Ease of propagation is intimately tied to seed germination. Oboho (2014) defined germination as the process by which dormant embryo in the seed gets activated grows out of the seed coat and establishes itself as a seedling. Germination is critical to regeneration and dormancy limits the seed germination and seedling availability for afforestation, domestication (Adelani, 2015, Adelani *et al.*, 2018a), reforestation (Aduradola *et al*., 2005) as well as biodiversity conservation of some important indigenous agroforestry trees species. Oboh and Igharo (2017) reported that even and adequate germination of seeds sometimes requires seed dormancy to be broken either by natural or artificial means in a process known as pre-treatment. There could be physical, physiological or morphological forms of dormancy in a seed (Oboh and Igharo, 2017).
The *V. doniana* seeds present a combination of physical (PY) and physiological dormancy (PD), based on classification by Baskin and Baskin (2004) and Silveira (2013). However, little is known about dormancy breaking requirements and no reliable techniqueis available yet. Imbibition tests revealed that *V. doniana* seeds are physically dormant (N’Danikou *et al.*, 2014) but different treatments

tested so far resulted in germination rates below 60% after six months (Mapongmetsem, 2006; Ky, 2008; Ahoton *et al.,* 2011). Uniform germination is one of the important agronomic requirements for successful domestication of wild harvested economic plants (N'Danikou *et al*., 2015). Priming is one of the methods of ensuring uniform germination. Seed priming is a method to promote rapid and uniform germination of seeds, by controlling imbibitions to an extent where germination is initiated, but insufficient to cause radical emergence (Schmidt, 2000).

Seed priming is an efficient technique for improvement of seed vigor, increasing germination and seedling growth (Dastanpoor *et al.,* 2013). To meet the current demand of forest products through domestication, there is need to embrace cheap, fast and adoptable modern physiological techniques as priming that increase the seed germination percentages, reduce mean germination time and increase seedling growth of agro-forestry tree species (Adelani, 2015). Hydro-priming is a special type of seed priming in which seeds are soaked in water followed by drying of seeds, but the emergence of the radicle is prevented (Farooq *et al.,* 2006). This technique is a common method that can increase rate, percentage and uniformity of germination of seeds (Farooq *et al.,* 2005, 2006; Srivastava *et al.,* 2010). There is dearth of quantified information on the potential of hydro-priming in improving the mean germination time and germination percentage of seeds of forest tree species as *V.doniana.*

Some of the methods as physical, chemical and mechanical scarification only degraded the seed coat for germination (Aliero, 2004; Abubakar and Muhammad, 2013); without rapidly and uniformly influencing the physiology of the seeds (Dewir *et al.,* 2011) and seedlings (Gehlot and Kasera, 2012). Most of methods of breaking seed dormancy do not promote rapid and uniform germination as hydro-priming. Periods of hydro-priming of particular seed weight is essential for successful germination for propagation as well as domestication of indigenous trees species for agroforestry systems. Seed weight is an important factor for successful germination study (Malcolm *et al.,* 2003; Kambizi *et al.,* 2006; Perez-Garcia *et al.,* 2006). Li *et al.* (2015) reported that seed weight had significant influence on seed germination time and total germination fraction. In this light, investigation was conducted to assess the effect of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds.

Overcoming dormancy of *V.doniana* seeds of different weights by hydro-priming will help in meeting the needs of Nigerian without jeopardising environment. New initiatives in agro-forestry are seeking to promote poverty alleviation and environmental rehabilitation through efficient information on overcoming constraints in seed germination and seedling growth (Adelani *et al.,* 2014a) for propagation as well as for domestication purposes (Adelani, 2015).

MATERIALS AND METHODS

Study Area

The pot experiment was carried out at the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna State. The college is located in the Northern Guinea Savannah ecological zone of Nigeria. It is situated in Igabi Local Government Area of Kaduna state, Nigeria. It is located between latitude $10^{o}34'$ and 10^{o} $35'$ and longitude 7^{o} $20'$ and 7^{o} $21'$ (Adelani, 2015). Mean annual rainfall and humidity are approximately 1000 mm and 29% respectively. The vegetation is open woodland with tall trees, usually small boles and broad leaves (Otegbeye *et al.,* 2001).

Fruit collection and Materials

The fruits of *Vitex doniana* were sourced from the mother tree in Buruku Forest Reserve, Kaduna State, Nigeria. The seeds were extracted from the fruits and air dried for 30 minutes. The viability of the randomly selected seed samples was assessed with the cutting method (Schmidt, 2000). The sand was collected from the floor of the college dam, allowed to pass through 2mm sieve and sterilized at $160^{o}C$ for 24hrs in oven (Adelani and Joseph, 2014). The polypots of $20x10x10cm^3$ filled with sterilized sand in the nursery was used. Distilled water was used for the experiment.

For this experiment, germination percentage and mean germination time were calculated using the

following formula (1 and 2) suggested by Schelin *et al*. (2003).
Germination percentage was computed using the formula:

$$\text{Germination Percentage} = \frac{Totalseedgerminated}{Totalseedsown} \text{x } 100 \quad \ldots\ldots (1)$$

Germination count was recorded every two (2) days interval for 12 weeks when no more germination was recorded.
Mean germination time is a measure of the rate and time spread of germination (Soltani *et al.*, 2015). It is denoted as MGT. The unit of mean germination time can be hours, days or other time unit (Ranal and Santana, 2006; Schelin *et al.* (2003)).

$$\text{MGT} = \frac{\sum(f_x)}{\sum X} \ldots\ldots (2)$$

Where: x is the number of newly germinated seeds on each day; f is the numbers of days after seeds were set to germinate; X is the Total number of seeds that germinated at the end of the experiment. Germination percentage and mean germination time were recorded at two days interval for 12weeks.

Experimental design

To investigate the effect of periods of hydro-priming and seed weights on the germination of *Vitex doniana* seeds, a split-plot experimental design with five replications was involved. Six periods of hydro-priming (0, 6, 12, 18, 24 and 36hrs) and three seed weights (1.2, 1.4 and 3.3g) constituted main and sub-plot treatments respectively. The initial moisture content of the samples of extracted ninety (90) seeds was determined by weighing balance (Model-Mettler PM 11-K) before and after drying to constant weight. Five (5) seeds of different weights (1.2, 1.4 and 3.3 g) were soaked in distilled water at periods (0, 6, 12, 18, 24 and 36hrs). Stirring or bubbling was done to ensure uniform treatment and aeration (Adelani, 2015).

After each of duration of the experiment, the seeds were removed, washed, air dried for 30 minutes and treated with fungicide (Vinclozolin). The seeds were sun dried back to the initial moisture content of the seeds. Treated seeds were sown in 4cm depth of the sterilized sand and 200mL / seed of water was applied at two days interval (Adelani *et al.*, 2014b). Seeds that were not soaked in the distlled water served as control. A seed was considered germinated if the radical was able to break open the seed coat and plumule emerged. Final germination count was taken when no further germination took place for several days.

Data analysis

The data was collected on the effect of periods of hydro-priming and seed weights on the germination of *V. doniana* seeds. The data were subjected to two way analysis of variance (ANOVA) using SAS (2003) software. Comparisons of significant means were accomplished using Fischer's Least Significant Difference (LSD) at 5% level of significance.

RESULT

Effect of periods of hydro-priming and seed weights on the germination of *V. doniana* seeds

The result of the effect of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds is presented in Table 1. A significant germination percentage value of 50% was recorded in seeds hydro-primed for 36hours. A significant germination percentage was recorded in average seed size of 1.4 g.

Table 1: Effect of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds

P. H. P	P. G (%)	M G T (days)	SW (g)	P.G (%)	M GT (days)
0	0.00^{b}	0.00^{c}	-	-	-
6	7.00^{ab}	13.00^{c}	-	-	-
12	7.00^{ab}	13.00^{c}	-	-	-
18	33.00^{ab}	82.00^{b}	1.2	7.00^{b}	48.00^{b}
24	40.00^{ab}	117.00^{a}	1.4	40.00^{a}	95.00^{a}
36	50.00^{a}	118.00^{a}	3.3	13.00^{b}	27.00^{c}
SE±	15.91	10.8	SE±	12.24	6.00

**Means on the same column having different superscript are significantly different P (<0.05) vertically*
Key: P. H. P- Periods of Hydro-priming, P. G- Percentage germination, M G T- Mean germination time
SW- Seed Weights

Interactive effect of periods of hydro-priming and seed weights on the germination of *V. doniana* seeds

The result of the interactive effect of periods of hydro-priming and seed weights on the germination of *V. doniana* seeds is presented in Table 2. A significant germination percentage of 100% was recorded in 1.4g seeds soaked in water for 36hours.

Table 2: Interactive effect of periods of hydro-priming and seed weights on the germination of *V. doniana* seeds

P. H. P (hrs)	S W(g)		
	1.2	**1.4**	**3.3**
0	0.00^{a}	0.00^{a}	0.00^{a}
6	0.00^{a}	0.00^{a}	20.00^{a}
12	0.00^{a}	20.00^{a}	0.00^{a}
18	80.00^{a}	20.00^{b}	0.00^{c}
24	20.00^{b}	80.00^{a}	20.00^{b}
36	0.00^{c}	100.00^{a}	40.00^{b}
SE±	12.24	12.24	12.24

**Means on the same rows having different superscript are significantly different P (<0.05) vertically*

Key: P.H.P- Periods of Hydro-priming, SW- Seed W eights

Interactive effect of mean germination time of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds

The result of interactive effect of mean germination time of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds is presented in Table 3. A significant least mean germination time of 8days was recorded for seeds of weight 3.3 and 1.4g soaked for 6 and 24hrs as well as 12 and 18hrs respectively.

Table 3: Interactive effect of mean germination time of periods of hydro-priming and seed weights on the germination of *V.doniana* seeds

P.H.P	Seed weights		
	1.2	**1.4**	**3.3**
0	0.00^{b}	0.00^{b}	0.00^{b}
6	0.00^{b}	0.00^{b}	8.00^{b}
12	0.00^{b}	8.00^{b}	0.00^{b}
18	41.00^{a}	8.00^{b}	0.00^{b}
24	17.00^{b}	45.00^{a}	8.00^{b}
36	0.00^{b}	53.00^{a}	16.00^{b}
SE	5.96	5.96	5.96

**Means on the same rows having different superscript are significantly different P (<0.05) vertically*

Key: P.H.P- Periods of Hydro-priming, SW- Seed Weights

Table 4 : ANOVA for effect of periods of hydro-priming and seed weights on the germination of *V. doniana* Seeds

Source	Df	Ss	Ms	Fcal	Ftab
Total	89	155,555.556			
Replication	4	3333.333	833.33	0.66ns	2.87
A	5	30,222.223	6,044.444	4.22*	2.71
Error (a)	20	28,666.667	1433.33		
B	2	9,555.556	4,777.78	6.37*	3.19
AB	10	47,777.777	4,777.78	6.37*	2.03
Error (b)	48	36,000	750		

Table 5: ANOVA for mean germination time of the effect of periods hydro-priming and seed weights on the germination of *V. doniana* seeds

Source	Df	Ss	Ms	Fcal	Ftab
Total	89	46, 940			
Replication	4	1,237.222	309.31	0.53ns	2.87
A	5	8, 756.667	1751.33	2.99*	2.71
Error (a)	20	11,696.778	584.84		
B	2	14, 486.667	7,243.33	36.69*	3.19
AB	10	1,776.667	177.67	0.95ns	2.03
Error (b)	48	8986	187.21		

DISCUSSION

It can be inferred that germination percentage increase with increasing periods of soaking of *V.doniana* seeds in water. Similar observation has been reported by Adelani (2015) and Adelani *et al.* (2018b). Akinola *et al*. (2000) reported that higher duration of exposure to seed treatment resulted in higher cumulative germination in wild sunflower. Positive effect of seed priming on seed invigoration depends on priming duration (Ashraf and Foolad, 2005). Kaya *et al.* (2006) working on germination of sunflower under drought and salt stress reported that hydro-priming improved both rate of germination and mean germination time both under salt and drought stress conditions.

Average seed weight gave highest germination percentage. The better germination exhibited by the heavier seeds could be the result of greater availability of food reserves (Offiong, 2008). Various investigators such as Kolodziejek (2017) and Khan and Shankar (2001) have adduced the highest germination percentage recorded in heavier or heaviest seeds to the presence of more food reserves compare to other weight investigated. Similar observation has been made by Khan (2004). Missanjo *et al.* (2013) stated that larger seeds resulted in higher germination percentage since larger seeds contain more food reserves to support germination.This is in consonance with the reports of Khan *et al.* (2002)., Mosseler *et al.* (2000)., Gholami *et al*.(2009)., Olorunmaiye *et al.* (2010) and Hojjat, (2011). Similar observations have been made by Khurana and Singh (2004), Mwase and Mvula (2011)., Chidumayo (2007). Esen *et al.* (2007) stated that higher performance of larger seeds could be a reflection of the greater amount of nutrients available to the embryo.

A significant germination percentage recorded in seeds hydro-primed for highest periods of time investigated. This shows that water uptake rate in hydro-priming period is slow and seeds had enough time to complete the pre-germination process. Similar observations have been reported by Schmidt (2000)., Varier *et al.(*2010) and Adelani *et al.* (2013). The zero germination percentage recorded for an untreated seed (control) shows that hydro-priming enhances the germination of *V.doinana* seeds. The ability of hydro-priming to enhance seeds germination could be traced to stimulatory effects which emanates from three stages of uptake of water which are the rapid initial uptake due to the seed low water potential and proteins synthesized as well as mitochondria repair, initiation of physiological activities as synthesis of protein by translation of new mRNAs and synthesis of new mitochondria and the completion of process of germination with radicle emergence. Similar observations have been reported by Varier *et al.* (2010). The afore-mentioned reports are in consonance with that of McDonald (2000); Jowkar *et al.* (2012) and Wattanakulpakin *et al.* (2012).

Hydro-priming is beneficial to seed and seedlings by enhances germination as well as seedling growth. Beneficial effects of hydro-priming on grain yield were reported in maize (Murungu *et al.*, 2004), sunflower (Hussain *et al.*, 2006), chickpea (Ghassemi-Golezani *et al.*, 2008; Zarei *et al.*, 2011) and pinto bean (Ghassemi-Golezani *et al.*, 2010). Average seed weight gave higest germination percentage. This statement is corroborated by the reports of Adelani *et al.* (2018b). One can deduce that average seed size coat was not affected by low or high damaging effect of periods of soaking the seeds in water during hydro-priming. Least mean germination time reported in average and a large seed is an indication that large and average weight seeds germinates early than small seeds. Similar observation has been reported by Adelani *et al.* (2018b). The reason for earlier germination of average and largest seed weight could be traced to the fact that heavier seed weight contains greater amount of food reserves to influence germination most compare to others.

CONCLUSION

Investigation conducted into effect of periods of hydro-priming and different seed weights on the germination of *V.doniana* revealed that highest germination was recorded in seeds soaked in water for 36hours. The result of interactive effect of periods of hydro-priming and seed weights revealed that average weight seeds soaked in water for 36 hours gave highest germination percentage. A hydro-priming of *V.doniana* seeds for 36 hours is recommended for mass production of its seedlings for agroforestry systems. Least mean germination time was recorded in average and largest seeds. Seedlings of high vigour were obtained by selecting the best seed weight and adopting the appropriate pre-sowing treatments to break dormancy of the seeds of indigenous priority species for biodiversity conservation. Breaking the dormancy of the appropriate seed weight will enhance robust germplasm conservation programmes. In the long run, the accessibility of Nigerians to the ample benefits of the high physiological quality tree species will be increased.

REFERENCES

Abubakar, Z.A and Muhammad, A. (2013). Breaking seed dormancy in tamarind (*Tamarindus indica*). A case study of Gombe Local Government Area. *Journal of Applied Sciences and Environmental Management*, 17(1): 83-87.

Adelani, D.O., Oyekola, A.A and Suleiman, R.A. (2013). Effects of some pre-treatments on the germination of tamarind (*Tamarindus indica* L) seeds. *Forests and Forest Products Journal* 6: 18-24.

Adelani, D.O and Joseph, A. (2014). Storability of Japanese Acacia (*Acacia auriculiformis* A. Cunn. Ex Benth) in northern guinea savanna ecological zone of Nigeria. *Forests and Forest Product Journal* 7:1-10.

Adelani, D.O., Adedire, M.O., Aduradola, M.A and Suleiman, R.A. (2014a). Enhancing seed and seedling growth of forest trees. *Biological and Environmental Sciences Journal for the Tropics 11*(1):50-56.

Adelani, D.O; Akande, M.T and Samaila, Z (2014b). Effectof hydro-priming and potassium nitrate concentrations on the germination of *Balanites aegyptiaca*. *Horticulture for a Healthy and Wealthy Nation. In:* Olsantan, F.O., Aiyelaagbe, I.O.O., Olubode, O.O., Makinde, E.A and Bodunde, J.G. (Eds). Proceedings of *32nd Annual Conference of Horticultural Society of Nigeria* (HORTSON).Pp62-65.

Adelani, D.O. (2015). Effect of hydro-priming and potassium nitrate priming on the germination of *Balanites aegyptiaca* L. *Applied Tropical Agriculture* 20 (2): 17-23.

Adelani, D.O., Aduradola, M.A., Akande, M.T and Bamikole, J.A. (2018a). Germination of *Chrysophyllum albidum* seeds in response to seed weights and temperatures. *Horticulture For improved livelihoods*. In: Aiyelaagbe, I.O.O., Adeoye, I.B and Akintoye, H.A (eds). *Proceedings of III All Africa Horticultural Congress*. PP 275-279.

Adelani, D.O., Amos, S.O and Ojo, O.S. (2018b). Effect of some pre-germination treatments and seed weights on the germination of *Zizyphus mauritiana* Lam seeds. *Journal of Sustainable Environmental Management* 10: 218-234.

Aduradola, A.M., Adeola, B. F and Adedire, M.O. (2005). Enhancing germination in seeds of African Star Apple, *Chrysophyllum albidum* (G. Don). *Journal of Food, Agriculture and Environment* 3(2):292-294.

Aliero, B.L. (2004). Effect of sulphuric acid, mechanical scarification and wet heat treatments on germination of seeds of African locust bean tree, *Parkia biglobosa*. *African Journal of Biotechnology* 3(3): 179-181.

Ahoton, L. E., Adjakpa, J. B., Gouda, M., Daînou, O and Akpo, E. (2011). Effet des traite ments de semences du prunier des savanes (*Vitex doniana* Sweet) sur la regeneration et la croissance des plantules. *Annales des Sciences Agronomiques*, 15: 21-35.

.Ajiboye, A.A. (2010). Dormancy and seed germination of *Tamarindus indica* (L). *The Pacific Journal of Science and Technology*, 11 (2): 463-470.

Akinola, J.O., Larbi A., Farinu G.O. and Odunsi, A.A**. (**2000). Seed treatment methods and duration effects on germination of wild sunflower. *Experimental Agriculture,* 36: 63-69.

Arbonnier, M.(2002). Arbres arbustes et lianes deszones sèches d'Afrique de l'Ouest, CIRAD-MNHN, Montpellier, France. pp573.

Arbonnier, M. (2004). Trees, shrubs and lianas of West African dry zones. France: Editions Quae. pp573.

Ashraf, M and Foolad M .R (2005). Presowing seed germination. A shot gun approach to improve germination growth and crop yields under saline and none-saline conditions. *Advances in Agronomy* 88:223-267.

Baskin, J. M and Baskin, C.C. (2003). New approaches to the study of the evolution of physical and physiological dormancy, the two most common classes of seed dormancy on earth. In *The Biology of Seeds: Recent Research Advances: Proceedings of the Seventh International Workshop on Seeds*, (eds. Nicolás, G., Bradford,K. J., Côme, D and. Pritchard, H.W), pp. 371-380, CAB International

Baskin, J.M and Baskin, C.C. (2004). A classification system for seed dormancy. *Seed Science Research*, 14: 1-16.

Burkill, H.M. (2000). *The Useful Plants of West Tropical Africa*, second ed., Volume 5, Families S–Z, Addenda. Royal Botanic Gardens, Kew, Richmond, United Kingdom. pp 686.

Chidumayo, E. N. (2007). Growth responses of an African savanna tree, *Bauhinia thonningii* Schumacher, to defoliation, fire and climate. *Trees*, 21 (2): 231–238.

Dadjo, C., Assogbadjo, A. E., Fandohan, B., Kakaï R.G., Chakeredza, S., Houehanou, T. D., Damme, P. V and Sinsin, B. (2012). Uses and management of black plum (*Vitex doniana* Sweet) in Southern Benin. *Fruits* 67(4): 239-248. http://dx.doi.org/10.1051/fruits/2012017

Dastanpoor, N; Fahimi, H; Shariati, M; Davazdahemami, S and Hashemi, S. M. M. (2013). Effects of hydro priming on seed germination and seedling growth in sage (*Salvia officinalis* L.). *African Journal of Biotechnology 12* (11): 1223-1228.

Dewir, Y. H., El-Mahrouk, M. E and Naidoo, Y. (2011). Effect of some mechanical and chemical treatments on seed germination of *Sabal palmetto* and *Thrinax morrisii* palms. *Australian Journal of Crop Science* 5(3): 248-253.

Esen, D., Yildiz, O., Sarginci, M and Isik, K. (2007). Effects of different pretreatments on germination of *Prunus serotina* seed sources. *Journal of Environmental Biology*, 28 (1):99–104.

Farooq, M., Basra, S. M. A., Hafeez, K and Ahmad,N. (2005). Thermal hardening: a new seed vigour enhancement tool in rice. Journal *of Integrative Plant Biology*, 47:187-193.

Farooq, M., Basra, S. M. A., Afzal, I and Khaliq, A. (2006). Optimization of hydropriming techniques for rice seed invigoration. *Seed Science Technology*,34: 507-512.

Food and Agricultural Organization, FAO. (2000). Global Forest Resources Assessment. *FAO Rome Pape*r 140-479.

Food and Agricultural Organization, FAO. (2004). *Preliminary results from the project: Lessons Learnt on Sustainable Forest Management in Africa* pp3-4.

Ghassemi-Golezani, K., Sheikhzadeh-Mosaddegh, P and Valizadeh, M. (2008). Effects of hydro-priming duration and limited irrigation on field performance of chickpea. *Research Journal* of *Seed Science*, 1:34-40.

Ghassemi-Golezani, K., Chadordooz-Jeddi, A., Nasrollahzadeh, S and Moghaddam, M. (2010). Effects of hydro-priming duration on seedling vigour and grain yield of pinto bean (*Phaseolus vulgaris* L.) Cultivars.*Notulae Botanicae Horti Agrobotanici* Cluj-Napoca, 38(1):109-113.

Gehlot, M and Kasera, P. K . (2012). Improvement of seed germination behavior in *Phyllanthus amarus* by acid and mechanical scarification pretreatments. *Ecoprint*, 19: 1-5.

Gholami, A., Sharafi, S., Sharafi, A and Ghasemi, S. (2009). Germination of different seed size of pinto bean cultivars as affected by salinity and drought stress. *Journal of Food, Agriculture and Environment*, 7(2): 555-558.

Hojjat, S.S. (2011). Effect of seed size on the germination and seedling growth of some genotypes (*Lens culinairs* Medik). *International Journal of Agriculture and CropScience*, 3(1): 1-5

Hounkpèvi, A., Kouassi, E. K and Kakaï, R. G. (2018). Effects of climatic variability and local environment patterns on the ecology and population structure of the multipurpose plant species, *Vitex doniana* Sweet (Lamiaceae) in Benin. *Tropical Ecology* 59(1): 129–143.

Hussain, M., Farooq, M., Basra, S. M. A and Ahmad, N. (2006). Influence of seed priming techniques on the seedling establishment, yield and quality of hybrid sunflower. *International Journal of Agriculture and Biology* 8(1):14-18.

Iwueke, A. V., Nwodo, O. F. C and Okoli, C. O. (2006). Evaluation of the anti inflammatory and analgesic activities of *Vitex doniana* leaves. *African Journal of Biotechnology* 5: 1929–1935.

Jowkar, M., Ghanbari, A., Moradi, F and Heidari, M. (2012). Alterations in seed vigor and antioxidant enzymes activities in *Silybum marianum* underseed priming with KNO_3. *Journal of Medicinal Plant Research*, 6(7):1176-1180.

Kambizi, L., Adebola, P.O and Afolayan, A. J. (2006). Effects of temperature, pre-chilling andlight on seed germination of *Withania somnifera*. A high value medicinal plant. *SouthAfrican Journal of Botany*, 72: 11-14.

Kaya, M.D; Okcu , G; Atak, M; Cikili, Y and Kolsarici, O.(2006). Seed treatments to overcome salt and drought stress during germination in sunflower (*Helianthus annuus* L). *European Journal of Agronomy* 24:291-295

Kilani, A. M. (2006). Antibacterial assessment of whole stem bark of *Vitex doniana* against some enterobactriaceae. *African Journal of Biotechnology* 5: 958–959.

Khan, M. L. and Shankar, U. (2001). Effect of seed weight, light regime, and substratum microsite on germination and seedling growth of *Quercus semiserrata* Roxb. *TropicalEcology*, 42: 117-125.

Khan, M.L., Bhuyan, P., Singh, N.D and Todaria, N.P. (2002). Fruit set, seed germination and seedling growth of *Mesua ferrea* Linn. (Clusiaceae) in relation to light intensity. *Journal of Tropical Forest Science*, 14: 35–48.

Khan, M.L. (2004). Effects of seed mass on seedling success in *Artocarpus heterophyllus* L., a tropical tree species of north-east India. *Acta Oecologica*, 25: 103–110

Khurana, E and Singh, J. S. (2004). Germination and seedling growth of five tree species from tropical dry forest in relation to water stress: impact of seed size. *Journal of Tropical Ecology*, 20 (4): 385–396.

Kolodziejek, J. (2017). Effect of seed position and soil nutrients on seed mass germination and seedling growth in *Pencedanum oreoselinum* (Apiaceae). *Scientific Reports*, 7: 1959-1969.

Ky, K.J.M. (2008). *Vitex doniana* Sweet, in: Louppe, D., Oteng-Amoako,A.A., Brink, M. (Eds.), Prota 7(1): *Timbers/Bois d'oeuvre 1. BacqkhuysPublishers,Leiden,/CTA,Wageningen, PROTA Foundation,Wageningen, Pays Bas*, pp. 578–581.

Ladeji, O., Udoh, F.V and Okoye, Z.(2005). Activity of aqueous extract of the bark of *Vitex doniana* on uterine muscle response to drugs. *Phytotherapy Research* 19:804-806.

Li, Z., Lu, W.,Yang, L., Kong, X and Deng, X. (2015). Seed weight and germination behaviour of the submerged plant *Potamogeton pectinatus* in the arid zone of North West China. *Ecology and Evolution*, 5(7):1504–1512.

Louppe, D., Oteng-Amoako, A. A and Brink, M. (eds.). (2008). Ressources Végétales de l'Afrique Tropicale 7(1). Bois d'œuvre 1 (*Plants Ressources of Tropical Africa* 7(1). Timbers 1.) Fondation PROTA, Wageningen/ Backhuys Publishers, Leiden.pp 101.

Malcom, P.J., Holford,P., Mcglasson, W.B and Newman, S. (2003). Temperature and seed weight affect the germination of peach root stock seeds and the growth of root stock seedlings. *Scientia Horticulturae*, 98:247-256

Mapongmetsem, P.M., Benguellah, M. B., Nkongmeneck, B. A., Ngassoum, M. B., Gübbük, H., Baye–Niwah, C and Longmou, J. (2005). Litterfall, decomposition and nutrients release in *Vitex doniana* Sweet and *Vitex madiensis* Oliv. in the Sudano–Guinea savannah. *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi*, 18: 63-75.

Mapongmetsem, P.M. (2006). Domestication of *Vitex madiensis* in the Adamawa highlands of Cameroon phenology and propagation. *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi*, 19: 269-278.

Maundu, P.,Achigan-Dako, E.G and Morimoto, Y.(2009). *Biodiversity of African vegetables*, in: Shackleton, C.M., Pasquini M.W., Drescher A.W. (Eds.*)*, African Indigenous Vegetables in Urban Agriculture, Earthscan, London, UK. 65– 104.

McDonald, M. B. (2000). Seed priming. In Black, M and Bewley, J. D (eds.), *Seed Technology and its Biological Basis*. Sheffield Academic PressLtd., Sheffield, England, pp. 287-325.

Missanjo,E., Maya, C., Kapira, D., Banda,H and Kamanga-Thole, G. (2013). Effect of seed size and pretreatment methods on germination of *Albizia lebbeck*. *ISRN Botany*, 2013: 1-4.

Mosseler, A., Major, J.E., Simpson, D and. Rajora. O.M.P.(2000). Indicators of population viability in red spruce, *Picea rubens.* I: reproductive traits and fecundity. *Canadian Journal of Botany,* 78 (7): 928–940.

Murungu, F. S., Chiduza, C., Nyamugafata, P., Clark, L. J., Whalley, W. R and Finch-Savage, W. E (2004). Effects of "on-farm seed priming" onconsecutive daily sowing occasions on the emergence and growth of maize in semi-arid Zimbabwe. *Field Crops Research*, 89:49-57

Mwase, W. F and Mvula,T. (2011). Effect of seed size and pre-treatment methods of *Bauhinia thonningii* Schum. on germination and seedling growth. *African Journal of Biotechnology*, 10 (26): 5143–5148.

N' Danikou, S., Achigan-Dako, E.G., Tchokponhoué, D.A., Assogba Komlan, F., Gebauer, J., Vodouhè, R. S and Ahanchédé, A. (2014). Enhancing germination and seedling growth in *Vitex doniana* sweet for horticultural prospects and conservation of genetic resources. *Fruits*, 69: 279-291.

N'Danikou, S., Achigan-Dako, E.G., Tchokponhoué, D.A., Assogba Komlan, F., Vodouhè, R.S and Ahanchédé, A. (2015). Improving seedling production for *Vitex doniana*. *Seed Science and Technology*,43: 10-19.

Oboho, E. G, (2014). *Silviculture for Beginners.* Uniben Press, University of Benin, Ekehuan Campus, Benin City, 263 pp.

Oboho, E. G. and Igharo, B.(2017). Effect of pre-germination treatments on germination and watering regimes on the early growth of *Pycnanthus angolensis* (Welw) Warb. *Journal of Agriculture and Veterinary Science,* 10 (3): 62-68.

Offiong, M.O. (2008). *Variation in Growth and Physiological Characteristic of Xylopia aethopica* (DUNAL). A Rich from Akwa Ibom and Cross River States. *Ph.D Thesis*. Department of Forest Resources Management. University of Ibadan, Ibadan, pp 255.

Okunlola, O. A and Akinyele, A.O. (2017). *Vitex donian*: An important indigenous fruit species that is underutilized. *Harnessing the Uniqueness of Forests for Sustainable Development in a Diversifying Economy*. In: Adekunle, V.A.J., Ogunsanwo, O.Y and Akinwole, A.O. (Eds). *Proceedings of the 39th Annual Conference of the Forestry Association of Nigeria*. 627-633.

Olajide, O. (2003). Steps towards sustainable natural forest management for non-timber Forest products in Nigeria. Akindele, S.O and Popoola, L (eds).*Proceedings of the 39th Annual Conference of the Forestry Association of Nigeria*.6th-11th 2003, Cross River State, Nigeria pp 303-308.

Olorunmaiye, K.S., Olorunmaiye, P. M and Fatoba, P. O. (2010). The Effects of planting orientation and seed attributes on germination and seedling development of *Daniellia oliveri* (Rolf). Hutch and Dalz. *The Biological and Environmental Sciences Journal forthe Tropics*, 7 (2): 146-150.

Orwa, C., Mutual, A., Kinat, R., Jamnadass, R and Antony, S. (2009). Agroforestry Database, a tree reference and selection guide version 4.0 (http://www.agroforestry.org/sites/treadbs/ freeedatabases.asp)

Osugiri , I.I., Albert, I.U., Onyagnocha, S.U.O., Onyemanwa, C.S and Ben-Chendo, G.N. (2012). Population dynamics, labour and small holder farmers' productivity in Southeast, Nigeria. *Journal of Economics and Sustainable Development*, 3(12): 95-101.

Otegbeye, G.O., Owonubi, J. J and Oviasauyi, P.K. (2001). Interspecific variation growth of Eucalyptus growing in northern Nigeria. In: Popoola, L, Abu J.E and Oni, P.I (Eds). *Proceedings of 27th Annual Conference of the Forestry Association of Nigeria*, pp 12 –16.

Padmalatha, K., Jayaram K., Raju N. L., Prasad, M.N.V and Arora, R.(2009). Ethno pharma cological and biotechnological significance of Vitex. *Bioremediation, Biodiversity and Bioavailability,* 3: 6-14.

Pérez- García, F., Huertas, M., Mora, E., Peña, B., Varela,F and González, M.E. (2006). *Hypericum perforatum* L. seed germination: interpopulation variation and effect of light, temperature, pre-sowing treatments and seed dessication.*Genetic Resources and Crop Evolution*, 53: 1187-1198.

Ranal, M. A and Santana, D. G. (2006). How and why to measure the germination process? *Revista Brasileira* de Botânica, 29(1):1-11.

Sale, F.A and Olujobi, O.J. (2014). Influence of agroforestry practices on land reclamation for forest resources management in Nigeria. In: Ogunsanwo, O.Y., Akinwole, A.O., Azeez, I.O., V. A. J. Adekunle and N.A. Adewole (Eds). *Proceedings of the 37th Annual Conference of the Forestry Association of Nigeria*. Pp 195-201.

SAS,**(**2003). Statistical Analysis System. SAS release 9.1 for windows, SAS Institute Inc.cary,NC, USA

Schelin, M., Tigabu, M., Eriksson, I and Sawadogo, L.(2003). Effect of scarification, gibberellic acid anddry heat treatments on the germination of *Balanties aegyptica* seeds from the Sudanian savanna in BurkinaFaso. *Seed Science and Technology*, 31:605-617

Schmidt, L.(2000). *Guide to Handling Tropical and Subtropical Forest Seed*. *Danida Forest Seed Center*, Krogerupvej 21, Humleback, Denmark, pp 511

Silveira, F. A.O. (2013). Sowing seeds for the future: the need for establishing protocols for the study of seed dormancy. *Acta Botanica Brasilica*, 27: 264-269.

Soltani, E., Ghaderi-Far, F. Baskin, C.C and Baskin, J.M. (2015). Problems with using mean germination time to calculate rate of seed germination. *Australian Journal* of Botany, 63: 631-635

Srivastava, A. K., Lokhande, V. H., Patade, V.Y., Suprasanna, P., Sjahril, R and D'Souza, S. F (2010). Comparative evaluation of hydro- chemo- and hormonal priming methods for imparting salt and PEG stress tolerance in Indian mustard (*Brassica juncea* L.). *Acta Physiologiae Plantarum,* 32:1135-1144.

Varier, A., Vari, A. K and Dadlani, M. (2010). The subcellular basis of seed priming. *Current Science*,99 (4):450-456.

Wattanakulpakin, P., Photchanachai, S., Ratanakhanokchai, K., Kyu, K. L.,Ritthichai, P and Miyagawa, S. (2012). Hydropriming effects on carbohydrate metabolism, antioxidant enzyme activity and seed vigorof maize (*Zea mays* L.). *African Journal of Biotechnology,* 11(15):3537-3547.

Zarei, I., Mohammadi, G., Sohrabi, Y., Kahrizi, D., Khah, E. M. and Yari, K. (2011). Effect of different hydropriming times on the quantitative and qualitative characteristics of chickpea (*Cicer arietinum* L.*). African Journal of Biotechnology*, 10(66):14844-14850.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ugege and Ajewole , 2019

EVALUATING THE RECREATIONAL VALUE OF AGODI GARDENS AND PARK IBADAN, OYO STATE, NIGERIA

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ABSTRACT

The study was carried out to evaluate the recreational value of Agodi garden and park so as to bring its importance to limelight and promote its relevance. Primary data needed for the study were collected through the administration of questionnaires to visitors in the park. Eighty questionnaires were administered to the respondents and seventy eight were used for analysis. Travel cost method and regression analysis were used to analyze the data. The result showed the individual consumer surplus to be ₦29.41k and the annual use value to be ₦955,857.50 (Nine hundred and fifty five thousand, eight hundred fifty seven naira fifty kobo); this shows that the Park is undervalued by the visitors. This could be possibly attributed to low patronage and also due to the fact that some of them have other recreational sites which they attach more value to. It also reveals that nature friendly environment is one of the major factors that influenced the respondents visit to the park. . Also the regression analysis showed that only the coefficients of travel cost and household size were statistically significant. Therefore prominent among the factors that influenced visitors' visits to the Park are travel costs and household size.

Keyword: Evaluating, recreational value, green park, gardens

INTRODUCTION

Good quality of life depends not only on a strong economy but also on a healthy natural environment. Contact with the natural world improves physical and psychological health, strengthens our communities, and makes our cities and neighborhoods more attractive places to live and work. **(**Ashish, 2014). Industrial growth and population expansion in cities have led to construction of buildings in which clean air and space of leisure are have been neglected. Nevertheless, for some reason, since the advent of the 20th century, urban man has paid attention back to nature and green areas in form of creating practical gardens rather than amusement gardens to respond to new needs of citizens (Moureh 1994). The major functions of urban green spaces is to provide a leisure environment that can improve social interactions physical and psychological health of communities through creating direct contacts between people and nature in other to promote pleasant lifestyle of city dwellers. According to Bijanzad,(1990) green spaces have social and psychological effects on creating a quasi-natural ecosystem for man within the city Many of the goods and services provided by the environment are important but not always quantifiable in monetary terms neither is there any effective mechanism for valuing them. They are not traded in the market place and so do not have an obvious price or commercial value. These goods can be viewed from two perspectives, social and environmental. The social consists of that part of the forests environment that provides such services as outdoor recreation, game viewing and space for spiritual activities. While the environmental focus primarily on the provision of life support requirement for human beings such as enhancement of watershed management, mitigation of global warming, reduction in air pollution etc. This forest services are often referred to as public goods and services. Valuing services such as Recreation Park can be quite difficult, because markets and prices for such ecosystem services do not exist. Economists make use of other approaches such as stated preference approach and revealed preference approach. Stated preference approaches are survey based involving the use of questionnaire. As a result a market and demand for eco-system services is simulated revealing Willingness to Pay (WTP) or Willingness to Accept (WTA) for hypothetical changes in the provision of ecosystem services (TEEB, 2010). The challenge with the use of this approach is that they are theoretically based and could involve some degree of bias. This approach includes contingent valuation method and choice modeling. Revealed preference method quantify the influence of preference for non- market goods or services on the actual market for other goods (Pearce *et.al.*, 2006) it can also be described as inferring an individual demand for private good to demand for public goods. Travel cost and hedonic prices are the two different method of this approach. Hedonic pricing method attempts to isolate the influence of non-market attributes (like proximity to parks or landfills) on the price of goods (such as houses) While Travel cost involve calculating the visitation rate, distance traveled, converting travel time to monetary values and computing the travel cost for each user. It simply means using recreation expenditure and travel time to impute the value people place on visiting a specific site (TEEB, 2010). Travel cost methods are widely used and generally accepted by most economists and policy analysts (Melstrom, 2013).

Travel Cost Method (TCM): TCM is one of the techniques used to estimate the value of recreational sites using consumption behavior in related markets. TCM simple model is usually estimated as a trip generating. A demand curve is produced by the TCM relating individual annual visits. Integrating under this curve gave us the consumer surplus (CS) per individual. Multiplying the CS by the number of individuals visiting the site annually helps to estimate the consumer surplus for the recreational site. (Koutsayannies, 1979) defines consumer surplus as the difference between the amount of money that a consumer actually pays to buy a certain quantity of a commodity and the amount he would be willing to pay for the commodity rather than do without it. This in effect implies subtracting what consumers pay from the maximum they would be willing to pay. The study was to examine the perception and recreational value of Agodi garden and park Ibadan,Oyo state Nigeria.

MATERIAL AND METHODS

Study Area

Ibadan the capital of Oyo state is located in southern western Nigeria .There are eleven (11) Local governments in Ibadan metropolitan area consisting of five urban local government in the city and six semi urban local governments in the less city .The urban local government comprises of Ibadan North, Ibadan North East, Ibadan North West, Ibadan South West, Ibadan South East. The Ibadan semi urban comprises of Akinyele, Egbeda, Ido , Lagelu , Ona Ara, and Oluyole. The garden is in Ibadan North Local Government area. Ibadan has a population of about 3.2 million from the 2011 National population census. Ibadan is located on longitude 3^0 53’47” E and latitude 7^0 23’16” N with total area of 3080km^2 .The city ranges in elevation from 150m in the valley area to 275m above sea level on the major north south ridge. Ibadan has a tropical wet and dry climate with lengthy wet season and relatively constant temperature throughout the course of the year. Ibadan wet season runs from march through October. The mean total rainfall is 1420.06mm approximately 109 days. The mean maximum temperature is 26.46c, minimum 21.42c and the relative humidity is 74.55%. Agodi garden is situated near the Oyo state secretariat complex. It stands out as a green lung in the surrounding urban landscape with a great recreational potential. The garden was established as a biological and relaxation centre to provide recreational as well as educational services for inhabitant and visitor in 1967. It lost it glory as a foremost centre particularly following its destruction by the famous 1980 flood disaster dubbed Omiyale that swept through the ancient city. The Agodi garden of Oyo state has been completely renovated to contain a zoo, swimming pool, bar and restaurants (Wikipedia 2014). It equally contains an indigenous forest, lake, tree plantation, and an abundant of medicinal plants and some rare tree species.

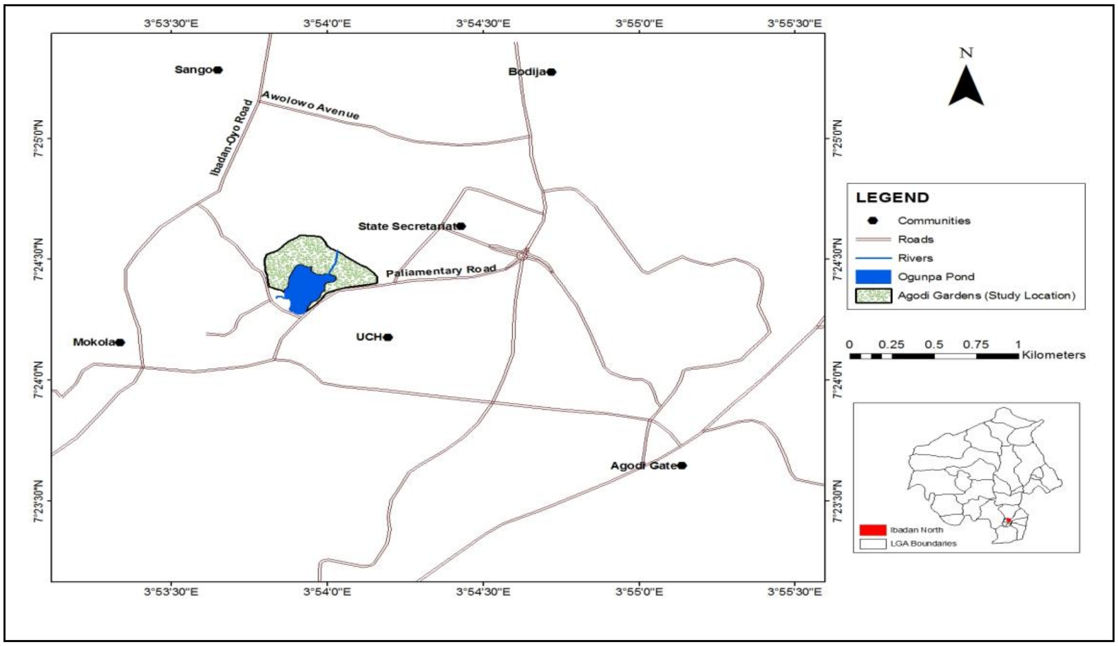

Figure 1: Map of Agodi showing garden and park

Data Collection

In the course of this study, primary and secondary data were used for collection. The primary data was collected with the use of interview schedule and structured questionnaires. Seventy-eight questionnaires were used to elicit information on the socio- economic characteristics. The secondary data were obtained from journals, periodicals and conference materials.

Data Analysis

Data collected for the study were analyzed using Descriptive statistics such as frequency distribution to examine the demographic characteristics of the respondents. Likert scale was used to examine respondent perception on the factors that influenced visitors' visit while Travel cost method (TCM) was used to measure the used value by generating a travel cost simple model and this is estimated as a trip generating function to get the total consumer surplus.

Vij = f (Cij, Xi) ……………… (1)

Where

Vij: Number of visits made per year by the individual i to recreation site j;

Cij: visit cost by the individual i to recreation site j;

Xi: all other socio-economic variables determining individual visits.

Total consumer surplus = $N_J \int f \{C_{i\,j} X_i\}.Vij$ ------------------------(2)

Where

N_{ij} is the number of individual visits to recreational site per year

C_{IJ} is the visits cost by individual i to recreation site j

X_i is other socio-economic variable determining individual visits.

Creel and loomis (1990) was used to derive the per trip consumer surplus

Where

Consumer surplus = -1/bc

bc =the coefficient of the travel cost function

RESULTS

Table 1 shows that majority of the respondents are female (41%).This may be due to the fact that female like outing and excitement. In this sample size it was also observed that (40%) were married and (38%) were single. This is in relation with the theory that people with kids are happier and have a sense of responsibility. High percentage of the respondent have formal education, this result is similar to that of (Luke and Amujo, 2011) that higher educational attainment tends to increase the awareness and relevance of recreational park.

(39.8%) of the visitors to the site are business men and women. This may be due the fact that their nature of job is not stereotype. It also revealed that the two middle age classes (31-50) have the highest visitors. This could be due to that they are in their active age. This result similar to the result of (Limaei *et.al,* 2014) which stated that recreational site is more attractive to these age classes.

Table 1: Demographic characteristic of respondent (visitors to the park)

Variable	Frequency	Percentages
Gender		
Male	37	(47.4)
Female	4	1(52.6)
Total	**78**	**(100)**
Educational Qualification	-	
Secondary	8	10.25
HND/B.Sc	36	46.15
Postgraduate	34	43.59
Total	**78**	**100**
Marital Status		
Single	38	48.72
Married	40	51.28
Total	**78**	**100**
Age		
13-20	9	11.54
21-30	22	22.80
31-40	27	34.66
41-50	15	19.23
51-60	5	6.41
Total	**78**	**100**
Occupation		
Government worker	19	24.42
Private Organization	14	17.94
Self employed	14	17.94
Other(business)	31	39.80
Total	**78**	**100**

The result in Table 2 revealed the perception of the factors that influences visitors visit to the park. Looking at the highest and lowest percentage respondents, the following can be deduced from the table. (33.3%) consider proximity as one of the factors that influences their visit to the park with (7.7%) (not at all) meaning proximity does not define their visit. 46% (well) consider service rendered as one of the factors that influences their visit with 2.6% (not at all). 39.7% (well) sees facilities in the site as one of the factor that influences their visit with 6.4% (don't know). 43.6 % (well) consider accessibility as one of the factor that influences their visit, with 1.3% (not at all). Majority of the respondents (60%) see nature friendly environment as a factor that influences their visit with 1.3% (not at all). 44.9% (well) consider cost of transportation as one of the factor that influences their visit with 7.7% (not at all). 34.6% (very well) consider health benefit as one of the factor that influences their visit with 2.6% (not at all). 52.6% (very well) consider relaxation as one of the factor that influences their visit with 1.3% (not at all). 50.6% (very well) consider fun and entertainment as one of the factor that influences their visit with 2.6% (don't know). From the result it was observed that majority of the respondent appreciate green environment

Table 2: Respondents perception on factors that influence their visits to the park (visitor)

Variable	Very well		Well		Don't know		Not at all	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Proximity	23	(29.5)	26	(33.3)	10	(12.8)	6	(7.7)
Services rendered	20	(25.6)	36	(46.2)	10	(12.8)	2	(2.6)
Facilities in the site	26	(33.6)	31	(39.7)	5	(6.4)	8	(10.8)
Accessibility	29	(37.2)	34	(43.6)	4	(5.1)	1	(1.3)
Nature friendly environment	47	(60.3)	26	(33.3)	1	(1.3)	1	(1.3)
Cost of transportation	17	(21.8)	35	(44.9)	8	(10.8)	6	(7.7)
Health benefit	27	(34.6)	23	(29.5)	15	(19.2)	2	(2.6)
Improvement in quality of air	26	(33.3)	30	(38.5)	6	(7.7)	2	(2.6)
Affordability	11	(14.1)	41	(52.6)	2	(2.6)	5	(6.4)
Learning and education	16	(20.5)	32	(41.0)	9	(11.5)	4	(5.1)
Relaxation	41	(52.6)	32	(41.0)	4	(5.1)	1	(1.3)
Fun and entertainment	39	(50.0)	27	(34.6)	2	(2.6)	3	(3.8)

Values in parenthesis are percentages

Table 3: Estimation of travel cost and determinant of factors that influence visit to the park.

Variable	Coefficient estimate	t	sig
(Constant)		2.140	.040
Age of visitor	.049	.406	.687
Monthly income	.110	.977	.336
Household size	-.348	-3.188	.003
Educational Qualification	.132	1.265	.215
Gender of visitor	-.027	-.250	.804
Marital Status of Visitor	-.078	-.616	.542
Visit to substitute site	.024	.234	.816
Total travel cost	-.632	-5.736	.000

However, the Park seems to be undervalued by the visitors. This could be possibly attributed to the fact that some of them have other recreational site which they attach more value to Park. Also from the regression results, only the coefficients of travel cost and household size were statistically significant. This implies that with increase in the travel cost to the Park, the number of visits made to the Park will reduce, and visitors with large family size are likely to spend a relatively larger proportion of their income on consumption of some other goods than recreational activities. Therefore prominent among the factors that influenced their visits to the Park are travel costs and household size.

CONCLUSION

The study has clearly shown that recreational park in Ibadan is highly esteemed with great multifarious potentials to meet both the social and economic needs of the teeming Ibadan metropolitan populace. It is obvious that most of the urban dwellers appreciate and cherish green environment. However, the Park seems to be undervalued by the visitors considering the consumer surplus This could possibly be attributed to low patronage and the fact that some of them have other recreational site which they attach more value to. It is therefore recommended that urgent and salient move to inculcate the impact of environmental consciousness and sustainable management of our natural resources use be undertaken by relevant authorities

REFERENCE

Ashish Batra (2014). Community Benefits of Green Areas and Parks

https://www.linkedin.com/pulse/20140922075014-150737338-architecture-and-urban-planning

Bijan Zadeh M (1990). Evaluation of Tehran Landscape, publication of the Office of Cultural Jihad University, Tehran.

Creel, M., and J.B. Loomis. 1990. "Theoretical and empirical advantages of truncated count data estimators for analysis of deer hunting in California." American Journal of Agricultural Economics 72:434-441.

Koutsyannies A (1979). Modern Microeconomics, 2nd ed. London: Macmillan.

Limaei S .M , Ghesmati H , Rashidi R andYamini N (2014) Economic evaluation of natural forest park using the travel cost method (case study; Masouleh forest park, north of Iran). *Journal of Forest Science*, 60, 2014 (6): 254–261

Luke O. Okojie1 and Amujo B. T.(2011) Socio-economic determinants of on-day site demand for recreation in old Oyo National Park, Nigeria. *Journal of Development and Agricultural Economics* 3(6); 230-235,

Melstrom, R. T. (2013). Valuing Historic Battlefields: An Application of the Travel Cost Method to Three American Civil War Battlefields. *Journal of Cultural Economics*, 38(3):223-236.

Pearce D.W, Markandya A, Barbier E,(2006). Blueprint for a green economy, Earthscan publications Ltd. London

Peier Moureh, J (1994). Urban Spaces – Design and Management, Translated by Rezaei. H and Interior Ministry.

TEEB 2010. The Economics of Ecosystems and Biodiversity for National and International Policy Makers

Wikipedia (2014). Ibadan. https://en.wikipedia.org/wiki/Ibadan. Accessed March 12 2018

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Jande et al., 2019

ASSESSMENT OF LAND USE AND LAND COVER CHANGES AND URBAN EXPANSION USING REMOTE SENSING AND GIS IN GBOKO, BENUE STATE, NIGERIA

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ABSTRACT

There has been a rapid growth of urban areas across the globe since 1950s with the majority of world population living in urban areas rather than rural areas, in search of better job opportunities and higher quality of services. This trend of transition from rural to urban is expected to continue to rise and government in developing countries are likely going to face more challenges in different sectors, necessitating the need of understanding the spatial pattern of the growth for effective urban planning. The objectives of this study were to map and determine the nature, extent and rate of land use and land cover changes, to analyze the spatio-temporal land use and land cover change patterns and assess urban expansion in Gboko Local Government Area of Benue State, Nigeria. The emphasis was on determining the extent and rate of urban expansion in the area. The study focused on a period of 30 years; from 1987 to 2017. Satellite imageries used included Landsat TM (1987); Landsat ETM+ (2007); and Operational Land Imager (OLI) (2017). The Landsat imagery dataset was sourced from the Earthexplorer platform from United States Geological Surveys (USGS), Global Land Cover Facility (GLCF) and GloVis. The three images of 1987, 2007 and 2017 were classified using maximum likelihood classifier in Idrisi Selva to detect the land cover changes. The study resulted in an overall classification accuracy of 80.77% ,85.84% and 86.24% for 1987, 2007 and 2017 respectively. The result of the classification revealed that between 1987 and 2017, urban area increased from 3232ha (1.68%) in 1987 to 8542ha (4.45%) in 2007 and rose up to 16614ha (8.65%) in 2017. Forest land on the other hand declined from 52108ha (27.13%) to 46523ha (24.23%) down to 16723ha (8.71%) in the same period. Grassland was the dominant land cover occupying 69074ha (35.97%) in 1987 increasing to 79874ha (41.59%) and 129715ha (67.54%) in 2007 and 2017 respectively. The overall trend (1987-2017) revealed that urban area has increased up to 13382ha (9.01%) at an annual rate as high as 2.7% higher than the rate in the first period. Forest declined throughout the period with a loss of 5585ha(12.57%) in the first period at the annual rate of -2.51% and 29800ha (25.7%) in the second period at the annual rate of -2.57%. The overall trend shows that forest lost 35385ha (23.82%) at the rate of -7.15%. Farmland also decreased during the period losing 16006ha (36.03%) in the first period at an annual rate of -7.21% and 22317ha (19.25%) in the second with an annual rate of change of -1.93%. This high rate is an indication that in no distant future the area may be completely devoid of forest vegetation. From the result, it is evident that the rate of urban growth will continue and would certainly threaten forest areas in Gboko LGA. Finally, this study provides a guide to planners for successive urban planning in exploring the rate and pattern of urban growth in Gboko LGA.

KEY WORDS: Urban growth; LULC change; Landsat TM; Landsat ETM+; and Operational Land Imager (OLI), spatio-temporal, maximum likelihood classifier, Idrisi Selva , Gboko.

INTRODUCTION

Human activities have continued to significantly shape the surface of the earth and the existence of man on the surface of the Earth and his activities on it has affected the environment in its natural setting greatly thereby leading to a noticeable pattern in the land use and land cover (LULC) dynamics over time. Increase in human population will hence have a greater influence on the surface of the earth. Over the years, it has been observed that urban areas are the most areas prone to changes on the surface of the Earth. Urban growth exert a lot of influence on the immediate ecosystem despite their regional economic importance(Yuan *et al*, 2005). In most cases, urban growth is experienced towards the boundary between urban and rural areas where the density of settlements is less. Over the past few years, there has been a lot of growth in urban areas the world over, and population increase is one of the key reasons responsible for this. By 2015, the population of the world reached 7.3 billion and out of this, 16% lives in Africa according to the United Nations (UN) (UN, 2015).

By the 21st century, urban population had reached landmark point with half of the world's population living in urban centres (Jiao, 2015). Due to rapid upsurge in the population of urban areas, policymakers, and planners are faced with the problem of resources planning and redistribution to deal the envisaged hitches that may crop up in the future in trying to achieve sustainability in the growth of urban cities. Nigeria's population growth is not very different from the global picture. Today, Nigeria's population is projected to be more than 170 million and there is the general desire for urban migration which will increase the burden on the available resources. The continued increase in population in urban areas has led to modification in the land use and land cover at the urban fringes. This is because; the urban population has to be supported by an increase in food production and urban infrastructure and this is usually achieved through an increase in urban housing and the expansion of area under cultivation.

Nigeria has been witnessing a rapid change of her residents from the hinterland to urban cities. This increased rate of urbanisation has undoubtedly stimulated numerous problems. (Ojo, *et al* , 2017) identified some of the problems facing urban areas and their inhabitants in Nigeria to include poverty, unemployment, spreading destitution and expansion of slums, growing insecurity and increasing crime wave, poor housing, services and amenities.

Gboko as the traditional home of the Tiv has witnessed tremendous growth over the years. This has given rise to a steady upsurge in urban population especially of the town. The key problem of the research is the astronomical expansion and growth of the town. This infers that the growth of the town will have a great effect on the landscape on the outskirts of the town by changing them. As a result, there is need for special care and constant evaluation of our decision-making to monitor and plan the growth of the area. With the increasing importance of urban area of Gboko town in driving changes in the environment, there is burning desire to know how the urban area of Gboko has evolved, and how to plan for the expansion in the future.

It is against this background that this research assessed land use and land cover changes and urban expansion using Remote Sensing and GIS in Gboko, Benue State, Nigeria. This will have the potential to assist communities in their decision-making processes on land use. Certainly, increase in population may give rise to the expansion of urban areas which causes alteration in LULC in many urban cities (Hashem and Balakrishnan, 2015; Mundhe and Jaybhaye, 2014; Opatoyinbo, et al, 2015; Triantakonstantis and Mountrakis, 2012). The rate of such change is apparent in less developed countries where the percentage of population increase is high like Nigeria, Benue State and Gboko LGA in particular. The need to monitor the growth of these urban areas and be able to predict future scenarios for proper planning is, therefore, very pertinent (Adewumi, 2013; Ohwo and Abotutu, 2015). These processes of urban growth are not static but dynamic with time with its attendant products. Information on the rate of urban expansion, effects of these activities and their trend is however lacking or scarce. This research was aimed at filling this gap. This study aimed at Assessing Land Use and Land Cover Changes and Urban Expansion using Remote Sensing and GIS in Gboko, Benue State, Nigeria.

MATERIALS AND METHODS

Study Area

Gboko is located between Latitude 7° 0′ and 7° 40′ North of the Equator and Longitude 8° 35′ and 9° 15′ East of the Greenwich Meridian. It is bounded by Tarka LGA to the north, Buruku to the east, Ushongo to the south and Gwer East and Vandeikya to the west. Gboko is a fastest-growing towns in the Benue State, Nigeria. The name Gboko also refers to a Local Government in Benue State. The population for the town is over 500,000, mostly Tiv people. It is the traditional capital of the Tiv tribe and it has the official residence of the Tor-Tiv, who is the paramount traditional ruler of the Tiv people. The size of the study area is approximately 1920.48km^2.The relief of the area consist of hills prominent among which is the Mkar Hills and valleys with gently undulating plains. The area lies in the tropical climatic zone and it has two seasons: rainy season which starts from April to November and the dry season which starts from November to March. The rains are mostly convectional with isolated orographic type around Mkar hills. The yearly rainfall is between 15cm and 18cm. Temperatures varies between 23 ^{o}C-38 ^{o}C for most of the year. According to the classification by Thornthwaite,(1948) the area is represented as*B3* (Humid climate with seasonal distribution of moisture). The mean monthly values of rainfall in the area range from 0.77cm to 22.75cm. The vegetation consist mainly of Guinea savannah made up of trees and grasses mixed together having average height. The natural vegetation consists of woodland and tall grass. The guinea savannah has isolated forests, patches of woodland, scrubs and shrubs in addition to tall grasses (Abah, 2014). Halima and Edoja, (2016) and Hula, (2014)observed that the vegetation of the area was hitherto covered by forest but due to uncontrolled and continuous clearing of the vegetation for agricultural activities together with other anthropogenic activities such as burning of the bushes, grazing and hunting among other have to a large extent impacted on the original forests. The original forest vegetation is now reduced to secondary forest and savannah vegetation. There are pockets of scattered trees that are of economic benefits and include mango, shea butter, locust bean, African iron, Isoberlinia, cashew, *Daniella oliveri*, *Gmelina arborea*, oil palm, etc. These trees produce products that serve as raw material for some small-scale industries. The area has a population of 361325 according to the 2006 Population Census. It has one of the highest population densities in the state with over 300 persons/km^2. The people of the area are mainly farmers. Over 80% of the total population is dependent on farming for their living taking advantage of the rich alluvial soils of the Benue valley and the foothills of Mkar. The area is blessed with great agricultural products such as yam, cassava, rice, soya beans, millet, potatoes, guinea corn, groundnuts, maize and benniseed. Gboko produces over 40% of the state's soya beans yield, (Benue State Government 2017).

Satellite imageries used included Landsat TM (1987); Landsat ETM+ (2007); and Operational Land Imager (OLI) (2017). The Landsat imagery dataset was sourced from the *Earthexplorer* platform from United States Geological Surveys (USGS), Global Land Cover Facility (GLCF) and GloVis. Changes in land cover were measured using time series of remotely sensed data (Landsat TM, ETM and OLI). Table 1 gives a summary of the image characteristics for the dataset used. Dry season images of the three data sets were acquired from January to March in order to reduce the effects of clouds that are prevalent during the rainy season. Because the images are from the same season and comparable climatic conditions, it enhanced the classification as the spectral reflections of most features are easily comparable across the different images. In addition, high resolution Google earth images were used to aid in classification.

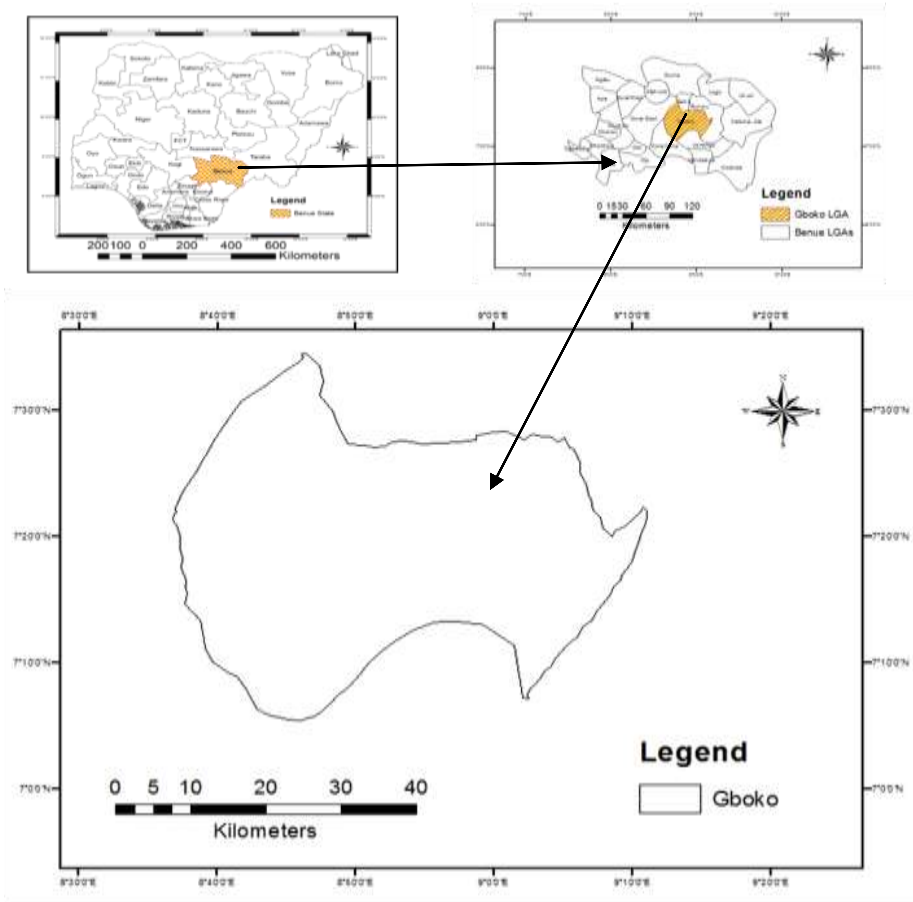

Figure 1 Study Area

The tools used for carrying out the research were; ArcGIS 10.2 used for pre-processing of images and vector data; ERDAS Imagine 2014, used for classification, accuracy assessment of classification; Idrisi Selva, used for change detection; Google Earth Image, used for delineation and ground truthing and Global Positioning System-used for classification and data validation. Mapping the types and extent of land use and land cover classes in Gboko was achieved through the examination of Landsat TM of 1987, Landsat ETM+ of 2007 and Landsat OLI of 2017 images acquired and their subsequent classification.

Table 1: Specifications of Satellite Imageries Used

Satellite	Path/Row	Sensor	No of Bands	Bands used	Date Acquired	Spatial Resolution
Landsat	188/54,55 187/55,56	TM	7	NIR, R, G (4,3,2)	29/01/1987	30m
Landsat	188/54,55 187/55,56	ETM+	8	NIR, R, G (4,3,2)	21/12/2007	30m
Landsat	188/54,55 187/55,56	OLI	11	NIR, R, G (5,4,3)	16/02/2017	30m

TM= Thematic Mapper, ETM+= Enhanced Thematic Mapper Plus, OLI = Operational Land Imager:

Source: Modified from(Northrop, 2015)* http://www.gisat.ez/content/en/products/digital-elevation-model/aster-gdem

In order to map the types and extent of LULC classes in the area, the data were subjected to some processing and analytical procedures which include data pre-processing, image rectification, image enhancement, Image classification. These procedures involved correction of Landsat images through haze removal, cloud removal, mosaicking of images scenes and clipping the images using the shapefile of Gboko LGA. The shapefile of Gboko LGA was used to clip from the larger scenes that were earlier mosaicked. The technique used was the subset method in ERDAS 2014 where the desired shapefile of Gboko was used as the Area of Interest (AOI). The choice of this method was based on its simplicity of use and its higher accuracy. This is because the mosaicked area is larger than the Area of interest (AOI) and it helps in defining precisely the study area.

Image enhancement was done to increases the contrast among different features thereby enhancing easy identification of features and subsequent classification. A band combination of 4,3,2 (for RGB) was used for the Landsat TM and ETM images and 5,4,3 for OLI images as this produced superior results. It is suitable for urban application and delineating land, water and vegetation boundary. Image classification was done using supervised classification algorithm which is a procedure for categorizing spectrally similar areas on an image by identifying "training" sites of known targets and then generalizing those spectral signatures to other areas of targets that are unknown *(*Mather and Koch, 2011). A Maximum Likelihood algorithm of supervised classification was adopted because it is one of the best classification methods which assigns pixels to the class with the largest probability to determine class ownership of a particular pixel. In choosing training sites, colour composite images formed by the combination of three individual monochrome images, which highlight certain surfaces, and help photo-interpretation were viewed; each band is assigned to a given colour: Red, Green and Blue (RGB)(NASA, 2011). A Supervised classification of Landsat image data for the three periods (1987, 2007 and 2017) was performed using the Maximum Likelihood Classifier to identify and map land use and land cover classes. In order to ascertain the areal extent and rate of change in the LULC in Gboko, the following variables were computed.
Total area (T_a), Changed area (C_a), Change extent (C_e) and Annual rate of change (C_r) .These variables can be described by the following formula as given by: (Yesserie, 2009).

$C_a = T_a(t_2) - T_a(t_1)$; …………**(1)**

$C_e = C_a / T_a(t_1)$; ……………..**(2)**

Where t_1 and t_2 are the beginning and ending time of the land use and land cover studies conducted.

Fieldwork was done so as to collect geographical data to map land cover and for accuracy assessment of the land cover classification. Ground-truth data was also collected on spatial features from the study area, such as spatial location, land cover and land use, road network with the aid of a GPS. Ground truthing enabled the collection of inference data and to increase ones' knowledge of land cover conditions. It also enables familiarity of features as the appear on the satellite image on the computer screen, for verification and validation of the interpreted results. The process of identifying and transferring ground points onto the screen was done using the GPS. Each LULC class was physically identified in the field and the position of the area recorded using GPS which was later transferred to the image whereby it was easier to identify the appearance of such land uses on the screen. Inaccessible areas were complimented with the use of Google earth images. In summary, both visual interpretation and digital image classification methods were employed in data interpretation.

A stratified random sampling technique was adopted in selecting control points for accuracy assessment so as to improve the precision of the accuracy and area estimates (Olofsson*et al*., 2014). It avails one the opportunity of selecting control points within the different land use and land cover classes (strata) to be used for accuracy assessment. Each of the land use and land cover classes had control points proportional to the size of the area covered.
The accuracy of satellite image classification could be inhibited by the resolution of images used and dearth of fine details as well as unavoidable

generalization impact and therefore, errors are always expected. This is why, to ensure wise utilization of the produced LULC maps and their associated statistical results, the errors and accuracy of the analysed outputs should be quantitatively explained (Siddhartho, 2013).

Accuracy assessment is a process whereby the final product of classification is compared with ground truth or reliable sources so as to assess the extent of agreement or disagreement. This study adopted the Error Matrix approach (ERRMAT in Idrisi Selva) to assess the accuracy of the classification. The error matrix assesses accuracy using four parameters which include overall accuracy, user's accuracy, producer's accuracy and the Kappa Index of agreement (KIA). The overall accuracy specifies the total pixels correctly classified and is derived by dividing the total number of pixels correctly classified by the total number of pixels in the error matrix. The producer's accuracy defines the probability of a reference pixel being correctly classified; it represents the error of omission.

Table 2: Classification scheme

S/No	Class	Description
1	River/ water bodies	Open water features including lakes, rivers, streams, ponds and reservoirs.
2	Built-up/Urban Area	Urban and rural built-up including homestead area such as residential, commercial, industrial areas, villages, settlements, road network, pavements, and man-made structures.
3	Grassland	Areas dominated by grasses including vegetated sandbars and grazing areas/
4	Bare surface	Fallow land, earth and exposed river sand land in-fillings, construction sites, excavation sites, open space and bare soils.
5	Forest	Trees, natural vegetation, mixed forest, gardens, parks and playgrounds, grassland, vegetated lands.
6	Farmlands	Areas consist of cultivated lands used for the production of annual crops, perennial woody crops. agricultural lands, and crop fields.

Source: Modified from Anderson *et al*.(1976)

The number of samples correctly classified for a given column is divided by the total for that column (Pedro, 2015). The user's accuracy on the other hand defines the probability that a pixel classified on a map actually represents that category on the ground. User's accuracy represents to error of commission. This can be calculated by dividing the number of samples correctly classified for a given row by the total of the row (Sarmento, 2015). On the other, the Kappa index measures the agreement between classification map and reference data (Congalton and Green, 2008). All accuracy parameters have index values between 0 and 1, where 0 symbolizes poor and 1 strong classification accuracy/agreement.

The Kappa statistics formula developed by Cohen Kappa in 1960 and modified by Jenness and Wynne (2007) was adopted for calculating Kappa statistic. It has the advantage of correcting for chance agreements between the observed and predicted values.

$$k = \frac{N\sum_{i=1}^{n} m_{i,i} - \sum_{i=1}^{n}(G_i C_i)}{N^2 - \sum_{i=1}^{n}(G_i C_i)} \qquad \ldots\ldots\ldots\ldots \textbf{(3)}$$

Where :i is the class number

N is the total number of classified pixels that are being compared to ground truth

mi,i is the number of pixels belonging to the ground truth class i,that have also been classified with a class i (that is values found along the diagonal of the confusion matrix)

Ci is the total number of classified pixels belonging to class i

Gi is the total number of ground truth pixels belonging to i

Kappa value changes from -1 to +1 and the interpretation of the values can be determined according to these values:

< 0: Less than chance agreement
0.01–0.20: Slight agreement
0.21– 0.40: Fair agreement
0.41–0.60: Moderate agreement
0.61–0.80: Substantial agreement
0.81–0.99: Almost perfect agreement. (Borana and Yadav, 2017).

Under ideal conditions, the accuracy of the classification ought to be assessed by overlaying an already existing LULC map. Due to absence of already existing LULC classification for Gboko LGA, handheld Garmin GPS receiver was used to take coordinates of selected LULC as ground control points from the field complimented with Google Earth images. The points of these reference data were determined through stratified random sampling by identifying and locating the land use classes of interest in the field and their GPS points and coordinates taken at ±3m accuracy and recorded as was used by Appiah, (2016).

RESULTS AND DISCUSSION

The results of classification for the land use land cover changes in 1987, 2007 and 2017 are presented using tables, charts and figures for illustration and interpretation of all LULC classes in the three periods. The results are discussed immediately as they are presented for the area. The classification reveals that there was a steady increase in urban area from 3232ha (1.68%) in 1987 to 8542ha (4.45%) in 2007 and rising up to 16614ha (8.65%) in 2017. The growth of the urban area has been directed towards the northeast area of the map as can be seen from Figures 3 and 4. Forest land on the other hand declined from 52108ha (27.13%) to 46523ha (24.23%) down to 16723ha (8.71%) in the same period. Grassland was the dominant land cover occupying 69074ha (35.97%) in 1987 increasing to 79874ha (41.59%) and 129715ha (67.54%) in 2007 and 2017 respectively as shown in Table 3. Water body and Bare surface experienced slight variations during the same period. The classification accuracy for the three periods of 1987, 2007 and 2017for Gboko showed an overall accuracy of 80.77%, 85.84% and 86.24% respectively (see Table 4). This was also considered a decent overall accuracy for the subsequent analysis and change detection. The user's accuracy of different classes ranged between74.07% and100% and producer's accuracy ranged between 64 % and 94.44%. The overall Kappa index was also calculated for each classified map to determine the accuracy of the results.

The LULC distribution of extent for Gboko for the 3 Periods is shown in Table 3 and Figures 2, 3 and 4. The results of the three periods 1987, 2007 and 2017revealed Kappa statistics of 0.76, 0.83 and 0.83 respectively. The Kappa coefficient for the three periods ranges from substantial agreement to almost perfect agreement on the kappa scale, an indication that it can be used.

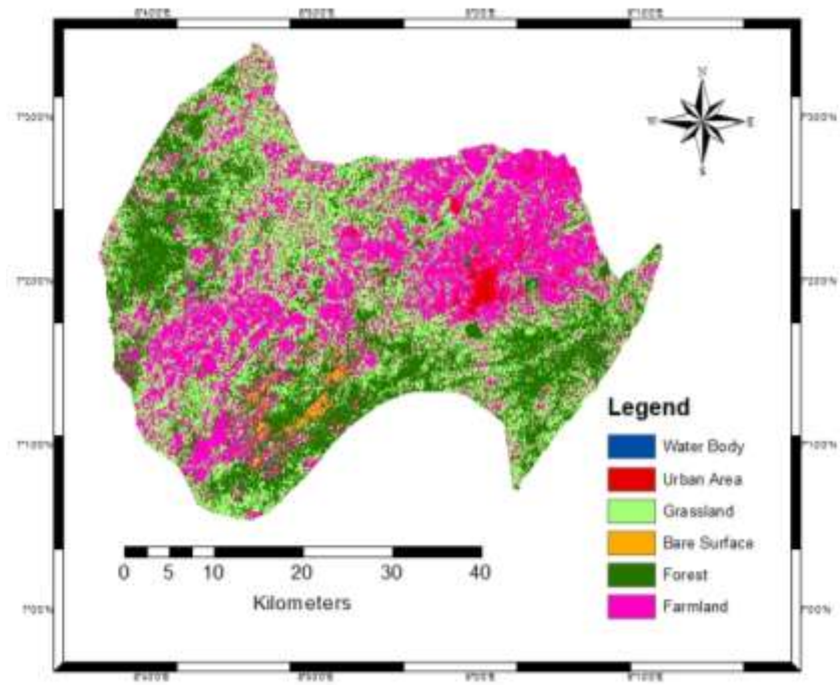

Figure 2: Land use and Land cover map of Gboko for 1987

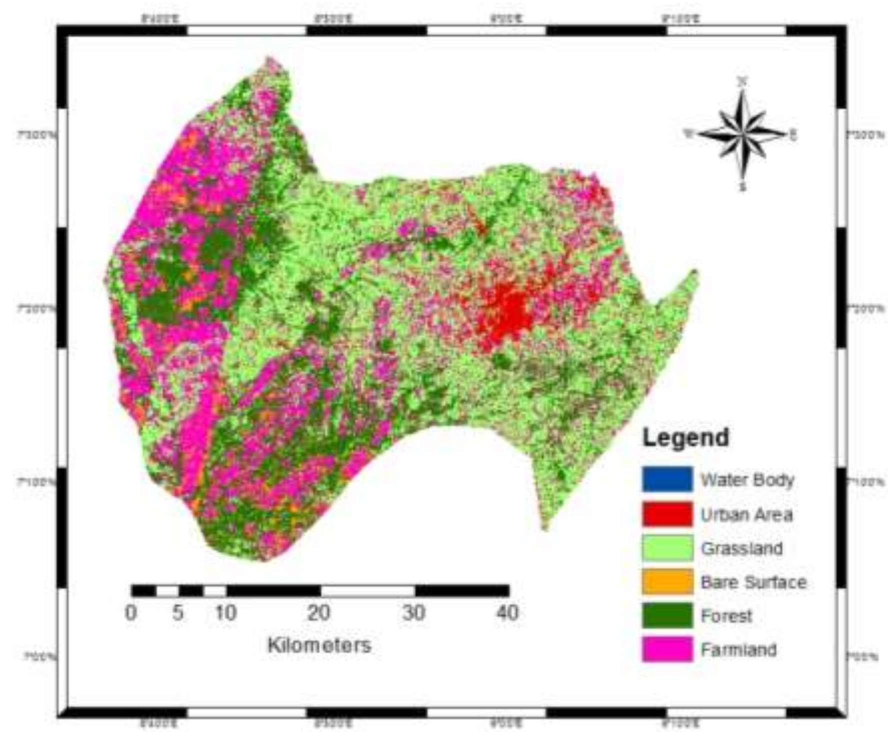

Figure 3: Land use and Land cover map of Gboko for 2007

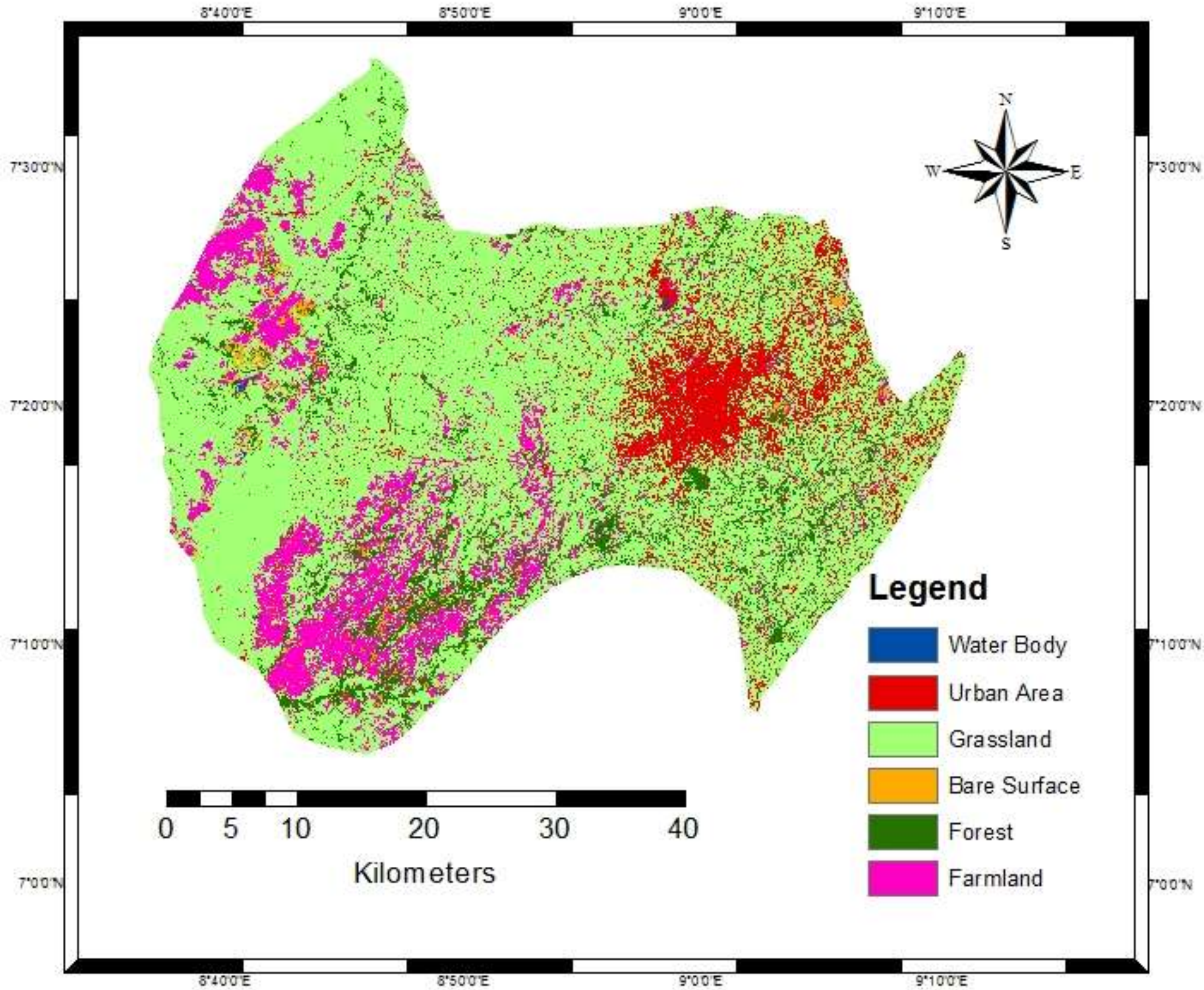

Figure 4: Land use and Land cover map of Gboko for 2017

Table 1: Area Statistics of LULC in Gboko (1987, 2007 and 2017)

	1987		**2007**		**2017**	
land cover Class	**Area (Ha)**	**Area (%)**	**Area (Ha)**	**Area (%)**	**Area (Ha)**	**Area (%)**
Water Body	840	0.44	220	0.11	277	0.15
Urban Area	3232	1.68	8542	4.45	16614	8.65
Grassland	69074	35.97	79874	41.59	129715	67.54
Bare Surface	2252	1.17	8353	4.35	2500	1.30
Forest	52108	27.13	46523	24.23	16723	8.71
Farmland	64542	33.61	48536	25.27	26219	13.65
Total Area	**192048**	**100**	**192048**	**100**	**192048**	**100**

Table 4: Accuracy assessment result of LULC classification in Gboko

LULC Class	1987 classification Producer's Accuracy (%)	1987 classification User's Accuracy (%)	2007 classification Producer's Accuracy (%)	2007 classification User's Accuracy (%)	2017 classification Producer's Accuracy (%)	2017 classification User's Accuracy (%)
Water Body	80.95	89.47	80	84.21	94.44	77.27
Urban Area	86.49	91.43	88.89	100	74.19	85.19
Grassland	80.56	76.32	82.98	81.25	86.89	82.81
Bare Surface	64	84.21	71.43	83.33	86.36	82.61
Forest	82.93	79.07	91.67	86.84	82.05	100
Farmland	83.33	74.07	90	80.36	93.62	88
Overall Accuracy	**80.77%**		**85.84%**		**86.24%**	
Overall Kappa	**0.76**		**0.83**		**0.83**	

The trend in land use and land cover changes in Gboko (Table 5 and Figure 5) shows that urban area increased by 5310ha (11.95%) in the first period at an annual rate of change of 2.39% while in the second period the change was 8072ha (6.96%) and the annual rate of change of 0.7%. Even though, there was an increase, the rate reduced greatly to 0.7% which signifies a slowdown in the rate of urban expansion between 2007 to 2017. The overall trend (1987-2017) revealed that urban area has increased up to 13382ha (9.01%) with an annual rate of change as high as 2.7% higher than the rate in the first period. Forest land in Gboko has been on the decline throughout the period with a loss of 5585ha(12.57%) in the first period having an annual rate of change of -2.51% and 29800ha (25.7%) in the second period with an annual rate of change of -2.57%. The overall trend shows that forest lost 35385ha (23.82%) with an annual rate of change of -7.15%.

This high rate is an indication that in no distant future the area may be completely devoid of forest vegetation. Farmland also decreased during the period losing 16006ha (36.03%) in the first period with an annual rate of change of -7.21% and 22317ha (19.25%) in the second with an annual rate of change of -1.93%. The overall trend indicates that 38323ha (25.8%) was lost between 1987 and 2017 with an annual rate of change of -7.74%. The decline in farmland could be due to involvement of the aged and absence of the youth who have migrated to the cities. Grassland increased throughout the period, 10800ha (24.31%) by the first period with a 4.86%change rate.

By the second period, it increased to 49841ha (42.99%) even though the annual rate of change decreased to 4.3%. The overall trend shows that it increased by 60641ha (40.82%) at an annual rate of change as high as 12.25%. This might be due to clearance of forested areas for agriculture and later abandoning it for grassland to take over. Water body and bare surface recorded minimal changes. The trend of land use and land cover changes in which urban area continue to increase at the expense of other classes and the decline in forest area and farmland agrees with the results of Addae and Oppelt, (2019) in Greater Accra Metropolitan Area (GAMA), Ghana.

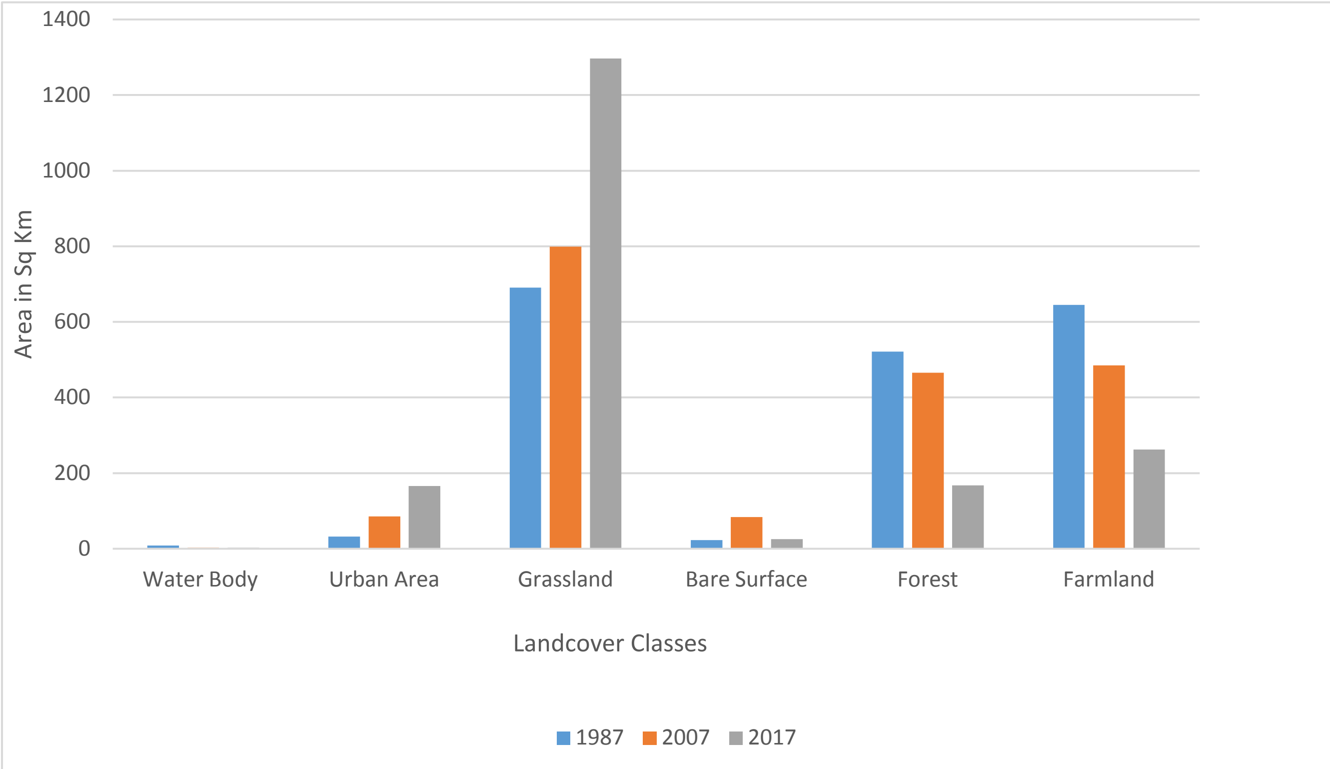

Figure 5: Trend of Land cover changes in Gboko (1987-2017)

Table 5: Annual Rate of change for Gboko (1987, 2007 and 2017)

LULC Class	1987-2007 Area(ha) Change	Percentage of Change	2007-2017 Area (ha) Change	Percentage of Change	1987-2017 Area (ha) Change	Percentage of Change	Annual Rate of Change		
							1987-2007 (%)	2007-2017 (%)	1987-2017 (%)
Water Body	-620	-73.81	57	25.91	563	67.02	-3.69	2.59	2.23
Urban Area	5310	164.29	8072	94.5	13382	414.05	8.21	9.45	13.8
Grassland	10800	15.64	49841	62.4	60641	87.79	0.78	6.24	2.93
Bare Surface	6101	270.91	-5853	-70.07	248	11.01	13.54	-7.01	0.37
Forest	-5585	-10.72	-29800	-64.05	-35385	-67.91	-0.54	-6.41	-2.26
Farmland	-16006	-24.8	-22317	-45.98	-38323	-59.38	-1.24	-4.6	-1.98

Gboko, the traditional headquarters of the Tiv people show marked trend in land cover transitions. All the classes experienced transitions but farmland had the highest positive transition followed by urban area. Grassland had the highest negative transition closely followed by forest land (Figure 6a). Farmland, grassland and forest were the major contributors to urban area expansion. Farmland, grassland and urban area were responsible for the decline in the forest land. In a similar vein, land cover transition pattern in the second period had a lot of resemblance to that of the first period. as can be seen in Figure in (6b). The period between 1987-2017 saw grassland having the dominant positive transition closely followed by urban area. Farmland and forest witnessed a negative transition (Figure 6c). Again, farmland, grassland and forest were the major contributors to urban growth while grassland, farmland, bare surface and urban area accounted for the decline in forest land.

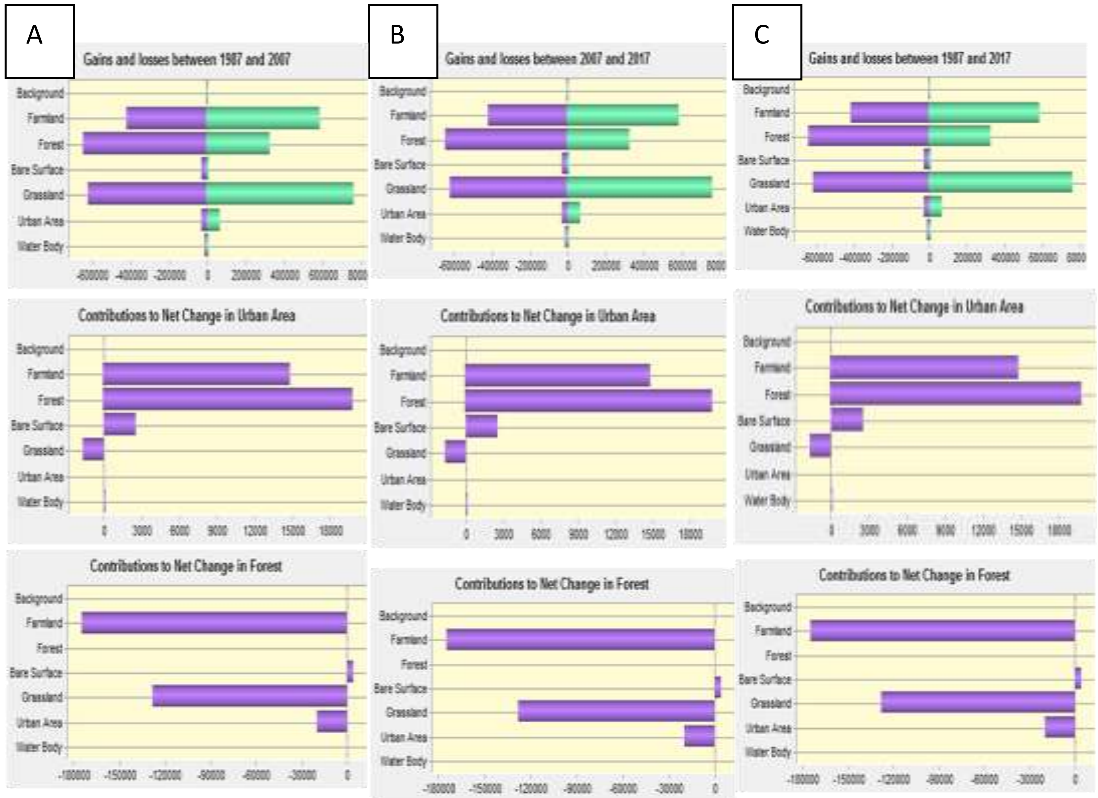

Figure 6: Gains/losses of LULC categories, contribution to net change in Urban area and Forest (ha) in Gboko from (A):1987 – 2007, (B): 2007 -2017 and (C): 1987- 2017.

The gain and losses graphs in Gboko (Figure 6a, b and c) show that grassland witnessed the major positive transition followed by urban area. Farmland had a negative transition in the first and second but was positive in the overall trend while forest declined throughout during the period. Contributors to urban expansion came mainly from farmland, grassland and forest during the first two periods but bare surface took over leadership in the overall trend. This was followed by farmland, forest and grassland.

.CONCLUSION

Land use and land cover change information over time is necessary not only for planning of urban areas, but also to improve the management of the use of earth resources. This study has established the value of using satellite remote sensing and GIS technique in producing accurate land use and land cover maps and change statistics for Gboko LGA, which is critical in monitoring urban expansion effectively over a time. The change detection results of the study area reveal that there was a steady increase in urban area from 3232ha (1.68%) in 1987 to 8542ha (4.45%) in 2007 and rising up to 16614ha (8.65%) in 2017. This increase in urban extent can be attributed to the increase in population due to large rural- urban migration The growth of the urban area has been directed towards the northeast area of the area. Forest land on the other hand declined from 52108ha (27.13%) to 46523ha (24.23%) down to 16723ha (8.71%) in the same period. The overall trend (1987-2017) show that urban area increased by 13382ha representing 414.05% at an annual rate of 13.5%. Forest and farmland declined to the tune of 35385ha and 38323 ha representing -67.91% and -59.38% respectively. In this study, the accuracy of the maps proved satisfactory; it confirms that the image processing procedures were effective in producing land use and land cover maps from Landsat images. It is therefore, highly recommended that city planners and decision makers can employ remote sensing and GIS techniques for effectively monitoring urbanization trends.

REFERENCES

Abah, R. C. (2014). Rural perception to the effects of climate change in Otukpo, Nigeria. *Journal of Agriculture and Environment for International Development*, *108*(2), 153–166. https://doi.org/10.12895/jaeid.20142.217

Addae, B., & Oppelt, N. (2019). Land-Use / Land-Cover Change Analysis and Urban Growth Modelling in the Greater Accra Metropolitan Area (GAMA), Ghana. *Urban Science*, *3*(26), 1–20. https://doi.org/10.3390/urbansci3010026

Adewumi, A. S. (2013). Analysis of Land Use / Land Cover Pattern along the River Benue Channel in Adamawa State , Nigeria. *Academic Journal of Interdisciplinary Studies*, *2*(5), 95–108. https://doi.org/10.5901/ajis.2012.v2n5p

Anderson, J. R., Hardy, E. E., Roach, J. T., & Witmer, R. E. (1976). *A Land Use and Land Cover Classification System for Use with Remote Sensor Data* (Fourth). Washington: United States Department of the Interior.

Appiah, D. O. (2016). *Geoinformation Modelling of Peri-Urban Land Use and Land Cover Dynamics for Climate Variability and Climate Change in the Bosomtwe District*, *Ghana*. Unpuplished PhD Thesis Kwame Nkrumah University of Science and Technology, Kumasi.

Borana, S. L., & Yadav, S. K. (2017). Prediction of Land Cover Changes of Jodhpur City Using Cellular Automata Markov Modelling Techniques. *International Journal of Engineering Science and Computing*, *7*(11), 15402–15406.

Congedo, L., & Munafò, M. (2012). *Development of a Methodology for Land Cover Classification in Dar es Salaam using Landsat Imagery*. Rome.

Halima, C. I., & Edoja, M. S. (2016). Exploring the relationship between farming practices and vegetation dynamics in Benue State, Nigeria. *African Journal of Geography and Regional Planning*, *3*(1), 218–225. Retrieved from http://wsrjournals.org/journal/wjas

Hashem, N., & Balakrishnan, P. (2015). Annals of GIS Change analysis of land use / land cover and modelling urban growth in Greater Doha , Qatar. *Annals of GIS*, *21*(3), 233–247. https://doi.org/10.1080/19475683.2014.992369

Hula, M. A. (2014). Population Dynamics and Vegetation Change in Benue State , Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries*, *2*(1). https://doi.org/10.13140/2.1.4805.1847

Jiao, L. (2015). Landscape and Urban Planning Urban land density function : A new method to characterize urban expansion. *Landscape and Urban Planning*, *139*, 26–39. https://doi.org/10.1016/j.landurbplan.2015.02.017

Mundhe, N. N., & Jaybhaye, R. G. (2014). Impact of urbanization on land use / land covers change using Geo-spatial techniques. *International Journal of Geomatics and Geosciences*, *5*(1), 50–60.

NASA. (2011). *Landsat 7 science data users handbook. National Aeronautics and Space Administration Landsat*. Retrieved from http://glovis.usgs.gov/%0Ahttp://edcsns17.cr.usgs. gov/EarthExplorer/%0Ahttp://www. landcover.org/index.shtml%0A

Northrop, A. (2015). *IDEAS – LANDSAT Products Description Document*. Bedfordshire. Retrieved from http://www.gisat.cz/content/en/products/digital-elevation-model/aster-gdem

Ohwo, O., & Abotutu, A. (2015). Environmental Impact of Urbanization in Nigeria. *British Journal of Applied Science & Technology*, *9*(3), 212–221. https://doi.org/10.9734/BJAST/2015/18148

Ojo, S. S., Barau, D., & Pojwan, M. A. (2017). Urbanization and Urban Growth : Challenges and Prospects for National Development. *Journal of Humanities and Social Policy*, *3*(1), 65–71.

Opatoyinbo, O. O., Adepetu, A. A., & Abdullahi, M. L. (2015). Population Growth and Urban Land Use Change along River Kaduna Floodplain Population Growth and Urban Land Use Change along River Kaduna Floodplain. In *FIG Working Week 2015 From the Wisdom of the Ages to the Challenges of the Modern World Sofia, Bulgaria, 17-21 May 2015* (pp. 1–14).

Sarmento, P. A. R. (2015). *Error and Uncertainty in the Accuracy Assessment of Land Cover Maps*. Unpublished PhD Thesis NOVA Information Management School.

Siddhartho, S. P. (2013). *Analysis of land use and land cover change in kiskatinaw river watershed: a remote sensing, gis & modeling approach*. Unpublished Master Thesis University of Northern British Columbia.

Thornthwaite, C.W. (1948). "An Approach Toward a Rational Classification of Climate"*F). Geographical Review*. ***38*** *(1): 55–94. doi:10.2307/210739. JSTOR 210739.*

Triantakonstantis, D., & Mountrakis, G. (2012). Urban Growth Prediction : A Review of Computational Models and Human Perceptions. *Journal of Geographic Information System*, *2012*(4), 555–587.

UN. (2015). *World population prospects*. *United Nations*. New York: Department of Economic and Social Affairs Population Division United Nations. https://doi.org/10.1017/ CBO9781107415324.004

Yesserie, A. G. (2009). *Spatio-Temporal Land Use/Land Cover Changes Analysis and Monitoring in The Valencia Municipality, Spain*. Unpblished Master Thesis Universitat Jaume I.

Yuan, F., Sawaya, K. E., Loeffelholz, B. C., & Bauer, M. E. (2005). Land cover classification and change analysis of the Twin Cities (Minnesota) Metropolitan Area by multitemporal Landsat remote sensing. *Remote Sensing of Environment*, *98*(1), 317–328. https://doi.org/10. 1016/j.rse.2005.08.006

DETERMINING THE PHYSICOCHEMICAL PROPERTIES OF SOIL IN THE SELECTED EROSION SITES IN THE RAINFOREST ECOSYSTEM IN ABIA STATE, NIGERIA

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ABSTRACT

This study determined the physico-chemical properties of soil in selected erosion sites in rainforest ecosystem in Abia State Nigeria. Conventional analytical methods were employed for the determination of these physicochemical parameters. Sand content was highest at Ikwuano LGA (82.2%), Ossah-Ibeku (77.2%).0 Ahiaeke (75.20%) and Amigbo (70.20%) were statistically similar. Results of clay contents (%) were significantly different in the following order; Amigbo Ubakala (16.40%) > Ossah Ibeku (13.40%), =Ahiaeke Ntugbu (11.40%) = Oloko (10.40%).For Nitrogen content, the two depths 0-15cm and 15-30cm were statistically similar, while the location (L) x Soil depth (D)treatment interactions were significantly different. For phosphorus content, Ossah Ibeku (20.60%) > Amigbo (14.25%) > Oloko (13.60%) > Ahiaeke (11.74).The difference in the mean potassium (%) content in the locations sampled was significant at P≥ 0.05 except Amigbo-Ubakala in Umuahia south LG.A. and Oloko in Ikwuano LG.A. which had statistically similar values. Potassium (k) content at (15-30cm) soil depth (0.136%) was significantly different from the (0-15cm) soil depth (0.0950%).Sodium (%) contents in Ossah Ibeku and Oloko were statistically similar. Sodium (%) contents decreased with increasing soil depth; the 0-15cm soil depth had higher sodium content (0.13%) than the 15-30cm soil depth (0.12%).Calcium content also decreased with increasing soil depth from 0-15cm depth (5.20%) to 15 - 30cm (4.30%).No significant difference existed between the mean magnesium (%) content of the soil depths (0.15cm and 15.30cm). The EA (%) capacity increased with soil depth. Location x Soil Depth (LxD) treatment interactions, the 0-15cm soil depth generally gave lower EA capacity than the 15-30cm soil depth at P≤ 0.05.

Keywords: Soil erosion, Rainforest ecosystem, Erodibility

INTRODUCTION

Soils in Nigeria are predominantly alluvium deposits, coastal plain sands, sand stones, basement complex material and older granite, these soils exhibit variables resistances to erosion with the sandy soil being more vulnerable to erosion than clay (Onweremadu, 2007). Soil erosion occurs when soil particles are carried off by water or wind and deposited somewhere else. Erosion begins when rain or irrigation water and wind detaches soil particles from the earth surface. Relf (2001) stated that when there is too much water on the soil surface, it fills surface depressions and begins to flow. With enough speed, this surface runoff carries away the loosed soil. According to Nyakatawa *et al*. (2001), soil erosion is a major environmental problem worldwide. Soil moved by erosion carries nutrients, pesticides and other harmful chemicals into rivers, streams and ground water resources. Population growth, urbanization, industrialization, mining, agricultural practices and anthropogenic activities, have led to the increase of soil erosion and land degradation, particularly in the arid and semi-arid regions of the world (Hammad *et al*., 2006). Soil can be described as an essential input in agricultural production. Agricultural production is crucial to food availability, sustenance of livelihoods and national prosperity.Majority of the population depend on naturally abundant resources which agriculture provides (Ubuoh *et al*., 2013).

Anthropogenic causes include farming and uncontrolled grazing practices, deforestation, and mining activities (Abdulfatai *et al*., 2014; Nuga *et* *al.*, 2006; Uwanuruochi & Nwachukwu, 2012). Soil erosion is considered to be a major environmental problem since it seriously threatens natural resources and the environment (Rahman *et al*., 2009). Soil erosion diminishes soil quality and reduces the productivity of natural, agricultural and forest ecosystem (Pimentel, 2006). The soil in the South-Eastern Nigeria is poorly drained and is subjected to permanent or periodic flooding (Hulugalle*et al.*, 1990). The communities living in these areas encounter adverse effect of soil erosion and degradation especially gully erosion. This problem is affecting the development of the area because infrastructures such as houses, roads and even life are lost yearly apart from constitutes an environmental menace (Abdulfatai*et al*., 2014; Idah*et al*., 2008). To effectively tackle this problem, there is a need to identify those factors which contributes to soil erosion using scientific knowledge through laboratory investigations, addressing the causes will ensure lasting solutions to the menace of erosion and degradation and prevent future damages to human and infrastructures of the region. Soil is a basic necessity for agricultural production. Factors that affect the soil also affect agriculture and therefore a solution to such factors will increase food production.

Gully erosion has been recognized as one of the major global environmental problems. Many States in Nigeria are currently under the threats of this phenomenal process, south-eastern part of the country being the most affected. It has numerous causes; and these causes can be both naturally and artificially-induced, but the underlying geology and the severity of accompany surface processes play a key role. Observations have shown clearly that gully erosion is more prevalent in sedimentary terrain than in the basement complex of Nigeria. This erosion activity at various scales has resulted in the loss of lives and properties almost on a yearly basis. Solutions that have been proffered include public awareness campaign, improved farming techniques, cultural method of gully control, enactment of laws against any activities that favour gully growth, and thorough implementation of suggested solutions (Montgomery, 2007).

Control measures to stem gully erosion that are incipient are most effective when erosion is still at an early stage (Obidimma and Olorunfemi, 2011). Organic carbon, textural characteristics and moisture content of the soil have been suggested as the most useful factors to be considered in a detailed survey and control of gully (Osadebe and Enuvie, 2008). According to Ufot*et al*., (2016) south eastern Nigerian soils are low in organic matter content, base status and water storage capacity with high susceptibility to accelerated erosion and land degradation. Ezezika and Adetona (2011) further states that the soils have low silt/clay content thus resulting in a sandy soil which isnon-cohesive, very permeable with very high infiltration rates.

MATERIALS AND METHODS

Study area

The research was carried out in Abia State in South Eastern Nigeria that is seriously ravaged by soil erosion. It lies between Latitudes 05° 25′N and Longitude 07° 30′E, it covers area of 6,320 km^2 and a population of 2,845,380.Ithas two district seasons in a year, rainy season and dry season. The mean annual climatic data in Abia State are as follows; maximum and minimum temperature 25^{o}C and 32^{o}C respectively; rainfall 2400mm; relative humidity 80-90% (Aregheore, 2005 and NPC, 2006). Abia State has three major agro ecological zones, fresh water swamp forest, rainforest and derived savannah. (Keay, 1959). The vegetation is predominantly secondary forest tending towards derived savannah because of repeated annual bush burning. (Aregheore, 2005).

The study was undertaken in the lowland agro-ecological zones of Abia State. Eleven local government areas were listed as high-erosion prone areas (Abia State Handbook1997), out of which four local government areas were randomly selected from for the study. The high erosion prone areas are; Umuahia South, Umuahia North, Ohafia, Bende, Ikwuano, Obingwa, Isikwuato, Arochukwu, Umuneochi, Isialangwa North, Isialangwa South and Aba North L.G.A.

Two Local Government Areas (LGAs) were randomly selected from the high-erosion prone sites in the rainforest ecosystems. The two LGAs selected in the rainforest zone are Umuahia South and Ikwuano LGAs

A 2x4 factorial experiment in randomized complete block design (RCBD) with three replications/blocks was used to determine the physico-chemical properties of two soil depths horizon-factors A, top soil(0-15cm) and sub soil (15-30cm), and Four local communities (Factor B) in each of the two agro-ecological rainforest zones in Abia State, Nigeria.

The Soil particle size distributions were determined using the standard hydrometer and pipette technique (Kettler *et al*., 2001; Allision, 1973). The soil texture was determined using the soil textural triangle based on the percentages of the different soil particle size (Sutherland, 1990). The Dewis and Freitas (1990) and Min Liu *et al* (2004) procedures were used to determine the pH of each soil sample. Walkley and Blacks (1965) method as described by Allison (1973) was used to determine the organic carbon contents in each soil horizon per location. Percentage organic matter was considered to be the total carbon multiplied by a conversion factor of 1.72. Total N was determined using the micro Kjeldhal method (Jackson, 1964). Phosphorus (P) was determined spectrophotometrically by the Vanandemolybdate yellow method using the Bray No. 1 extraction method. Potassium and Sodium were determined by the flame emission photometer. Calcium and magnesium were determined using the ethylene-diamine–tetracettic-acid (EDTA) versanate complexometric titration method (Allison, 1973). Exchangeable acidity was measured with 0.1mlKCl extract and titrated with 0.lml NaOH. Effective Cation Exchange Capacity (ECEC) was obtained as the summation of exchangeable cations and exchangeable acidity. To calculate the percent base saturation, the sum of the Potassium (K)Magnesium (Mg)Calcium (Ca) and Sodium (Na) (the bases) in Meli equivalent per 100g of soil (Meg/100mg soil) was divided by the CEC and result was multiplied with 100%.

RESULTS

In Table 1, Oloko in Ikwuano LGAhad the highest sand content (82.2 %), Amigbo -Ubakala recorded the lowest value (70.20%). Sand contents in the two soil depths were not significantly different. In terms of the treatment interactions between Location and Soil depth (LxD), the top soil of Ossah Ibeku, Oloko Ikwuano and the sub soil at Ahiaeke-Ntugbu were higher than the sub soil in other locations.Results of clay contents in the sampled locations were significantly different, the highest value was recorded at Amigbo Ubakala (16.40%) while Oloko (10.40%) recorded the lowest value.Also, there were significant differences between the clay contentsof the two soil depths in the study sites. Soil depth treatment interactions (LxD) also showed significant difference in their clay contents. Result for silt content shows that Ahiaeke-Ntugbu had the highest silt content(14.4 %), Olokorecorded the lowest value (8.4%).Silt contents in the two soil depths were not significantly different. In terms of the treatment interactions between Location and Soil depth (LxD) were not significantly different.

Results from Table 2 above shows that pH level in the soils of the study sites was not significantly different. Highest pH was observed in Ossah-Ibeku (6.02) while Amigbo-Ubakala (5.11) recorded the lowest value.Ossah-Ibeku had significantly higher Organic Carbon content (0.42%) than Ahieke-Ntugbuwhich recorded (0.2%). In terms of the two soil depths, the differences between the OC content in the top soil (0.42%) and sub soil (0.14%) were very significant. However, the organic carbon content of all the other Location × Soil depths treatment interactions (LxD) were significantly different.Organic matter contents in all locations sampled were statistically different at $P \leq 0.05$, also, the Organic Matter content at top soil (0.99%) was significantly different from that of sub soil (0. 24%). Similarly, the Organic matter contents in the location x soil depth (LxD) treatment interaction were significantly different in all the sites. The top soil depth in all the locations gave higher Organic Matter content than their corresponding sub soil depth in the study area.

Table 1: Physical properties sand (%), silt (%) and clay (%) of two soil depths in the four locations.

Locations	Sand (%)			Silt (%)			Clay (%)		
	Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
	0 - 15	15 - 30	Mean	0 – 15	15 - 30	Mean	0 - 15	15 - 30	Mean
Amigbo-Ubakala	75.2	65.2	70.2	11.4	15.4	13.4	13.4	19.4	16.4
Ossah-Ibeku	83.2	71.2	77.2	7.4	11.4	9.4	9.4	17.4	13.4
Oloko	83.2	81.2	82.2	9.4	7.4	8.4	9.4	11.4	10.4
Ahiaeke-Ntugbu	67.2	83.2	75.2	19.4	9.4	14.4	13.4	9.4	11.4
Mean (soil depth)	77.2	75.2	-	11.4	10.4	-	11.4	14.4	-
FLSD(0.05) L			4.54			NS			1.23
D			NS			NS			0.87
L×D			6.41			NS			1.74

Table 2: pH and mineral contents (organic carbon (%) organic matter (%)) of two soil depths in four locations.

Locations	pH			% Organic Carbon			% Organic matter		
	Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
	0 – 15	15 – 30	Mean	0 – 15	15 – 30	Mean	0 – 15	15 – 30	Mean
Amigbo-Ubakala	5.34	5.11	5.22	0.51	0.05	0.28	0.81	0.09	0.45
Ossah-Ibeku	6.02	5.03	5.53	0.74	0.09	0.42	1.28	0.16	0.72
Oloko	5.14	5.23	5.53	0.37	0.09	0.23	0.64	0.16	0.4
Ahiaeke-Ntugbu	5.3	5.21	5.26	0.07	0.32	0.2	1.21	0.55	0.88
Mean (soil depth)	5.52	5.15	-	0.42	0.14	-	0.99	0.24	-
FLSD(0.05)L			**NS**			**0.098**			**0.039**
D			**0.26**			**0.07**			**0.028**
LXD			**NS**			**0.14**			**0.06**

Table 3 above shows that Oloko, Ahiaeke-Ntugbu, Amigbo- Ubakala were statistically similar in terms ofNitrogencontent of the soils while Ossah Ibeku in Umuahia South LGA gave statistically the least value (0.045%). The mean of Nitrogen content of the two depths were statistically similar, while the location (L) x Soil depth (D) treatment interactions was significantly different. The difference in the mean Potassium content was significant at P≥ 0.05 except Amigbo-Ubakala and Olokowhich had statistically similar values. The mean Potassium content at sub soil (0.136%) was significantly different from the top soil (0.095%). Sodium contents in Ossah Ibeku and Oloko were statistically similar. Sodium contents decreased with increasing soil depth; the top soil had higher sodium content (0.13%) than the sub soil (0.12%). In terms of Calcium (Ca) contents, Table 3 shows that there were also significant differences between the study sites /locations and the soil depths at P≥ 0.05. The Calcium content decreased with increasing soil depth from top soil (5.20%) to sub soil (4.30%). The Ca contents in Ahiaeke sub soil and Oloko sub soil and Ossah sub soil were statistically similar. The table also shows that no significant difference existed between the mean Magnesium (%) content of the two soil depths. However, there was significant difference between the mean.

Table 3: Mineral Elements (%) Nitrogen (N), Phosphorus (P) Potassium (K), Sodium (Na) Calcium (Ca) and Magnesium (Mg) of two depth in four location

Locations	% Nitrogen Soil depth (cm)			% Phosphorus Soil depth (cm)			% Potassium Soil depth (cm)			% Sodium Soil depth (cm)			% Calcium Soil depth (cm)			% Magnesium Soil depth (cm)		
	0 – 15	**15 – 30**	**Mean**	**0 – 15**	**15 – 30**	**Mean**	**0 – 15**	**15 – 30**	**Mean**	**0-15**	**15 – 30**	**Mean**	**0–15**	**15–30**	**Mean**	**0-15**	**15-30**	**Mean**
Amigbo-Ubakala	0.11	0.08	0.1	13.6	14.9	14.25	0.04	0.06	0.05	0.09	0.13	0.11	6.80	5.70	6.00	5.20	4.00	4.60
Ossah-Ibeku	0.08	0.1	0.05	28.6	12.6	20.6	0.25	0.03	0.14	0.2	0.09	0.14	6.80	4.00	5.40	4.00	2.80	3.40
Oloko	0.11	0.2	1.56	13.6	13.6	13.6	0.05	0.05	0.05	0.11	0.16	0.14	3.00	4.00	3.20	2.00	2.00	2.00
Ahiaeke-Ntugbu	0.08	0.14	1.11	9.17	14.3	11.74	0.05	0.41	0.23	0.13	0.09	0.11	4.00	4.00	4.00	1.60	2.40	2.00
Mean(soil depth)	0.1	0.11	-	16.24	13.85	-	0.01	0.14	-	0.13	0.12	-	5.20	4.30	-	3.20	2.80	-
FLSD (0.05) L			**0.02**			**1.72**			**0.033**			**0.1**			**0.24**			**0.57**
D			**NS**			**1.21**			**0.023**			**0.07**			**0.18**			**NS**
LXD			**0.02**			**2.43**			**0.05**			**0.02**			**0.37**			**0.81**

Magnesium (0.57) content in the four sampled locations using FLSD.

Table 4 above shows that the study sites had significant differences in their mean Exchangeable Acidity (EA) capacity as well as in the soil depths sampled. The EA capacity increased with soil depth. The sub soil had a higher (0.78%) EA capacity than the top soil (0.42%). Similarly, in the Location x Soil Depth (LxD) treatment interactions, the top soil generally gave lower EA capacity than the sub soil at P≤ 0.05.Table 4 also indicates that the ECEC of the soil in the study sites were statistically different between Amigbo-Ubakala (11.32) which had the highest ECEC and Ossah-Ibeku at P≤ 0.05 while Ahiaeke Ntugbu and Oloko had similar values. Percentage Base Saturation (BS) content in the study sites showsno significant difference existed between the locations. However, there was significant difference between the soil depths. In the location x soil depth (LxD) treatment interactions all the samples were statistically similar except Ossah Ibeku sub soil with the least BS% (83.56) which was significantly different from all treatment samples.

Table 4: Exchangeable Acidity (EA) %, Effective Cation Exchange Capacity (ECEC)% and Base saturation (BS)% of two depths in four locations.

Location	Exchange Acidity (EA)			ECEC			Base Saturation (BS)		
	Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
	0-15	15-30	Mean	0-15	15-30	Mean	0-15	15-30	Mean
Amigbo-Ubakala	0.56	0.72	0.64	12.68	10.11	11.32	95.59	92.88	94.24
Ossah-Ibeku	0.32	1.32	0.84	11.51	8.27	9.9	97.23	83.56	90.39
Oloko	0.4	0.48	0.44	5.76	6.69	6.22	93.06	92.82	92.74
Ahiaeke-Ntugbu	0.4	0.56	0.48	6.18	7.09	6.63	93.52	92.1	92.81
Mean (soil depth)	0.42	0.78	0.29	9.03	8.04	0.8	94.85	90.34	2.67
F LSD (0.05) L			**0.42**			**1.14**			**NS**
D			**0.06**			**1.62**			**5.35**
L×D			**0.06**			**1.62**			**5.35**
Interaction L×D		**0.06**		**1.62**		**5.35**			

DISCUSSION

The percentage sand contents of the two soil depths in the rainforest and derived savannah ecosystems were generally high. Soils with high sand content of 70% and above are regarded as sandy soils (Ola-Adams *et al.*, 1998; Uluocha *et al.*,2016). The mean values of rainforest and derived savanna of the study sites for silt and clay were 10% and 15%respectively. The results show that soil of the study area was well drained and aerated. This is in line with the findings of Ola-Adams *et al.* (1998) which stated that soils with mean clay values lower than 20% indicate good drainage andaeration. The low clay contents of some the study site could be attributed to the downward migration of clay due to high rain water percolation of the area. This feature tends to remove fine particles in runoff water and enhance the chemical destruction of 1:1 kaolinite clay which dominates the top soil (Ola-Adams *et al.* 1998; Uluocha *et al.*,2016).

The soils of the study area were generally acidic as the pH level ranging from 4.0 - 5.5. This range could be attributed to marked leaching of exchangeable base due to high intensity of rainfall. This is in line with the result of Osadebe and Enuvie (2008)which reported low pH in areas with high rainfall in Nigeria. The organic matter distribution in the sampled soils were generally low, however,the top soil in the rain forest ecosystem had high organic matter content. This could be attributed to decomposition of organic matterand mineralization of tree roots at the top soil (Ubuoh *et al.*, 2013).

The low Organic Carboncontents of the study sites could be as a result of low Organic Matter contents resulting from bush burning, soil erosion and unsustainable farming practices. Allison (1973) had earlier explained that soil Organic

Carbon content is a medium of storage of plant nutrients, energysourcefor soil microbes and binding agent in the development and stabilization of soil structure. The low Nitrogen (N) contents in the soil could be attributed to loss of mobile nitrates as a result of soil leaching. However, the higher Nitrogen values recorded at Oloko, Amigbo Ubakala and Ahiaeke-Ntugbu areas of the study which were all in the rainforest zone could be as result of decomposition of solid wastes materials around the erosion sites. The relatively high-levelPhosphorus (P) in the sampled sites showed it wasunder- utilized due to the near absence of tree species in the erosion sites. Aluko (2001) reported that trees depend on soil Phosphorus for biomass production. Some of the waste materials littered around the erosion areas could be rich in Phosphorus and therefore contributed to the high Phosphorus contents of the soil.

The concentration of Cation Exchange Capacity (CEC) K, Ca, Mg and Na appeared to decrease with soil depth except in the sub soil of the rainforest. Generally, low levels of exchangeable cations and effective cation exchange capacity (ECEC) recorded in the soils at various locations indicated that the soil wee infertile. The result was in agreement with Jimoh(2010) who obtained similar results and attributed the trend to the effect of human activities. The effective cation exchange capacity (ECEC) depends mainly on the soil organic matter level and clay fraction which control nutrient absorption and release (Jimoh,2010). The low ECEC contents could be attributed to the low organic matter and percentage clay content. Ufot *et al*., (2016) reported that the loss of organic matter and acidification result in the decrease in the ECEC and loss of Ca and Ma.

The results of the base saturation (BS) show that the erosion sites have potential for productivity if rehabilitated. Aina, (2008) reported that most agricultural crops grow best when the base saturation is 80% or more and the pH is 6 or above. With the exception of Amaekpu-Ohafia and Oruruala-Amiyi, all in the derived savannah, the mean base saturation (BS) of the sampled soils of the other locations of study were above 80%. Soil erosion, affects soil physical and chemical properties and undermines the biological processes supporting nutrient cycling in soils, and impairs the capacity of these resources to sustain long-term productions (Ogunkunle, *et al.*, 1992; Aina, 2008).

CONCLUSION

The result obtained from this study revealed that Oloko in Ikwuano LGA. had significantly the highest sand content. Also, there were significant differences between the clay contents (%) of the two soil depths in the study sites. pH level in the soils of the study sites/locations in the rainforest ecosystem were not significantly different. Sodium contents decreased with increasing soil depth. %). Calcium contents shows that there were also significant differences between the study sites. For BS% content in the study sites, no significant difference existed between the locations, however, there was significant difference between the soil depths. It is then concluded that agriculture land use in Nigeria often results in the degradation of natural soil fertility and reduced productivity. The causes of this degradation in Nigeria include both natural and anthropogenic sources. The impacts include loss of human and animal lives, loss of properties and land resources.

This study recommends improved farming techniques, cultural method of gully control, and enactment of laws against any activities that favour gully growth. Though, if all the suggested solutions are carefully looked into, it is believed that the incidence of gully erosion in Nigeria would be drastically reduced and the security of the lives of Nigerians and their properties will be guaranteed.

REFERNECES

Abdulfatai, I., Okunlola, I., Akande, W., Momoh, L., and Ibrahim, K. (2014). Review of gully erosion in Nigeria: causes, impacts and possible solutions. *Journal of Geosciences and Geomatics,* 2(3): 125-129.

Abia State Handbook (1997). Published by Ministry of Information, Culture and Sports Umuahia, Nigeria. 1991-1997.

Aina, P.O. (2008). Soil changes resulting from long-term management practices in Western Nigeria. *Soil Sci. Society of America continuer journal of agronomy* 2: 8-18.

Allison, F. E (1973) Soil organic matter and its role in crop production, Elsevier publishers, New York.

Aluko, A.P (2001) Impact of plantation forestry on nutrient status in degraded soil for environmental management at Onne, Rivers State, Nigeria. In Forestry and National Development (ed) L. Popoola, J.E Abu and P.I Oni 27th Annual Conf. Proceeding of FAN. Abuja Nigeria.

Aregheore,E.M. (2005) FAO Grassland and pasture crops, South pacific special.

Dewis, J. and Freitas, F. (1990) Physical and chemical methods of soil and water analysis, FAO Rome pp:275.

Ezezika, O.C and O. Adetona (2011). Resolving the gully erosion problems in southeastern Nigeria: Innovation through public awareness and connectivity-based approaches. *Journal of Soil Science and Environmental management* 2(10): 286-291.

Hammad, A.H.A., Børresen, T., and Haugen, L. (2006). Effects of rain characteristics and terracing on runoff and erosion under the Mediterranean. *Soil and Tillage Research*, 87(1), 39-47.

Hulugalle, N.R., Lal, R., andGichuru, M. (1990) Effect of five years of no-tillage and mulch on soil properties and tuber yield of cassava on an acid Ultisol in south-eastern Nigeria *Experimental Agriculture*.26(02), 235-240.

Idah, P.A; Mustapha, Musa,H.I and Dike, J.J (2008) Determination of erodibility indices for soil in Owerri West Local Government Area of Imo State, Nigeria, A.U.J.J: 130-133

Jackson, M, L (1964). Soil chemical analysis. Prentice Hal INC. Engelwood Cliff. *New Jersey pp*56-92.

Jimoh, H.I (2010). Managing landuse to control soil erosion problems in a part of Kwara State of Nigeria. *Journal of geography and Regional Planning*, 4(1): 36-41.

Keay, R.W.T. (1959). An outline of Nigerian vegetation 3rd edition Federal Ministry of Information printing division, Lagos.

Kettler, T.A, Doran, J.W. and Gilbert, T.L. (2001). A simplified method for soil quantity analysis. *Soil science of America journal, 65:859-852*

Min Liu, D, Kissel, E; Vendrell and Cabrera,M.L (2004) soil lime requirement direct filtration with calcium hydroxide. *Soil science of America Journals 68:1228-1233.*

Montgomery, D. R. (2007) Soil erosion and agricultural sustainability. *Proceedings of National Academy of Science. USA*,104, 13268–13272.

N.P.C (2006). National population commission

Nuga, B., Eluwa, N., Akinbola, G., &Wokocha, C. (2006). Characterization and Classification of Soils Along a Toposequence in Ikwuano Local Government Area of Abia State Nigeria*Agricultural Journal*, *1*(4), 192-197.

Nyakatawa, E.Z.; Reddy, K.C.; and Lemunyon, J.L. (2001). Predicting soil erosion in conservation tillage cotton production systems using the revised universal soil loss equation (RUSLE). Soil and Tillage Research 57(4): 213-24.

Obidimma, C. E. and Olorunfemi, A., (2011) Resolving the Gully Erosion Problem in Southeastern Nigeria*:* Innovation Through Public Awareness and Community – Based Approaches, *Journal of Soil Science and Environmental Management Vol 2(10), 286-291*

Ogunkunle, A.O. and Eghaghara, O.O. (1992) Influence of Land Use on Some Soil Properties in a Forest Region of Southern Nigeria. *Soil Use and Management*, 8(3), 121 – 125.

Ola-Adams, B.A,Ojo, P.A. and Adegunji, M.T. (1998) Accumulation of soil Nutrient under different Forest land-uses: *Nigerian Journal of Forestry*, 28 (1): 2:5-10.

Onweremadu, E. (2007). Pedology of near gully sites and its implications on the erodibility of soils in central South-Eastern Nigeria. *Research Journal of Environmental Science*, *1*(2), 71-76.

Osadebe, C. C. and Enuvie, G., (2008). Factor Analysis of Soil Spatial Variability in Gully Erosion Area of southeastern Nigeria: A Case Study of Agulu- Nanka-Oko Area, Scientia Africana, Vol. 7 (No.2), Pp. 45.

Pimentel, D., (2006). Soil erosion: a food and environmental threat. *Environment, Development and Sustainability* 8(1): 119-137.

Rahman, E.L., M.A. Abd, Ali, R.R, Hussain, M.A and M. A El-Semey (2009), Remote Sensing and GIS based physiography and soils mapping of the Idku-Brullus Area, North Delta, Egypt: *Egyptian Journal of Soil Science*,49 (3): 209-432.

Relf, D. (2001). Reducing erosion and runoff. Virginia Cooperative Extension, Publication No. 426-722, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

Sutherland, R.A and Dejong, E (1990). “Estimation of sediment redistribution within agricultural field using Caesium-137, Crystal springs, Saskatchwan, Canada”. *Applied Geography*, 10: 205-221.

Ubuoh, E.A, Akhionbare, W.N, Onweremadu, E and O.A Onifade (2013), Characterization of Soil Quality in erosion prone environment of Ukpor, Nnewi-South L.G.A of Anambra State, Nigeria. *International Journal of Advances in Applied Sciences 2(1):1-8.*

Ufot, U.O., Iren, O.B., and C.U. Chikere-Njoku (2016). Effects of Land use on Soil physical and Chemical properties in Akokwa area of Imo State, Nigeria. *International Journal of Life, Science and Scientific Research, 2 (3):1-6.*

Uluocha, O. B., Udeagha, A. U. andUmeojiakor, A. O. (2016).Effect Of Land Use On Nutrient Content In Soil And Leaf Litter Under Bamboo Trees (BambusavulgairsShrad Ex J.CWendl) In South Eastern. *International Journal of Agriculture and Rural Development*, 19(1): 2511-2516.

Uwanuruochi, A., and Nwachukwu, O. (2012). Impact of erosion on selected soil structural indices of four Local Government Areas of Abia State, Nigeria. PAT, 8(2), 127-133.

Walkley, A. and Black, C.A. (1965) Organic Carbon, In: Black, C.A. (ed) Method of Soil analysis. Madson, *American Society of Agronomy*. *V(*4): 1372-1375.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Gana, 2019

TOURISM AS A STRATEGY FOR POVERTY REDUCTION FOR RURAL AREAS IN NIGERIA: A STUDY OF KUTIGI TRADITIONAL HAT AND FAN MAKING

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ABSTRACT

Poverty is regarded as the world epidemic disease that must be killed otherwise it will kill its victims. Poverty comes in different forms such as hunger, deprivation of social amenities by governments especially at the rural areas, inability to earn a daily living, inability to secure job opportunities which could be by government or private firms, and deliberate attempt to neglect certain section of the country either through tribe, region or religion. The study focused on tourism as a strategy for poverty reduction for rural areas in Nigeria, with emphasis on Kutigi traditional hat and fan making. Tourism is an industry that concerned itself with movement of people from one destination to another for the purpose of leisure and relaxation for a period of at least 24 hours. Tourism has diverse forms, however, the study centred on rural tourism. It is a form of mass tourism or alternative tourism which centred on rural natural destinations, handicrafts, and eco-tourism to enhance tourists' experience. The study use qualitative research and interview method to collect data for the study. Seven families, comprising of their heads were interviewed for a period of one week due to the fact that they were predominantly illiterates. The population of these traditional handicrafts range from 100 to 200 scattered among interior villages, and their monthly income is between ₦100, 000. 00 to ₦300,000.00 depending on the market demands of their products. The study therefore, found that rural tourism reduces poverty, creates employments, enhances living standard of the rural people, and develop rural areas.

Keywords: Poverty, Tourism, Rural tourism, Mass tourism, Kutigi, Rural area

INTRODUCTION

Tourism is a process of visiting a location or places perhaps for the benefit of leisure and relaxation which provides economic benefits to the host communities. The benefits provided by tourism industry to the host communities, and governments are the single factor that makes tourism a universal provider of foreign exchange earnings, income generation, employment, and socio-cultural development of rural areas across the globe. It seems to be a catalyst for rural development and poverty reduction especially for communities and governments which have realized its potentials. However, Yusuf *et al.*, (2017) found in their studies that rural areas and its people have not received developmental attentions it deserves on tourism potentials. Hence, rural areas, especially in Nigeria continues to be backward and known to be low income generators, and socially backward. They concluded that integration of rural areas particularly focusing on tourism becomes pertinent and necessary for the achievement of reduction of rural-urban migrations for white-colar jobs and other social amenities. It is on this premise that Henama, *et al.*, (2016) echoed that tourism attracts foreign exchange and foreign direct investments that stimulates home economies. For instance, Henama, (2017) reiterated that tourism has become alternative survival strategies for South Africa government which before independent and the days of apartheid solely depended on gold mining, while a country like Nigeria is yet to develop its tourism potentials.

Globalization effects has not only necessitates countries, organizations, and individuals to restructure their economic base, but continually searching for alternatives like tourism as the most viable socio-economic development catalyst. Rodriguez-Pose and Hardy (2015) observed that informality is a distinct facet of tourism economies in the developing world and global world respectively. Therefore, tourism induces other industries such as transport, hospitality, agriculture, and manufacturing which consequently has direct, indirect and induce impact at the destination economy Gana, (2018). It should be borne in mind that the tourism destination experiences create backward linkages in other industries like aviation industry which serve as tourism supply chains impact.

The United Nation World Tourism Organization (WTO) (2004) reported that tourism is currently the world's largest industry with annual revenues of over $3 trillion dollars; and that tourism provides over six million jobs in the United States, making it the country's largest employer.

Besides, the development of mass travel and standardization of tourist's services, it seems that people have turned to natural, preserved and clean environment which could be found in rural areas in search of an authentic experience. The attraction of rural areas to tourists is therefore connected with the possibility of satisfying needs for relaxation, vacations or holiday making, and gaining knowledge about people, cultural, and environment which are natural in nature. It is on this premise that Petroman (2013) reported that the development of rural tourism are linked to the experiences of privileged social class (the feudal lords, the bourgeoisie, and the aristocracy) who spent their time in rural areas. More so, intensive development of rural tourism in rural areas linked to the year 1970 in developed countries, which has contributed to the strengthening of villages in economic and social terms.

Therefore, rural tourism visa-vis rural areas composed of high-quality natural resources, rich cultural and historical heritage, traditions, events, and handicrafts which are integrated for the betterment of tourists experience and relaxation which rural tourism focused upon. They however argue that due to the infancy of tourism as a developmental strategy in developing countries like Nigeria, there is need for more research to expose its potentials to individuals and nations. This was further corroborated by Koens and Thomas (2015) that although, policy makers have attached importance to tourism development in developing countries; this has been insufficiently examined by academic researchers. In line with these arguments, Abbas (2016) noted that despites efforts put in place by governments and individuals in reducing poverty in Nigeria, the outcome across the country remain worrisome. This study is therefore conducted to bridge the gaps in order to facilitate the attention of individuals and governments towards tourism as a strategy for reducing poverty among rural people in Nigeria with focus on Kutigi local fans and hats making. Therefore, the development and attraction of tourists to any tourist destination will not only enhance economic development but also it will open-up various employment opportunities for local people. Hence, the targeted area of rural tourism is summarized by World Tourism Organization (2004) in Figure 1 below:

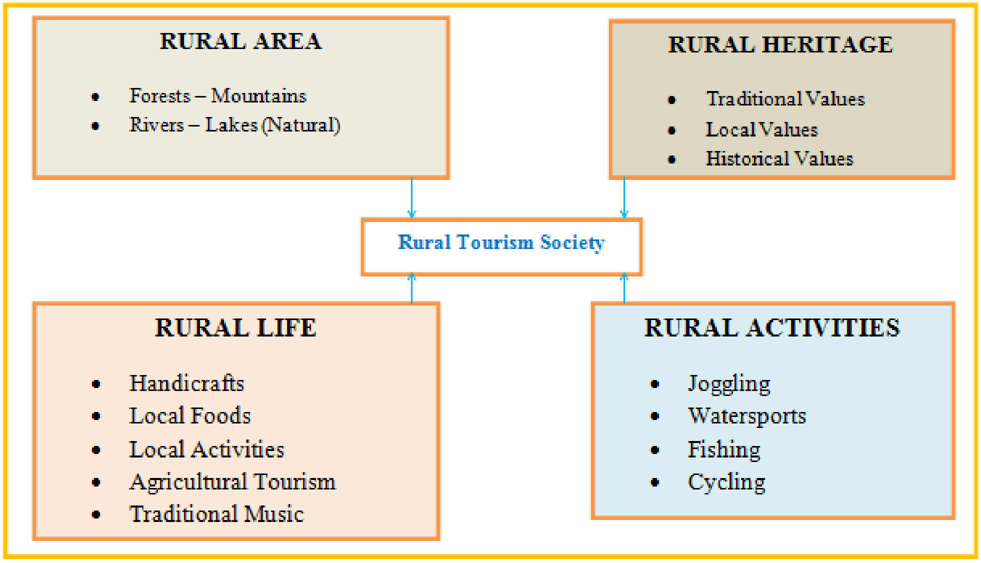

Fig. 1: Targeted Area of Rural Tourism.
Source: WTO (2004)

MATERIALS AND METHODS

Study Area

Kutigi is the Local Government Headquarters of Lavun LGA and has an area of 2,835 km^2 and a population of 209,917 (National Census, 2006). The people are predominantly peasant farmers, producing rice, sorghum, maize, millet and guinea-corn. There are two main seasons, the rainy season and the dry season with luscious guinea savanna vegetation of herbs, shrubs and various tree species like *Daniella oliveri, Parkia biglobosa, Vitelleria paradoxia, Vitex doniana, Terminalia mentalis, Khaya senegalensisand Ceiba petandra.*

Kutigi traditional handicrafts comprise of six families, and three of these families are Ndaceko, Dakpan and Cekpako and they are known for their specialization in local fan production. The other three families, the Wonko, Tsama and Wunru specialize in hat production. These local handicrafts Fig.2, were produced from the guinea corn husk which are gathered and sun dried after harvest.

Fig. 2: Samples of Handicraft Products from Kutigi.

The locals affirmed that an experienced weaver can produce five of the mats or fans in a day especially the ones without names inscribed on them while the ones with names takes a longer time and days to be completed depending on the number of letters the names carry. Rural tourism is an industry that occupies significant position in the affairs of an individual, people and communities due to the fact that its contributions to human development and capital generation are enormous. It is on this basis that Kutigi handicrafts, is viewed as a strategy for poverty reduction and promoter of rural tourism.

Thus, rural tourism aims at increasing net benefits of rural economy, conservation of cultural diversity, strategy for diversifying rural resources and alleviates poverty associated with rural dwellers in our society. It is liken to community- based tourism which serves as a catalyst for socio-cultural, environmental, and economic needs of the rural communities through offering of their products to tourist who visits rural tourism destinations. The rural communities benefit directly from the tourism industry and serves as a turn- around for small-scale enterprises and job creation, and thus uplifting the living standard of the local communities. Thus, the research questions for this study will include; does rural tourism reduce poverty level, create employment, enhance living standard of the rural people and develop rural areas.

Data collection

The study adopted an observational rapid field survey procedure as recommended by Malgosia *et al.*, (2013) which included combining data from survey, documentation, and information from key players, interviews and questionnaire. The interview was centered on four areas which included – poverty reduction through rural tourism, creation of employment, living standard of rural people, and development of rural areas through rural tourism. The study focused on traditional handicrafts, the popular Kutigi hats and fans making. Seven family heads with a population of 200 people were interviewed which was conducted among the scattered villages in one week.

RESULTS AND DISCUSSION

Poverty reduction through rural tourism.

The interviewees reported that there was high demand for their products as souvenirs for wedding, naming, and housing warming ceremonies; especially those with names inscribed on them which cost between ₦4,000.00, ₦3, 000.00 and ₦1,000.00 each respectively. While those without names inscribed cost between ₦400.00, ₦300.00, and ₦200.00 each depending on their sizes. The total monthly sales ranges between ₦100, 000.00 to ₦300,000.00 depending on the demands and quantity to be supply in advanced.

This analysis demonstrated that local tourism industries indeed reduce poverty looking at the amount of money realized from the sales of local handicrafts like fans and hats as souvenirs. This is in line with the finding by Eneji *et al.,* (2016) that rural tourism is one of the fastest growing industries with an annual growth of 5 percent worldwide and represents 6 percent of the world Gross Domestic Product. This was also supported by Hailaly (2016) opined that tourism contributes significantly in socio-economic and cultural development of the rural communities. This means that if rural tourism is opened-up focusing on inter-state and international tourists patronize on local handicrafts, this will increase its demands, earnings, and thus have multiply effects on government taxes to provide social amenities to the citizens.

Tourism creates employment

The interviewees response as to the number of houses and an average number of people involved in making these local handicrafts; their response was that it comprises of 15 houses that has between 100 to 200 adults, and young people. These analyses imply that rural tourism actually creates employment. These families depend entirely for their daily earnings from these local handicrafts, and if rural tourism is encouraged through good policies and innovative skills among our youths, this will reduce unemployment in the country and fasten rural development. For example, the World Poverty Clock (2018) reported that 86.9 million Nigerians are living in extreme poverty and if rural tourism is encouraged it will reduce pressure on governments for white-collar jobs especially among the youths.

Rural tourism enhance living standard of rural people

The response of the interviewees with regards to rural tourism enhancing living standard is that the locals do not depends on the governments for their livelihood; rather, they solely depend on their handicrafts which they inherited from their fore-fathers. Their children are trained in schools from the proceeds realized from the local handicrafts. This assertion was supported by the findings of Strydom *et al.,* (2018) who reiterated that rural tourism serves as the spin around for small-scale enterprises and job creation, and enhancing living standard of the local communities. Rural tourism or handicrafts requires little capital for the take off as opposed to the modern businesses which requires reasonable capital that entails collateral securities, which the local entrepreneurs are unable to meet. It is on this premise that Ojo (2014) found that poverty is a world-wide epidemic that will continue to inflict rural communities except local tourism is strengthened to serve as strategy to reducing poverty at the local level.

Rural tourism develop rural areas

In response to the above, the interviewees reported that rural tourism develop rural areas through patronage of tourists who socialized with the locals, purchase their local handicrafts and encourages local set-up of eateries, super markets, lodgings, and organization of cultural music which tourists cherished most. This is in consonance with the findings by Bukola *et al.* (2018), affirmed that tourism development has a significant impact on sustainable economic development, and it has assumed a social dimension of poverty reduction in the developing world in addition to its traditional role of foreign exchange earnings. It can be inferred that rural tourism as an industry serves as an instrument of poverty reduction for rural areas especially among the under-developed and developing countries like Nigeria.

CONCLUSION

Poverty is a world-wide epidemic disease that must be curtailed and one way of achieving this, especially among the developing countries like Nigeria is diversifying the economy to embrace tourism, with specially attention to rural tourism.

Recommendation

The following recommendations were suggested based on the findings of this study:

1. There should be good policies-framework in Nigeria towards the development of rural tourism
2. Inter- state and intra-state tourism should be encouraged
3. Rural infrastructure should be revisited among states' and local government authorities.
4. Indigenous and local handicrafts should be encouraged among Nigeria youths especially in technical schools.

REFERENCES

Abbas, A.I.(2016) Between Policy Expectation and Realities of Poverty Reduction Efforts: An Assessment of National eradication Programme (NAPEP) in Yobe State, Nigeria. *Journal of Social Science for Policy Implementation. 4(1).* 37-62.

Bukola, A.A and Olaitan,L.L (2018) Tourism development and sustainable economic development : evidence from South West Nigeria. *South Asia Journal of Social Studies and Economics. 6(3)* 1-9

Eneji, M.A., Odey, F.A and Bullus , L (2016) Diversification of Nigeria's Economy :Impact of tourism on sustainable development in Nigeria. International *Journal of Research in Humanities and Social Studies*. 3(5) 36-44.

Gana, M.A. (2018) Effects of crisis in tourism destination markets: A study of Yankari Game Reserve, Bauchi State , Nigaria. *Journal of Hospitality and Tourism. 9(2).* 10-18.

Henama, U.S., Acha-Anyi, P.N and Sifolo, P.P.S. (2016) The low cost carrier bandwagon lessons fo Skywise-Airline. *African Journal of Hospitality, Tourism and Leisure. 5(2)* 1-10.

Hailey, J.F (2016) Race, Ethnicity, Gender and Class: *In The sociology group conflicts and change*. 8th Ed. California: Thousand Oaks.

Koens, K and Thomas , R (2015) Is small beautiful? Understanding the contribution of small businesses in township tourism to economic development. *Development Southern Africa 32(3)* 320-332.

Malgosia, M. Asmelash, H.T. and Micheal, N. (2013) Managing risks to Agricultural livelihoods. Impact evaluationof the Harita Program: *In Tigray, Ethiopia*. 2009-2012.

National Population Census (2006).

Ojo, J.S. (2014) Managing Tourism for socio-economic development in Nigerian Local Government: A case study of idare Local Government. *Journal of African studies and Development. 6(2)* 29-35.

Petroman, I. (2013) Types of cultural tourism. Scientific Papers Animal Science and Biotechnologies 46(1) 385-388.

Rodriguez-Pose, A and Hardy, D (2015) addressing Poverty and inequality in th rural economy from a global perspective. *Applied Geography*, *61*. 11-23.

Strydom, A.J., Mangope, D and Henama, U.S. Making community base-tourism sustainable: Evidence from the free State Province, South Africa. *Geo-Journal of Tourism and Geosites 24(1)* 7-18.

World Poverty Clock. (2018). https.worldpoverty 10. Accessed 8th August, 2019.

World Tourism organization (2004). Statistics and economic measures of tourism. Retrieved *8th August, 2019* www.world-tourism.org.

Yusuf, I.D., Abbas, B., Husain, M.A. and Mohammed, R.I. (2017) Appraisal of the contribution of Non-Government Organisations NGOs to poverty alleviation and community development in Gombe State. *American Journal of Engineering Research*. 32-40.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adeoti, 2019

VOLUME EQUATIONS FOR FIVE ECONOMIC HARDWOOD SPECIES IN OLUWA FOREST RESERVE, ONDO STATE, NIGERIA

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ABSTRACT

Tropical rainforest remains one of the most complex ecosystems in the world. Tree growth dynamics is a major technique in quantifying the forest composition. However, there is dearth of knowledge on tree volume equations of hardwood tree species in the tropical rainforest especially in Nigeria. Therefore, this study was carried out to develop tree volume equations for selected economic hardwood species (Lovoa trichiliodes, Celtis zenkeri, Picralima nitida, Buchlozia coriacea and Diospyros crassiflora) in Oluwa Forest reserve, Nigeria. Two transect (500m) were laid in the study area, in which distance between each transect was 400m. Systematic sampling technique was adopted to lay four temporary sample plots (TSP) on each transect making a total of Eight TSPs (size 50 x 50m) for the study. All tree species of the aforementioned hardwood species with dbh ≥ 10cm were identified in each TSP. Five models were selected as candidate models for the study. The result revealed that nonlinear model produced the best fit for Buchhlozia coriacea, Celtis zenkeri, Diospyros crassiflora and Picralima nitida while generalized nonlinear model produced a better fit for Lovoa trichiliodes. Residual analysis was carried out to validate the best fitted model for each species. The selected models (Nonlinear and Generalized nonlinear equations) can be very useful for sustainable forest management assessment of Lovoa trichiliodes, Celtis zenkeri, Picralima nitida, Buchhlozia coriacea and Diospyros crassiflora plantations in the study area and similar ecological areas.

Keywords: Volume Equation, nonlinear model, generalized nonlinear model

INTRODUCTION

Tropical Rain Forest (TRFs) is one of the most diversified and a complex ecosystem types in the world (Ojo, 2004). This ecosystem experiences high average temperatures and a significant amount of rainfall yearly. It occupies a total area of 1818.43 million hectares, representing 47% of the total land area occupied by all forest types of the world (Ige *et al*, 2013). Tropical Rain Forests exhibit high levels of biodiversity. TRFs are home to half of all the living animal and plant species on the planet and two-thirds of all flowering plants can be found in rainforests (Wikipedia). It is likely that there may be many millions of species of plants, insects and microorganisms still undiscovered in tropical rainforests. There are very distinct layers of trees in a tropical rain forest. These layers have been identified as the emergent, upper canopy, understory, and forest floor. Each layer is a unique biotic community containing different plants and animals adapted for life in that particular stratum. A report by the Food and Agriculture Organization quoted by Ettah (2008) estimated that tropical countries are losing 127,300 km of forest annually (Jacob *et al* 2015). In view of the great value of the tropical rain forest and the grave consequences of losing it to unregulated logging activities and over-exploitation, it has become the focus of increasing public attention in recent years (Morris, 2010).

Nigeria has a tropical climate with variable rainy and dry seasons, depending on location. The main vegetation patterns run in broad east-west belts, parallel to the Equator. Mangrove and freshwater swamps occur along the coast and in the Niger delta and low rain forest. The most prominent wood industry in Nigeria is the sawmilling industry. In a review of the wood-based industrial sector in

Nigeria, (Ogunwusi, 2014) reported that there were 1300 sawmills in the country. With recent economic reforms and Government efforts i.e. Introduction of the REDD++, Consolidation and expansion of the forest estate and its management for sustained yield, Forest Conservation and protection of the environment; Forest regeneration at a rate greater than exploitation, Reduction of waste in utilizing both the forests and its products, Protection of the forest estates from fires, poachers, trespassers and unauthorized grazer towards poverty reduction, it is likely that this number has increased(Wikipedia).

The wood industries rely mainly on the natural forests as reservoir of wood resources to meet their growing demand. Although large areas of plantations exist, natural forests are of greater attraction to timber contractors due to their wide variety of species and sizes (Fuwape, 2003). Furthermore, many of the well-known indigenous timber species are yet to be established as plantation species on a large scale. Tree volume measurement is a laborious and time consuming task, even for felled trees. In modern forestry practice, one of the most common reasons for taking such measurements is to develop stem volume functions or taper functions, for a particular tree species in a particular forest region. Volume functions allow estimation of the total stem volume of a standing tree from simple measurements, usually its diameter at breast height over bark and its total height (Hernan Attis Beltran *et al*, 2017).Tree volume equations are commonly developed from measurements of tree height and diameter at a number of points along the main stem (Norman *et al* 1998). These are used to predict the content of stems of standing trees, the predictor variables required in order to achieve acceptable accuracy vary by tree form. This form is typical of many conifers and few hardwood species such as yellow poplar (Harold and Margarida, 2012).

Decurrent (also called deliquescent) crown forms result when lateral branches grow as fast or faster than the terminal leader, decurrent crowns are typical of many hardwood species such as elms, oaks and maples. For excurrent forms, the usual predictors for stem volume are diameter at breast height (dbh) and total tree height (Harold and Margarida, 2012)

Total tree height is generally not highly correlated with the volume of the main stem of interest for decurrent tree forms, and a measure of merchantable height may be employed instead. For shrub forms estimation of volume in multiple stems requires additional independent variables, as well as use of diameter at root collar in lieu of diameter at breast height. (Harold and Margarida, 2012). Much of the research on estimating stem volume of trees has been directed towards excurrent forms and involves dbh and total height as predictors. Varying units for the dependent variable have been employed but cubit units are most commonly used, general conclusions reached for estimating cubit volume of stems apply if other measures of volume are used (Burkhart and Tome, 2012).

MATERIALS AND METHODS

Study Area

This study was carried out in Oluwa Forest Reserve, Ondo State, located in the Western part of Nigeria (Fig. 1) on Latitude 6.91°N and Longitude 4.59°E with an area of 827 km^2 and falls within the tropical rainforest. It is 50km east of Omo and 26km from Ore .The topography is undulating with a mean elevation of 90m above sea level, mean relative humidity of 80% and daily temperature of 25˚C. The vegetation of the study area is a mixed/moist semi-evergreen rainforest (Udoakpan, 2013). Although the reserve is biologically unique, it is threatened by logging, hunting and agriculture activities. The natural vegetation of the area in tropical rainforest characterized by emergent with multiple canopies and lianas. The forest comprises of Natural forest and plantations (*Tectona grandis*, *Gmelina arborea* among others) the natural forest is 8km^2 comprising of varieties of indigenous species which includes *Khaya ivorensis*, *Milicia excelsa*, *Afzelia bipindensis*, *Brachystegia nigerica*, *Lophira alata*, *Lovoa trichiliodes*, *Terminalia ivorensis*, *Terminalia superba*, and *Triplochiton scleroxylon.*

The rainy season in the reserves occurs from March to November while the dry season, is from December to February. Annual rainfall ranges from 1700 to 2200 mm. Annual mean temperature is about 26°C. Soils are predominantly ferruginous tropical, typical of the variety found in intensively weathered areas of basement complex formations in the rainforest zone of south-western Nigeria. The soils are well-drained, mature, red, stony and gravely in upper parts of the sequence. The texture of topsoil in the reserves is mainly sandy loam (Onyekwelu *et al.*, 2008; Adeduntan, 2009).

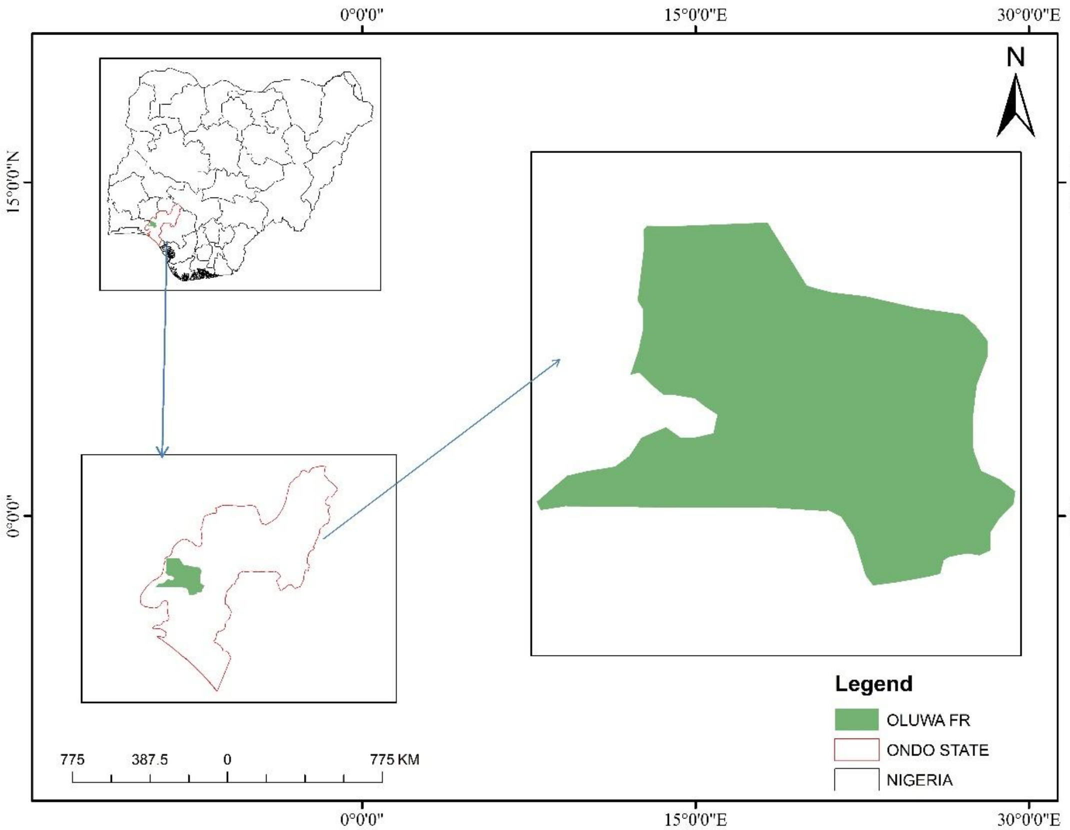

Fig.1: Map of Oluwa Forest Reserve in Ondo State, Nigeria.

Sampling Procedure and data collection
Systematic sampling design was used for the laying of plots. Two transects were laid of 400m apart at the center of the forest. Eight (8) Sample plots of equal size (50 × 50m) were laid in alternate direction along each transect at 100m apart (Fig 2). In each plot, all selected species with diameters ≥ 10cm (diameter at breast height) were identified and diameter at breast height (dbh), diameter (overbark) at base, breast height, middle and top positions along the stem, and stem height to the Crown Point, merchantable and total height were measured.

Data Analysis and Modeling The Tree Volumes were estimated for merchantable portion of the stem because the study is particular about the marketable part of the species selected. The Merchantable volumes for the selected tree species were first computed using the Newton-Simpson's formula (Ige, 2018) expressed as:

$$V = \pi \frac{H}{24}(D_b^2 + 4D_m^2 + D_t^2) \qquad \ldots\ldots\ldots\ldots\ldots [1]$$

Where: V = merchantable volume, overbark (in m^3),
H = merchantable height (in m),
D_b= diameter at the base (in m),
D_m = diameter at the middle position along the stem overbark (in m), and
D_t = diameter at the top (in m).

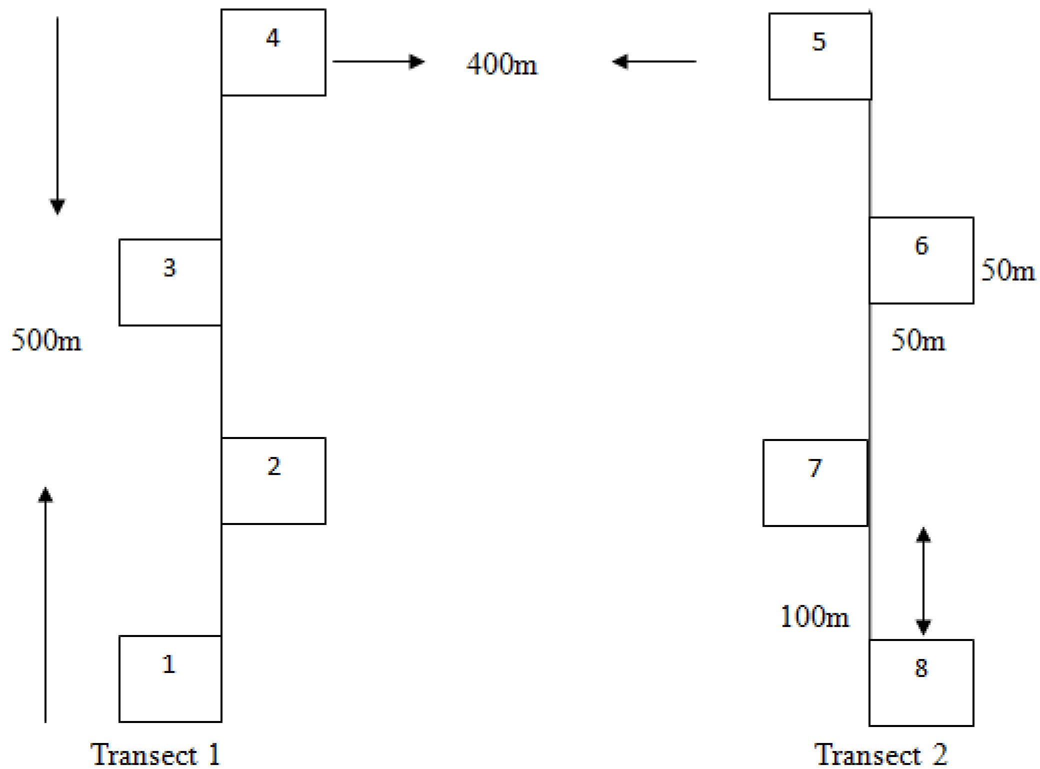

Fig.2: Plots location using systematic sampling

Following the computation of tree volume, the data was divided into two parts and 70% of the data was summarized by computing simple descriptive statistics for each species. The statistics included number of observations, range, mean and standard error of the mean. Graphs were also plotted to examine the relationship between the variables.

Correlation matrix was generated for the predictor variables and the response variable and these helped to determine the predictor variables that correlated more and well with the response variable. Diameter at breast height (DBH) was found to correlate most with the merchantable volume. Residual graphs and scatter diagrams were also plotted to portray the relationship between tree volume and diameter at breast height and Merchantable Volume and Merchantable Height. Series of regression equations were fitted to the data based on the relationship between variables.

The Five (5) modified volume equations were assessed and compared with each species on the basis of their correlation coefficient, coefficient of determination, variance ratio and standard error of estimate and Mean square error. The formulated model was adjudged based on the Co-efficient of determination (R^2), Mean Square Error (MSE) i.e. the model with the highest R^2, and least M.S.E were selected as a suitable model for the tree species.

The remaining 30% data were used on the modified equations for validation, this was to ensure the volume equations are biological plausible. T-test was used to compare the observed and predicted volume at 0.05 level. Generally, for a model to be biological plausible, it is expected that the test should produce a non-significant result (0.05).

Table 1: Modified Volume Equations for Five Economic Hardwood Species in Oluwa Forest Reserve, Ondo State, Nigeria.

Model No	Model type	Modified Model	Equation Numbers
1	Transformed Logarithm	$Ln\, V = b_0 + b_1 \ln \mathrm{D} + b_2 \ln H_i$	**[2]**
2	Constant Form	$V_i = b_1 D_i^2 H_i$	**[3]**
3	Non linear	$V_i = e^{b_1} D_i^{b_2} H_i^{b_3}$	**[4]**
4	Generalized combined	$V_i = b_0 + b_1 D_i + b_2 H_i + b_3 D_i^2 H_i$	**[5]**
5	Generalized Non linear	$V_i = b_0 + b_1\, D_i^{b_2} H_i^{b_3}$	**[6]**

b_0**.....**b_3 = regression constants D=diameter at breast height H= Merchantable Height.

RESULTS

The table below shows the distribution for Five Economic Hardwood Species in Oluwa Forest Reserve, Ondo State, Nigeria. It was observed in Plot 1 and 2 that *Celtis zenkeri* were highly dominated having 13 and 18 stems respectively while for plot 3, 4, and 8 *Picralima nitida* were highly dominated having the same number of stems of 7. Also, in plot 5 *Picralima nitida* has the highest number of stems followed by *Lovoa trichiloides* with 6 and 5 stems respectively. In the case of plot 6, *Celtis zenkeri* and *Picralima nitida* were high dominated with 7 stems.

Table 2: Distribution of Five Economic Hardwood Species in Oluwa Forest Reserve, Ondo State, Nigeria on Plot basis.

	Tree species				
Plot (50m x 50m)	***Buchhlozia coriacea***	***Celtis zenkeri***	***Diospyros crassiflora***	***Lovoa trichilioides***	***Picralima nitida***
1	4	13	7	3	8
2	9	18	5	2	8
3	0	3	1	1	7
4	3	6	2	4	7
5	2	3	1	5	6
6	3	7	5	5	7
7	4	4	3	1	5
8	6	5	1	4	7

Table 3, shows the growth characteristics of the five economic hardwood species in Oluwa Forest reserve. The result of the descriptive statistics shows that *Picralima nitida* has the highest diameter at breast height (Dbh) with 50.2 cm in girth while *Celtis zenkeri* has the lowest with 10cm while for the Stem Height (SHt) i.e. from the stem height to the crown point, *Bucholzia coriacea* has the highest Stem height of 33.6 m with the minimum stem Height of 4.3m also for Volume, *Picralima nitida* has the maximum volume with 3.56m^3 and the minimum volume of 0.008 m^3.

Table 3: Descriptive statistics of five economic hardwood species in Oluwa Forest Reserve, Ondo State, Nigeria.

Species	Tree Variable						
	HD (cm)	DBH (cm)	Dm (cm)	Dt(cm)	SHt(m)	MHt(m)	Vol(m^3)
Buchhlozia coriacea							
Mean	21.5	17.5	12.2	8.7	12.1	8.0	0.156
Standard Error	1.161	1.118	0.938	1.023	1.063	0.778	0.035
Minimum	13.5	10.1	5	2.5	4.3	2.1	0.010
Maximum	35.5	32.3	24.1	25	33.6	24.3	0.865
Celtis zenkeri							
Mean	24.3	20.2	13.8	9.3	15.1	10.8	0.313
Standard Error	1.194	0.998	0.924	0.749	0.672	0.542	0.062
Minimum	11.3	10	5	2.5	5.2	2.6	0.008
Maximum	57.2	42.5	38.6	34.7	30.1	24.2	3.306
Diospyros crassiflora							
Mean	18.0	15.3	11.4	7.5	11.2	7.3	0.140
Standard Error	1.227	0.963	1.100	0.794	0.871	0.770	0.042
Minimum	11.5	10.2	5	2.5	5.1	2.8	0.011
Maximum	30.6	25.2	30	17.4	20.3	16.1	0.910
Lovoa trichilioides							
Mean	26.6	22.3	16.5	12.9	15.9	11.3	0.496
Standard Error	2.451	2.135	1.981	1.966	1.673	1.381	0.125
Minimum	14.2	11.3	5.2	3.1	5.3	3.5	0.015
Maximum	56.2	45.4	41.4	37	41.7	31.3	2.578
Picralima nitida							
Mean	20.9	17.6	12.6	8.8	12.8	9.1	0.219
Standard Error	1.076	0.915	0.797	0.656	0.716	0.693	0.066
Minimum	11.3	10.2	5	2.5	5.1	2.1	0.008
Maximum	59.6	50.2	38.2	22.4	30.9	27.5	3.560

Table 4 shows the model statistics and parameters of volume equations developed for the five economic hardwood species (*Buchhlozia coriacea, Celtis zenkeri, Diospyros crassiflora, Lovoa trichiliodes, and Picralima nitida*) in Oluwa Forest reserve Ondo state. It was discovered that nonlinear logarithm equation produced the best fit for *Buchhlozia coriacea, Celtis zenkeri, Diospyros crassiflora* and *Picralima nitida* while the Generalized Non Linear equations produced a better fit for the *Lovoa trichiliodes*. However, model 2 (constant form equation) performed poorly for all the five hardwood species. This reveals the adequacy of nonlinear logarithm equation over transformed logarithm, constant form, generalized combined functions and Generalized Non Linear equations.

Table 4: Model statistics and parameters estimates of Five Economic Hardwood Species in Oluwa Forest Reserve, Ondo State, Nigeria.

Species	Model type	b_0	b_1	b_2	b_3	M.S.E	R^2
Buchhlozia coriacea,	$V_i = e^{b_1} D_i^{b_2} H_i^{b_3}$	-8.664	1.381	1.301	-	0.004	0.912
Celtis zenkeri	$V_i = e^{b_1} D_i^{b_2} H_i^{b_3}$	-10.554	1.091	2.356	-	0.015	0.800
Diospyros crassiflora	$V_i = e^{b_1} D_i^{b_2} H_i^{b_3}$	-13.121	2.742	1.457	-	0.008	0.863
Lovoa trichiliodes	$V_i = b_0 + b_1\ D_i^{b_2} H_i^{b_3}$	-0.517	0.052	0.686	0.345	0.027	0.871
Picralima nitida	$V_i = e^{b_1} D_i^{b_2} H_i^{b_3}$	-10.586	2.187	1.071	-	0.001	0.969

Key: b_0**…..**$b_{3=}$ regression constants; D=diameter at breast height; H= Merchantable Height; Ln = Natural log V= Volume

DISCUSSION

Akindele (2005) developed volume equations for common timber species in Nigeria's tropical rainforests. The volume equations were fitted for individual species, all species combined, and groups of species. From a series of model-fitting trials, the untransformed generalized logarithmic volume function (also termed Schumacher-Hall's volume function) was found to perform better than other forms of volume functions. The results indicated that the zero-intercept quadratic volume function was the most appropriate function for such single-variable volume prediction.

This is in line with Shamaki and Akindele (2013) who developed five different equations for teak (*Tectona grandis*) plantation in Nimbia forest reserve using stump diameter (Dst) as independent variable. The volume equations developed were linear, logarithm and quadratic in nature. Adjusted coefficient of determination (Adjusted R^2) and root mean square error (RMSE) were used to rank the developed models. The resulting equations were found to be desirable for estimating the merchantable volume for teak in Nimbia forest reserve, Nigeria.

Aigbe *et al.*, (2012) developed empirical equations for estimating tree volumes of *Terminalia ivorensis* from stump diameters, by determining relationship between volumes of *Terminalia ivorensis* trees. A series of regression equations were all fitted to the data, the regression equations were fitted for choosing the best model after critical consideration of model diagnostic criteria such as the coefficient of determination (R^2), variance ratio and overall standard error of the various equations. Out of the several regression equations fitted, the non-linear (quadratic) model of stump diameter was considered to be the best. With R^2 =0.69, RMSE = 0.00992 and F- ratio = 85.875; indicating the significant status of the model for predictive purpose. The results showed that stump diameter is appropriate for tree volume estimation and sustainable forest management of *Terminalia ivorensis* in Nigeria.

Wilson *et al.*,(2015) developed Allometric Models for Estimating Tree Volume and Aboveground Biomass in Lowland Forests of Tanzania. This study developed site specific and general models for estimating total tree volume and above ground biomass. Biomass models of trees found in the two study sites. The findings show that site specific ht-dbh model appears to be suitable in estimating tree height.

Daesung *et al.*, (2017) also developed the Estimation and validation of stem volume equations for *Pinus densiflora*, *Pinus koraiensis*, and *Larix kaempferi* in South Korea. The combined-variable function was shown to be the best model through the validation of the equation. Also, the model using only DBH was also evaluated to be applicable in the field. These models revealed higher accuracy when compared with previous studies.

Ige *et al.*, (2013) also developed Diameter Distribution Models for Tropical Natural Forest trees in Onigambari Forest Reserve. The models were developed using four – parameters Beta functions. Simple linear regression equation was used to fit the models for each of the parameters. The best model from each parameters were selected based on least Values of mean residuals, standard deviation of residuals, sum of squares of residuals, coefficient of variation of residuals; significance and high coefficient of determination.

Ebeniro (2018) developed Height Diameter Modelling Of Mixed Tree Species In Ibadan The study area hosts about 24 tree species dominated by Eucalyptus camaldulensis, Eucalyptus tereticornis, Nauclea diderichi, Terminalia superba, and Terminalia randii. Among the Five models, Shreuder model (M2) demonstrated the best fit and accounted for the greatest proportion of total height variations (R2 = 92.7%).Residual plots were plotted for each model as a means of verifying the validation of the equation.

Yousefpour *et al*., (2012) also predicted logarithmic stem volume equation based on tree height, diameter at breast height (dbh), and tree height and diameter at breast height were determined for Pinus pinaster Ait. Data were measured inkiashahr region of north of Iran. Least relative standard error of the volume estimation by two-variable model was 10%. They found out that transformed Logarithmic model came out as the best model.

John Fonweban *et al*., (2011) also developed variable-top merchantable volume equations for plantation-grown Scots pine (*Pinus sylvestris*) and Sitka spruce (*Picea sitchensis*). Logarithmic expression of timber tree volumegave the best results for total volume.

CONCLUSION

This study focused on developing volume equations for the five hardwood (*Buchhlozia coriacea*, *Celtis zenkeri*, *Diospyros crassiflora*, *Lovoa trichiliodes and Picralima nitida*). Each species was fitted to the five equations i.e. Non Linear logarithm equation, Transformed logarithm, Constant form, Generalized combined functions and Generalized Non Linear equations and the best equation was selected.

RECOMMENDATION

Based on the results from this finding, the following recommendations are made:

- The selected models can be very useful for sustainable forest management assessment of Lovoa *trichiliodes*, *Celtis zenkeri*, *Picralima nitida*, *Buchhlozia coriacea and Diospyros crassiflora* plantations in the study area and similar ecological areas.
- Further research should be carried out in this study area so as to test the validity of these models on some of the other species(*Khaya ivorensis*, *Milicia excelsa, Afzelia Bipindensis, Brachystegia nigerica, Lophira alata, Lovoa trichiliodes, Terminalia ivorensis, Terminalia superba*, and *Triplochiton scleroxylon*) if more datasets are provided perhaps other models may perform better.
- Man-made Plantations should be established in Oluwa Forest reserve to reduce the pressure on hardwood species available.

REFERENCES

Adeduntan, S.A. (2009): "Diversity and abundance of soil mesofauna and microbial population in South–Western Nigeria", *African Journal of Plant Science,* 3(9): 210-216.

Aigbe H. I., Modugu W.W., and Oyebade B. A. (2012): Modeling Volume From Stump Diameter Of Terminalia Ivorensis (A. Chev) In Sokponba Forest Reserve, Edo State, Nigeria. Journal of Agricultural and Biological Science. ISSN 1990-6145, 7(3).

Akindele, S. O. and J. A. Fuwape (1998): *Wood-based industrial sector review*. A Consultancy Report prepared as part of the national Forest Resources Study, Nigeria.74pp.

Akindele, S. O. (2005): Modeling tropical forest data in Nigeria – the challenges. Seminar presented at the Warnell School of Forest Resources, University of Georgia, Athens, Georgia (U.S.A). May 11, 2005.

Burkhart, H. E. (2002): Forest Measurement in McGraw-Hill Encyclopedia of Science and Technology. New York McGraw-Hill. pp. 430-435.

Daesung Lee, Yeongwan Seo and Jungkee Choi (2017): Estimation and validation of stem volume equations for *Pinus densiflora*, *Pinus koraiensis*, and *Larix kaempferi* in South Korea, Journal of Forest Science and Technology, ISSN 2158-0715, 13(2): 77–82.

Ebeniro S.T. (2018): Height-Diameter Modelling Of Mixed Tree Species in Ibadan. Journal of Research in Forestry, Wildlife & Environment 10(4) December, 2018 ISBN: 2141 – 1778 :44 – 52.

Ettah U.S. (2008): Conservation Strategies of Cross River gorilla (Gorilla gorilla diehli) in the Afi Mountain Wildlife Sanctuary of Cross River State, Nigeria, An Unpublished M.Sc. Thesis submitted to the University of Uyo, : 72.

Fonweban,J., Gardiner, B. and Auty, D.(2011): Variable-top merchantable volume equations for Scots pine (*Pinus sylvestris*) and Sitka spruce (*Picea sitchensis* (Bong.) Carr.) in Northern Britain. *Journal of Forest Research, Northern Research Station, Roslin, Midlothian EH25 9SY, Scotland, UK.*

FAO (2003): *State of the World's Forests,* Food and Agriculture Organization of the United.

Joseph Adeola Fuwape (2003)**:** The Impacts of Forest Industries and Wood Utilization on the Environment. A Paper Submitted To The Xii World Forestry Congress, Quebec City, Canada. 0122-A2.

Harold E. Burkhart and Margarida Tomé (2012): A textbook on Modeling Forest Trees and Stands .ISBN978 – 90 – 481 – 3170 – 9.XIV, 438.

Hernan A. B., Luis C., Ariana I., Guillermo M. P. (2017): Volume and Taper Equations for Commercial Stems of *Nothofagus Obliqua* and *N. Alpine.* 23(3).

Ige, P.O; Akinyemi, G.O And Abi, E.A (2013): Diameter Distribution Models For Tropical Natural Forest Trees In Onigambari Forest Reserve, *Journal Of Natural Sciences Research*, 3(12):14 – 23.

Ige (2018): Above Ground Biomass and Carbon Stock Estimation of *Gmelina Arborea* (Roxb.) Stands In Omo Forest Reserve, Nigeria. *Journal of Research in Forestry, Wildlife & Environment* 10(4): 71 – 80.

Jacob D.E., Eniang E.A.,Nelson U. , Udoakpan U.I. (2015): Vegetation Assessment of Sclaterâ€™s Guenon Habitat in Ikot Uso Akpan Forest, ITU, Southeastern Nigeria, International Journal of Molecular Ecology and Conservation, 5:1- 6

Morris R.J. (2010): Anthropogenic impacts on tropical forest biodiversity: a network structure and ecosystem functioning perspective, Philosophical Transactions of Royal Society B: Biological sciences, 365 (1558), 3709–3718 doi:10.1098/rstb.2010.0273.

Norman H. Pillsbury, Jeffrey. L. Reimer, Richards P. Thompson (1998): Tree volume equations for fifteen urban species in California. Urban Forest Ecosystems Institute. A technical report. 7.

Ogunwusi, A.A. (2014): Wood Waste Generation in the Forest Industry in Nigeria and Prospects for Its Industrial Utilization. *Journal of Civil and Environmental Research,* 6 (9): 62 – 73.

Ojo L.O. (2004): The Fate of a Tropical Rainforest in Nigeria: Abeku Sector of Omo Forest Reserve Global Nest: *The International Journal* 6(2): 116-130.

Onyekwelu, J.C., Mosandl, R. and Stimm, B. (2008): "Tree species diversity and soil status of primary and degraded tropical rainforest ecosystems in South-Western Nigeria". *Journal of Tropical Forest Science.* 20 (3): 193–204.

Shamaki and Akindele (2013): Volume estimation models from stump diameter for teak (*Tectona grandis* Linn f.) plantation in Nimbia forest reserve, Nigeria. *Journal of Environmental Science and Water Resources*, 2(3):089 – 094.

Udoakpan, U.I. (2013): An Evaluation of Wood Properties of Pinus Caribeae (Morelet) In Oluwa Forest Reserve, Ondo State, Nigeria. *Journal of Environmental Studies and Management* 6 (2): 159 – 169.

Wilson Ancelm Mugasha,,Ezekiel Edward Mwakalukwa, Emannuel Luoga,Rogers Ernest Malimbwi, Eliakimu Zahabu, Dos Santos Silayo,Gael Sola,Philippe Crete,Matieu Henry, andAlmas Kashindye (2016): Allometric Models for Estimating Tree Volume and Aboveground Biomass in Lowland Forests of Tanzania. International Journal of Forestry Research Volume 2016, Article ID 8076271, 13 pages.

Yousefpour1 M., Khoshkebijary F. F., Fallah A., and Naghavi A.A. (2012): Volume equation and volume table of Pinus pinaster Ait. *International Research Journal of Applied and Basic Sciences.* 3 (5):1072-1076

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Awe et al., 2019

ASSESSMENT OF TIMBER SPECIES AVAILABILITY IN SELECTED SAWMILLS AND TIMBER MARKETS IN KOGI STATE, NIGERIA

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ABSTRACT

This paper assessed the availability of timber species in Okun Area, Kogi West Senatorial District of Kogi State, Nigeria. One hundred copies of structured questionnaire were randomly administered to timber sellers from six selected timber markets and sawmills from two randomly selected Local Government Areas (LGAs) the State .Four timber markets were selected from Ijumu LGA and two from Kabba-Bunu LGA, making a total of six timber markets. Descriptive statistics such as frequency and percentage distributions as well as content analysis were used to analyse the collected data. Study revealed that 21% of the timber dealers were more than 50 years of age, with about 69% of them having been in business for 20 years and above. Different reasons were given by respondents on why they engage in the timber business and these include availability, durability and demand, with 40% of them citing the demand for the timber species as the reason why they traded the species. The study shows that certain timber species such as Terminalia spp, Milicia excelsa, and Nauclea dideriichii have become endangered species due to over exploitation. Therefore, there is need for the planting of fast growing plantation species by State Forestry Department in Kogi State to replace commercially popular and endangered species as alternatives to decreasing availability of popular timber species so as to avoid running out of valuable and good quality timber species in the near future.

Key words: Timber, Okun, durability, availability, demand, workability

INTRODUCTION

Timber, being a construction material, has been used for different purposes, including structural and ornamental purposes. It is used throughout the world for many tasks, from simple structural application to highly finished and ornate decoration and it is the dominant industrial material in Nigeria (Fuwape, 2000). There are approximately 200,000 hardwood species and 1000 softwood species in Nigeria, of the total number; only 2,300 tree species are commercially important (Oluyege, 2007). In building and furniture industries, various species of timber are used for different purposes. The choice of wood species used varies, due to different features and characteristics of the wood, some of these features are wood strength, natural durability, colour (appearance), ease of machine and workability, cost, contraction, hardness and availability.

In recent years the number of timber species harvested and marketed in production forests in Africa has grown in recent years, especially near seaports or major local markets, where prime species have been largely logged out. However, a handful of species still makes up the bulk of production. In Central African Republic, for example, loggers harvest 15 to 18 timber species, and five species make up 90% of production; in Northern Congo, 18 to 20 species are harvested, but five species account for nearly 80% of production (ITTO, 2006). The major timber species exported from Nigeria and some other African countries include Mahogany *(Khaya senegalensis*), Obeche (*Triplochiton scleroxylon*), Afara (*Terminalia superba*), Abura (*Mitragyna ciliate*), Iroko (*Milicia excelsa*), Teak (*Tectona grandis*) (ITTO, 2006). Timber can be described as wood in a form suitable for construction or carpentry, joinery or for reconversion to manufacturing purpose. Timber has been used as a building material for over 400, 000 years and it is very common and best known material for house construction including framing of floors, walls and roofs (RMRDC, 1998).

Timber accounts for about half of worldwide wood consumption and this exceeds the use of steel and plastic combined (Cunningham *et al*. 2005). According to Lucas (2006), the preference of timber may not be unconnected to its versatility, abundance, accessibility, renewability, less energy input required for processing and relative cheapness. However, it occurs in low density in most tropical forests, therefore, large areas tend to be exploited diffusely to extract a few prized logs. In the estimation of FAO (2010), Nigeria loses about 3.7 percent of its forest area yearly and this makes it to have the highest net loss from 2000 to 2010, mainly due to over-exploitation of wood for timber production. Consequently, yield of the most valuable timber species declined as a result of initial overcutting and failure to leave sufficient seed trees (Kellman and Tackabery,1993) leading to decline in the availability of some tree species like Iroko (*Milicia excelsa*), Opepe (*Nuclea diderrichii*), Teak (*Tectona grandis)* and many other valuable timber species. The scarcity of these fine quality timber species has forced into the markets species that ten to twenty years ago were considered only acceptable for low-end construction type uses. This reflected in the recent patronage given to the use of species such as*Pycnanathus angolensis* (Akomu), *Triplochiton scleroxylon* (Arere) and *Albizia zygia* (Ayunre) as general purpose wood in Nigeria (Wood Explorer, 2011). Recently the use has been extended as they are now sought for any end uses including structural and non-structural uses. This is due to scarcity of high quality species in the market. In view of this, the study was conducted to assess the availability and variation of timber species in selected sawmills and timber markets in Kogi State over the past three decades.

MATERIALS AND METHODS

Study Area

The study was carried out in Okun Area of Kogi State. The area comprises Ijumu, Kabba-Bunu, Yagba West, Yagba East, and Mopa-Muro Local Government Areas of the state. Kogi State is situated within the North-Central zone of Nigeria. It is the most centrally located of all the States of the Federation, with a population of 3,595,789 (NPC, 2006). It comprises Igala, Ebira, Kabba, Yoruba and Kogi divisions of former Kabba Province with Yoruba, Nupe and Bassa as the main ethnic groups and Yoruba, Nupe and Ebira as the major languages spoken. The State has two distinct seasons (the wet and dry seasons) and a humid tropical climate prevails over the State. The study was carried out in selected sawmills and timber markets in West Senatorial District of the State, which forms the Yoruba speaking part of Kogi State.

Data Collection and Analysis

One hundred (100) copies of structured questionnaire as well as Key Informant interview methods were used to elicit information from timber sellers in the selected timber markets and sawmills in the state. Two of the six LGAs that make up the Western District of the state were randomly selected for the study. Ten copies of questionnaire were randomly administered to timber sellers from each of the purposively selected six timber markets and sawmills within the study area. The number of sawmills markets selection was based on the number of sawmills and timber markets in each of the selected LGAs. More sawmills markets were selected from LGA with higher number of sawmills. Only ninety five (95) copies of the questionnaire were used for analysis, as five of the copies were discarded due to mismatched information. The selected timber markets and sawmills were Mosafunoto Sawmill and Ogo-Oluwa Sawmill (Kabba- Bunu LGA); Aare Sawmill, Iyah Sawmill, Face-one sawmill and Sunday sawmill (Ijumu LGA). Information obtained through the questionnaire was supplemented with information gathered from the key informant interview of the respondents.

Data Analysis

Descriptive statistics such as percentages and frequencies as well as content analysis and synthesis of the interviews were carried and were used in analysing the data.

RESULTS

Table 1 shows the socio-economic characteristics of timber sellers in the study area. The results showed that 15% of the sellers were less than 30 years while 80% were between 30 and 70 years of age and those that were above 70 years accounted for 5%. This is an indication that the timber business cuts across different age groups. The study showed that seventy percent of the sellers were male while female accounted for about 30%. This shows that both male and female engage in timber trading in the study area. From the educational distribution in Table 1, 95% of the sellers had formal education and at least primary education while only 5% had no formal education. It was also discovered from the study that the tribe of the timber marketers does not affect their involvement in the business, as Yoruba (50%), Igbo (20%), Hausa (25%) and other tribes (5%) engaged in timber trading. Seventy percent of the sellers claimed they have been in the business for more than forty (20) years while 30% of them were less than 30 years in the business.

Table1: Socioeconomic Characteristics of Timber Sellers

Variables	Frequency	Percentage
Age (in years		
Less than 30	16	16.84
30-50	59	62.11
51-70	17	17.89
Above 70	3	3.16
Total	95	100
Gender		
Male	65	68.42
Female	30	31.58
Total	95	100
Educational Level		
Primary	24	25.26
Secondary	20	21.05
Post-Secondary	46	48.42
None	5	5.26
Total	95	100
Tribe		
Yoruba	48	50.53
Hausa	16	16.84
Igbo	22	23.16
Others	9	9.47
Total	95	100
Years in Business		
Less than 20	29	30.53
	57	60
20-40	9	9.47
Above 40	95	100
Total		

Table 2 shows a list of timber species that have been in the market for the past three decades (30 years). Most of these species have now declined in availability; they have however registered their presence in the market in the past thirty years. Result on choices for the timber species traded shows that 40% of sellers' choice was based on the demand of the people while 35% of respondents' choice depended on species that were durable. Twenty percent of them based their reasons on both low cost and availability of the species. Only 5% of the sellers based their preference on other factors such as the colour and workability of such timber species, as indicated in Figure1.

Table 2: Species of Timber Traded over the last Thirty Years

Scientific Name	Local Name
Triplochiton scleroxylon	Obeche/Arere
Afzelia Africana	Apa
Ceiba petandra	Araba
Nuclea diderrichii	Opepe
Terminalia superba	Afara
Arogeissus leocarpus	Ayin
Milicia excelsa	Iroko
Albizia zygia	Ayunre
Vitellaria paradoxa	Emi
Mitragynia ciliate	Abura
Chrysophyllum delevayi	Osan
Cordia millenii	Omo
Daniella oleivera	Iyaa
Terminalia ivorensis	Idigbo/Afara Dudu

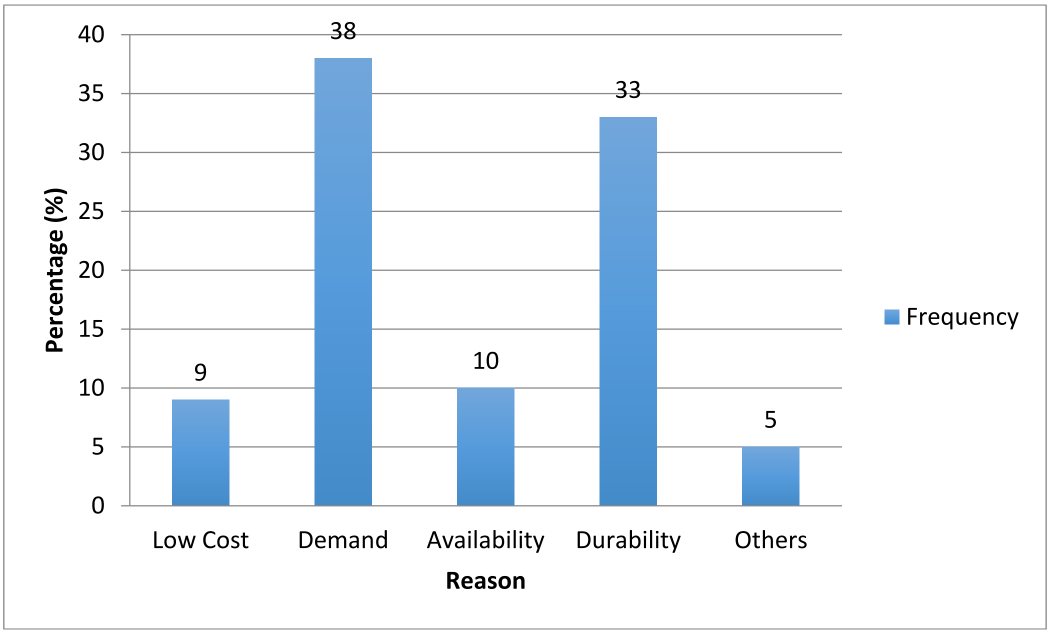

Figure1: Reason for choice of species traded.

From Figure2, 96% of the timber sellers agreed that there has been fluctuation and decline in the availability of the timber species traded within the last three decades and various reasons were given for the fluctuations. Prominent among the reasons given was over-exploitation, as shown in Figure 3. This confirms FAO (2010) estimate that Nigeria loses about 3.7% of its forest area per year and this makes it to have the highest net loss between the periods 2000 to 2010.

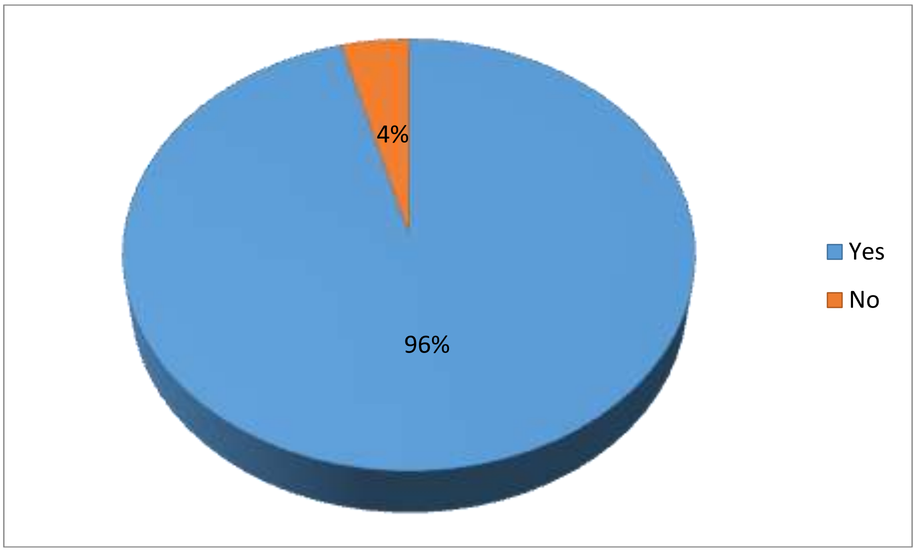

Figure2: Fluctuations in Species Availability for Trade

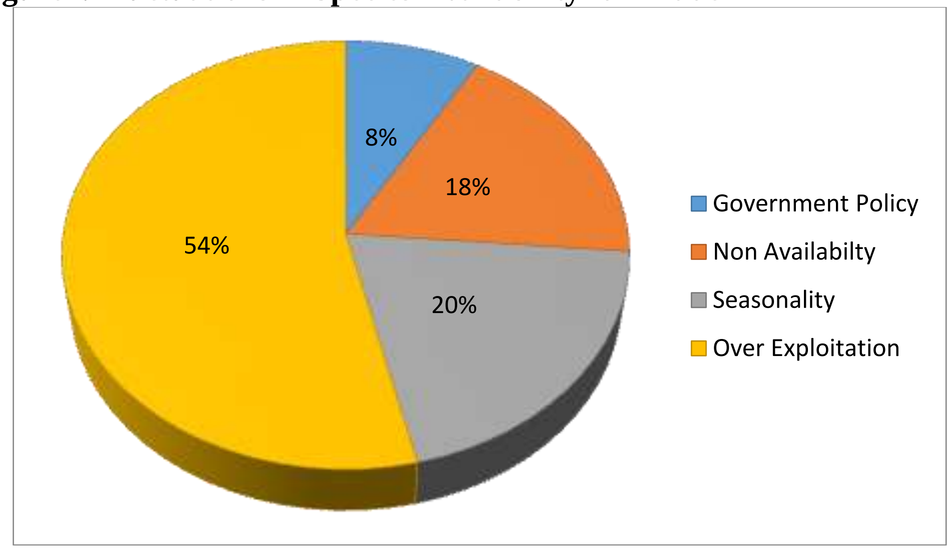

Figure 3: Reasons for fluctuation in timber species availability for trade

Table 3: Endangered Timber Species in Kogi State

Scientific Name	Local name
Ceiba petandra	Araba
Milicia excelsa	Iroko
Mitragynia ciliate	Abura
Nuclea diderrichii	Opepe
Cordia millenni	Omo
Chrysophyllum delevayi	Osan
Arogeissus leocarpus	Ayin
Triplochiton scleroxylon	Arere
Khaya senegalensis	Mahogany
Terminalia superba	Afara

Table 4 shows the list of timber species that were currently sold in the selected Timber markets and sawmills in Kogi State. They comprised both the existing and the new timber species that are being traded.

Table 4: Timber Species Currently Traded in Kogi State

Scientific Name	Local name
Alfezia africana	Apa
Daniella oliverii	Iyaa
Parkia biglobosa	Igbaa
Cassia bicarpsularis	Cassia
Mangifera indica	Mango
Gmelina arborea	Gmelina
Cola acuminata	Obi
Arogeissus leocarpus	Ayin
Tectona grandis	Teak
Ceiba petandra	Araba
Treculia africana	Breadfruit
Albizia zygia	Ayunre

DISCUSSION

From this study, it has been discovered that preference for certain timber species in the market due to their high quality, strength and durability has resulted in the over-exploitation of such species. Hence, such species are now scarce and not readily available in the market. These species are regarded as endangered species because of the sharp decline in their availability in the market. These endangered species in Kogi State are listed in Table 3. This also corroborates the work of Famuyide *et al*.(2012) that stated that species like *Milicia excelsa*, *Khaya spp.*, *Afzelia Africana*, *Nauclea dideriichii*, *Triplochiton scleroxylon*, and *Terminalia spp*. are now scarce in the market as a result of over-exploitation in the forests and forest reserves in Nigeria to meet increasing demands for them, as well as Lucas (1983) who reported that *Nuclea dideriichii* has been listed alongside other most common economic wood species that is fast thinning out of forests located in the Southwest Nigeria. This explains why timber traders in Southwest Nigeria travel as far as Kogi State in search of timber, following the depletion of timber species in the region. However, Kogi State is now facing similar challenge as most of the timber species in the forests have also been depleted. The resultant effect of the scarcity of the fine quality timber species is the presence of species which in a few years ago were considered only acceptable for low-end construction uses. Such species include *Pycnanathus angolensis* (Akomu), *Albizia zygia* (Ayunre), *Daniellia oliverii* which are now also used as general purpose wood in, Nigeria. Other wood species that are currently traded in addition to the existing ones include Mango (*Mangifera indica*), Cola (*Cola acuminata*), among others, as shown in Table4. This also corroborates the study by Famuyide *et al*. (2012) on timber species availability and variation in Oyo state. Likewise, in corroboration of the different reasons given by the respondents for the fluctuation in timber species availability in the study area, FAO (2010) estimate that Nigeria loses about 3.7% of its forest area per year and this makes it to have the highest net loss between the periods 2000 to 2010. More so, the choice of the type of wood species traded corroborates the work of Idumah and Awe (2011) who observed that the choice of wood species by furniture makers within Ibadan Metropolis was based, among others things, on the hardness (strength) and durability. The results also corroborated the work of Famuyide *et al.* (2012) on what influenced the choice of timber species traded by timber marketers in Oyo State. In addition, the number of years the respondents have been in business implies that majority of the respondents would have adequate knowledge and information about various timber species within the period of coverage of the study.

Conclusion and Recommendation

Timber species availability and variation in selected timber markets and sawmills in Kogi State, Nigeria have shown critical downward trend over the last three decades. The study showed that species that were relatively available in the last thirty (30) years have now become scarce in the market owing to excessive logging and over-exploitation of such species. Some of the endangered species include *Nauclea dideriichii* (Opepe), *Tectona grandis* (Teak), *Milicia excelsa* (Iroko).

It is therefore recommended that Kogi State Government should, as a matter of urgency, review the forest policy to actually know the predicament against conservation and preservation of economic species that are facing extinction and forestry act be enacted to control the excesses of overexploitation in various forests within the state. Plantation of fast growing tree species as a replacement for commercially popular species should therefore be encouraged as alternatives to decreasing availability of popular timber species so as to avoid running out of valuable and good quality timber species in the nearest future.

REFERENCES

Cunningham, P.W.; Cunningham, M.A. and Saigo, B (2005)**:** Environmental Science A Global Concern. 8th Edition, Mc Graw Hill, 600p

Famuyide, O.O.; Adebayo, O.; Odebode, A.V.; Awe, F.; Ojo, O.B. and Ojo, D. (2012). Timber Species Availability and Variation in Ibadan and Oyo Timber Markets over the last Forty Years. *Elixir Journal of Biodiversity. 49:10131-10136*

Food and Agricultural Organization (2010): Global Forest Resources Assessment 2010. Main Report, FAO Forestry Paper 163. Pp 378

Fuwape, J.A. (2000): Wood utilization from cradle to the grave. Federal University of Technology Akure. Inaugural lecture series no 25, pp 1-33.

Idumah, F.O. and Awe, F. (2011): Assessment of the Types of Wood used in the Furniture Making Industry in Ibadan Metropolis. *Journal of Sustainable Environmental Management. 3:117-121*

International Tropical Timber Organization. Status of Tropical Forest Management (2005). ITTO Technical Series, No. 24, 2006. Pp 32

Kellman, M and Tackaberry, R (1997): Tropical Environment: the Functioning and Management of Tropical Ecosystems. Routledge Publication London and New York. 594p

Lucas, E.; Olorunsola, A. and Adewole, N. (2006): Preliminary evaluation of *Psidium guajava* Tree Branches for Truss Fabrication in Nigeria. Agricultural Engineering *International: the CIGR Ejournal. Manuscript BC05010. 11pp.*

Lucas, E.B. (1983): Factors Preventing Wider Commercialization of Nigerian Tree. *Forest Product Journal*.33 (5):64-68

National Population Commission (2006): National Population Commission 2006, Abuja, Nigeria

Oluyege, A.O. (2007): Wood: A versatile material for natural development. Inaugural lecture series 45, delivered at the Federal University of Technology, Akure.

Raw Materials Research Development Council of Nigeria (1998). Audit of Indigenous Technologies for Processing Raw Materials in Nigeria.

Wood Explorer, (2011).Species Data. http://www.thewoodexplorer.com/maindata/we815.html.Accessed April, 2011.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Akomolafe et al., 2019

COMPARATIVE ANATOMICAL STUDIES OF RESPONSES OF SOME ROADSIDE PLANTS TO HIGHWAY AUTOMOBILE EXHAUSTS

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ABSTRACT

Urena lobata and Hyptis suaveolens growing along busy roadsides in Lafia, Nigeria were carefully sampled. This was with a view to investigate the effect of continuous impact of automobile exhausts on internal structures of the plants. Three major highways were chosen for study in Lafia. Plant samples were systematically collected in replicates from 0 m, 10 m and 20 m away from defined points of the roadsides. Leaf and stem anatomical sections were prepared for microscopic examinations following established procedures. The plants were observed to have more stomata and smaller area of guard cells at 0 m than those away from the roadsides. For H. suaveolens, the thickness of epidermis, thickness of vascular bundles, length and number of trichomes at 0 m are higher than those at 10 m and 20 m. The reverse was observed for U. lobata. However, U. lobata showed high number of parenchyma cells closer to the roadsides than those father away. Consequently, H. suaveolens seemed to have ability to withstand and thrive well in areas of heavy air pollution. These anatomical changes were described to be distinct with regards to individual species and could have been as a result of cumulative effects of air pollutants.

Keywords: Air pollutants, Anatomy, *Hyptis suaveolens*, Lafia, *Urena lobata*

INTRODUCTION

The consequence of civilization in the world has been described as the corresponding influence of pollutants on plants (Cvetanovska *et al*., 2010). Plants are prone to several unfavourable environmental conditions regarded as stresses which do alter their internal structures, metabolisms, growth and resulting yield (Reddy *et al*., 2004). One of those environmental stresses is pollutants from several sources. Güvenç and Duman (2010) reported that a lot of ecological factors do influence some anatomical features related with mesophyll cells and supporting tissues in plants. These anatomical structures vary in plants of different species under the same stress conditions (Makbul *et al*., 2008).

The ability of different plant species to withstand environmental stresses has been linked with their respective genetic constituents and growth stage at time of exposure (Garner, 2002). The effects of air pollutants are usually easily noticed on the leaves and flowers of plants with symptoms such as strange colourations, twisting of leaves and relative stunted growth (Otoide and Kayode, 2016). Air pollutants could get to plants from various sources such as industrial exhausts, agricultural discharges, household power generators, traffic / automobile exhausts and so-on (Otoide, 2015). However, a larger percentage of these pollutants has been reported to be from automobile exhaust. Some of the pollutants from automobile exhausts include carbon oxides, volatile organic carbons and particulate matters (dusts) (Otoide, 2015).

In this study, we investigated the anatomical responses of *Hyptis suaveolens* and *Urena lobata* to air pollutants from automobile exhausts. These two plants are found to be the most common plants growing along roadsides in North Central Nigeria.

MATERIALS AND METHODS

Study Site

The study was carried out in Lafia, Nasarawa State, Nigeria located in the North Central zone (Figure 1). Its climatic weather is characterized by rainy and dry season. The geographical coordinates and elevations of the sample collection points were taken with the aid of a GPS Garmin eTrex 10 device (Table 1).

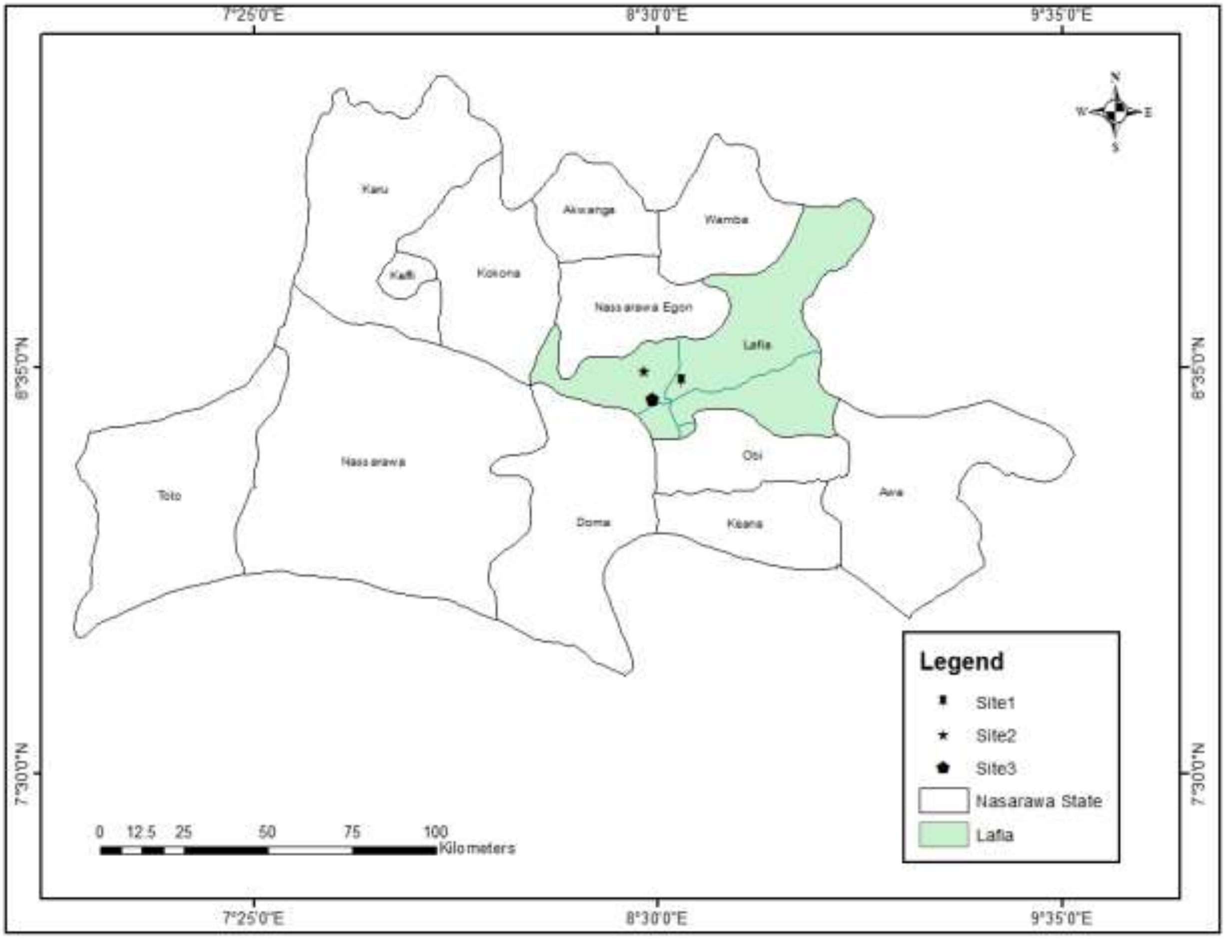

Figure 1: Study area map of Lafia showing the sampling locations

Table 1: The geographical coordinates of sampling locations

Distance from the road (m)	Site 1 (Lafia-Abuja road)			Site 2 (Lafia-Makurdi road)			Site 3 (Lafia-Doma road)		
	Latitude(N)	Longitude (E)	Elevation (m)	Latitude (N)	Longitude (E)	Elevation (m)	Latitude (N)	Longitude (E)	Elevation (m)
0	08.56322^0	008.54637^0	163	08.46281^0	008.57277^0	190	08.48666^0	008.49741^0	165
10	08.56311^0	008.54650^0	163	08.46283^0	008.57271^0	191	08.48654^0	008.49734^0	170
20	08.56316^0	008.54666^0	161	08.46282^0	008.57267^0	195	08.48643^0	008.49736^0	163

Plant Sample Collection

The road side plants used for this study include *Hyptis suaveolens* and *Urena lobata*. The plant samples were collected from three different locations/highways which were regarded to be highly busy with vehicular movements. The highways include Makurdi-Lafia road, Lafia-Doma road and Lafia-Abuja road. The approximate distance between each road location is 10,000 meters. At each roadside, plants were collected in different places i.e. 0m (close to the road), 10m away from the road and 20m away from the road. These samples were taken to the laboratory for further observations.

Anatomical Studies

For anatomical studies, the leaves and stems of 18 samples were assessed as follows:

Leaf Anatomical Study

Matured leaves were cut from the standard median positions and subjected to clearing process following the methods of Oloyede *et al*. (2011). These leaves were cleared by decolorizing in boiled 70% ethanol at 60ºC for 5-10 minutes and then rinsed with water. Theereafter, they were boiled in 2% sodium hydroxide for about 3-5 minutes and then further transferred into Petri dishes containing 2% Potassium hypochlorite. After they have been completely cleared, all traces of potassium hypochlorite were removed with water. The specimens were then stained with Safranin O and mounted on clean sides containing drops of 25% glycerol. The mounted specimens were observed with the aid of a digital compound photomicroscope. The leaf anatomical features observed include the intervenal distance, number of trichomes, length of trichomes, stomata frequency, length of guard cells and breath of guard cells.

Stem Anatomical Study

This was done using the methods of Akomolafe *et al*. (2017b). Free-hand fresh transverse sections of the stems of the two plants collected at different locations were made using a dissecting blade. They were stained using 2 drops of 1% Safranin O on clean slides and then rinsed with water. Thereafter, the specimens were mounted on 25% glycerol and observed using digital compound photomicroscope. The observed features include thickness of epidermis, thickness of cortex, diameter of vascular bundles, number of trichomes, length of trichomes and number of cells per mm.

Statistical Analysis

Each of the anatomical parameters of each plant between the locations (0m, 10m and 20m) was subjected to non-parametric Kruslal Walis test for significance differences at $P \leq 0.05$. The analysis was done using PAST software version 3.

RESULTS

The Effects of Air Pollutants on the Leaf Anatomy of Plants

The results of the leaf anatomy of plants at site 1 are shown in Table 2 and Plate 1. For *U. lobata*, the leaf intervenal distance (4.50 mm) at 20 m away from the road was higher than those of 10 m (1.99 mm) and 0 m (3.78 mm). The lengths of trichomes also differ in which 0 m had the lowest (1.38 mm), compared to (2.85 mm) at 10 m and (5.19 mm) at 20 m. The area of guard cell increased progressively from 0 m to 20 m. The stomata frequency of *U. lobata* at 10 m was the highest (4.33) while 0 m was the lowest (3.00). For *H. suaveolens*, the intervenal distance of the leaves at 10 m (8.24 mm) was the highest while 0 m had the lowest (2.74 mm). The length of trichomes observed at 0 m (3.21 mm) was higher than others. *H. suaveolens* at 10 m had more trichomes than those at 0 m and 20 m. However, the ones at 20 m had more stomata than those at 0 m and 10 m. The differences in the leaf anatomical features of the two plants between the locations are significant except for number of trichomes and stomata frequency.

Table 2: The effects of air pollutants on leaf anatomy of plants at site 1

Distance from the Road (m)	*Urena lobata*					*Hyptis suaveolens*				
	Intervenal distance (mm)	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**	**Intervenal distance (mm)**	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**
0	3.78± 0.44	1.38± 0.21	17.00± 3.51	0.09± 0.03	3.00± 1.00	2.74± 0.11	3.21± 1.15	4.67± 2.33	0.00± 0.00	3.67± 1.76
10	1.99± 0.21	2.85± 0.16	16.33± 6.33	0.57± 0.08	4.33± 0.88	8.24± 0.49	3.11± 1.10	26.33± 10.37	0.15± 0.03	4.67± 0.88
20	4.50± 0.41	5.19± 0.92	26.00± 3.06	0.13± 0.03	3.67± 0.88	4.83± 0.60	2.00± 0.76	19.33± 5.81	0.00± 0.00	6.67± 2.84

Values represent mean ± SE

Table 3: The effect of air pollutants on leaf anatomy of plants at site 2

Distance from the Road (m)	*Urena lobata*					*Hyptis suaveolens*				
	Intervenal distance (mm)	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**	**Intervenal distance (mm)**	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**
0	3.39± 0.51	3.16±1.21	28.33±1.20	0.13±0.00	7.33± 2.73	5.43±0.58	5.45±1.32	38.33±10.99	0.13±0.04	8.00±2.52
10	5.54±1.08	1.22±0.18	15.67± 2.33	0.19± 0.05	5.33± 3.33	7.91± 0.67	4.38±0.34	19.33±3.48	1.10±0.30	0.67± 0.67
20	4.50±1.00	1.81±0.21	14.33±3.18	0.28± 0.08	4.00± 3.06	9.41± 2.10	1.42±0.55	16.67±8.29	0.12±0.01	5.00±2.00

Values represent mean ± SE

Table 4: The effect of air pollutants on leaf anatomy of plants at site 3

Distance from the Road (m)	*Urena lobata*					*Hyptis suaveolens*				
	Intervenal distance (mm)	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**	**Intervenal distance (mm)**	**Length of trichomes (mm)**	**Number of trichomes**	**Area of guard cell (mm^2)**	**Stomata frequency**
0	2.98± 0.14	1.22±0.26	16.33±2.03	0.02± 0.00	3.00±1.53	4.44±0.23	1.37± 0.15	16.00±2.08	0.14±0.02	1.33± 0.33
10	6.43± 1.10	3.25±0.71	31.33± 8.17	0.04± 0.01	3.00±1.73	9.11±1.77	0.83± 0.13	8.33±2.33	0.17±0.03	5.00±2.87
20	4.05± 0.80	2.22±0.48	29.00± 6.66	0.26± 0.03	2.00±0.57	2.79±0.32	0.78± 0.11	18.00±5.86	0.09±0.02	1.33± 0.88

Values represent mean ± SE

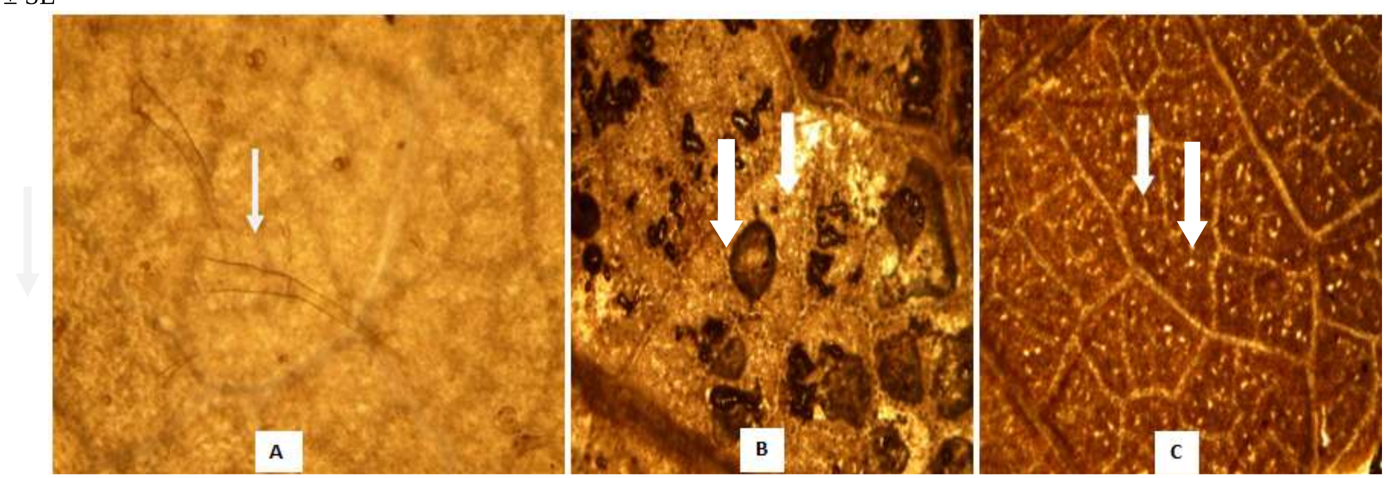

Plate 1: The leaf anatomy of: A. *Hyptis suaveolens* at 0 m showing trichomes (x40). B. *Urena lobata* at 0 m showing distorted veinlets (x40). C. *Urena lobata* at 10 m showing the veinlets (x40).

In site 2, the intervenal distance of *U. lobata* leaves at 10 m (5.54 mm) was higher than the others (Table 3). The length and number of trichomes at 0 m were the highest compared with those at 10 m and 20 m. The reverse was observed in the area of guard cell where 20 m (0.28 mm^2) is higher than those at 10 m (0.19 mm^2) and at 0 m (0.13 mm^2). However, the stomata frequency at 0 m the highest (7.33). For *H. suaveolens*, the intervenal distance of the leaves increased from 0 m to 20 m (Table 3). The length and number of trichomes at 0 m were higher than those at 10 m and 20 m. The area of guard cells at 10 m (1.10 mm^2) was higher than those at 0 m (0.13 mm^2) and at 20 m (0.12 mm^2). While the stomata frequency at 0 m was the highest. The differences in the leaf anatomical features of the two plants between the locations were significant ($P \leq 0.05$) except for intervenal distance and area of guard cells.

Considering *U. lobata* in site 3, the leaf intervenal distance, number of trichomes and length of trichomes at 10 m were the highest, while the lowest were at 0 m (Table 4). The area of guard cell increased from 0 m to 20 m. For *H. suaveolens*, the leaf intervenal distance at 10 m (9.11 mm) was highest, while the lowest was at 20 m (2.79 mm). The length of trichomes and area of guard cell at 20 m were the lowest. The number of trichomes and stomata frequency at 10 m were the lowest while the highest were at 20 m. The anatomical features of the two plants between the locations were significantly different at $P \leq 0.05$ except for number of trichomes and stomata frequency.

The Effects of Air Pollutants on the Stem Anatomy of Plants

In site 1, the thickness of stem epidermis (0.34 mm), cortex (0.42 mm), number of trichomes (27.33), length of trichomes (2.39 mm) and vascular bundles (4.04 mm) of *U. lobata* at 20 m were the highest compared to others (Table 5, Plate 2). The number of cell per area at 0 meter (40.00) was the highest. Those of *H. suaveolens* were entirely different, as the thickness of epidermis (0.31 mm), thickness of cortex (0.56 mm), number of trichomes (17.00) and length of trichomes (7.96 mm) at 0 m were the highest as compared with others (Table 5, Plate 2). The thickness of vascular bundles (2.98 mm) at 10 m was higher than that of 0 m (2.05 mm) and 20 m (1.29 mm). Also, the number of cells per area at 10 m (30.33) was the highest. The differences in the stem anatomical features of the two plants between the locations were significant ($P \leq 0.05$).

Table 5: The effect of air pollutants on stem anatomy of plants at site 1

Distance from the Road (m)	*Urena lobata*						*Hyptis suaveolens*					
	TOEPD (mm)	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**	**TOEPD (mm)**	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**
0	0.14 ±0.01	0.17±0.01	3.41±0.16	1.33 ±1.33	0.26 ±0.03	40.00±20.81	0.31 ±0.01	0.56± 0.09	2.05± 0.43	17.00± 4.58	7.96± 3.20	20.00±4.62
10	0.26 ±0.09	0.21±0.02	2.88±0.27	3.00 ±3.00	0.68 ±0.46	13.67 ±1.20	0.29 ±0.08	0.32± 0.06	2.98± 0.28	11.67± 4.41	0.83± 0.13	30.33±3.18
20	0.34 ±0.05	0.42±0.05	4.04±0.59	27.33 ±6.84	2.39± 0.57	20.00 ±5.77	0.05± 0.01	0.07± 0.02	1.29± 0.08	5.33± 1.45	2.27± 0.66	20.00±2.89

Values represent mean ± SE

KEY: TOEPD: Thickness of epidermis, TOCT: Thickness of cortex, TOVB: Thickness of Vascular bundle; NOTCH: Number of trichomes, LOTCH: Length of trichomes, NOCPA: No of cell per area

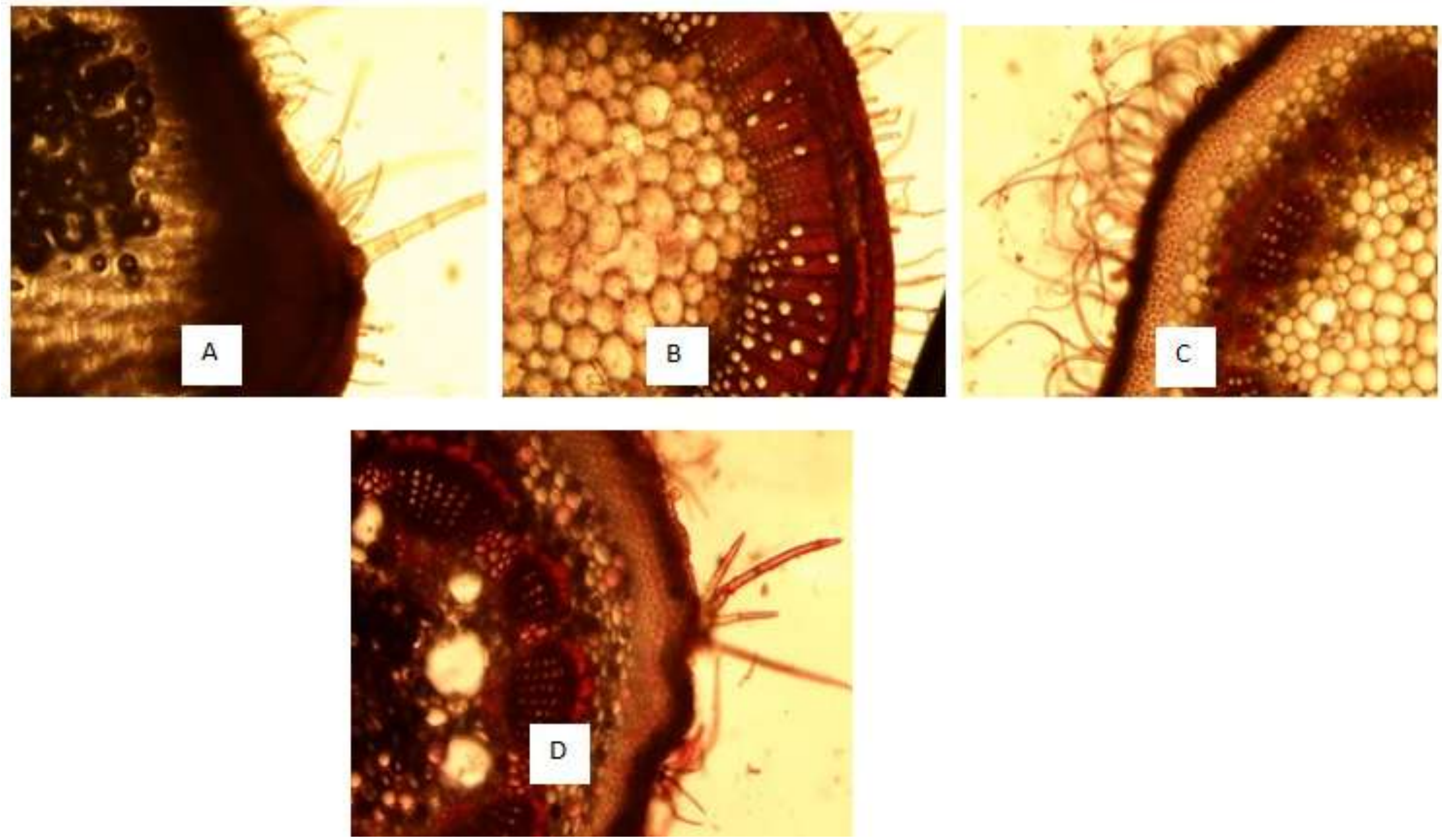

Plate 2: Stem anatomy of: A. *Hyptis suaveolens* at 0 m (x100). B. *Hyptis suaveolens* at 10 m (x100). C. *Urena lobata* at 0 m (x100) D. *Hyptis suaveolens* at 10 m (x100)

Also, the stem anatomical features of *U. lobata* and *H. suaveolens* at site 2 were presented in table 6. For *U. lobata*, the thickness of epidermis at 0 m (0.94 mm) and number of cells per area (15.67) were the highest. The length of trichomes, number of trichomes, thicknesses of cortex and vascular bundles at 10 meters were higher than others. The differences in these features of *U. lobata* were not significant (P≤0.05) except thickness of vascular bundles. In *H. suaveolens*, the thickness of epidermis, thickness of vascular bundles, number of trichomes and length of trichomes at 0 meter were the highest compared with others (Table 6). The thickness of cortex at 0 meter (1.54 mm) was the lowest while the highest is at 10 meters (1.77 mm). Number of cells per area also decreased from 0 meter to 20 meters. The differences in these features of *H. suaveolens* between the locations were significant (P≤0.05) except length of trichomes and number of cells per area.

Table 6: The effect of air pollutants on stem anatomy of plants at site 2

Distance from the Road (m)	*Urena lobata*						*Hyptis suaveolens*					
	TOEPD (mm)	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**	**TOEPD (mm)**	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**
0	0.94± 0.31	1.76±0.36	4.04±0.20	0.67± 0.67	1.08± 0.62	15.67±2.33	0.69± 0.04	1.54± 0.19	3.74± 0.52	7.33± 1.20	3.81± 1.82	37.33± 4.44
10	0.46± 0.18	1.38±0.13	2.44±0.14	7.33± 2.60	1.87± 0.47	7.67± 1.45	0.52± 0.05	1.77± 0.33	1.80± 0.37	0.00± 0.00	0.00± 0.00	29.00± 7.81
20	0.59± 0.07	2.13± .34	3.18±0.09	7.00± 3.79	1.82± 0.39	8.67± 3.48	0.38± 0.03	0.42± 0.03	1.14± 0.21	2.00± 1.15	1.29± 0.85	18.33± 4.41

Values represent mean ± SE

KEY: TOEPD: Thickness of epidermis; TOCT: Thickness of cortex; TOVB: Thickness of Vascular bundle; NOTCH: Number of trichomes; LOTCH: Length of trichomes; NOCPA: No of cell per area

Table 7: The effect of air pollutants on stem anatomy of plants at site 3

Distance from the Road (m)	*Urena lobata*						*Hyptis suaveolens*					
	TOEPD (mm)	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**	**TOEPD (mm)**	**TOCT (mm)**	**TOVB (mm)**	**NOTCH**	**LOTCH (mm)**	**NOCPA**
0	0.54± 0.03	0.34±0.07	3.16±0.18	8.00± 2.08	1.20± 0.10	6.33± 2.73	0.71± 0.16	0.65± 0.06	2.08± 0.44	15.67± 4.33	3.62± 1.10	19.00±5.57
10	0.52± 0.06	1.00±0.04	3.43±0.18	8.00± 2.08	5.80± 2.19	4.67±2.73	0.75± 0.05	0.40± 0.05	3.03± 0.13	2.00± 0.58	2.30± 0.61	21.67±6.01
20	0.22± 0.10	0.25±0.03	3.28±0.32	8.67± 2.33	1.78± 0.30	12.67±3.71	0.27± 0.02	0.31± 0.02	3.39± 0.07	3.33± 0.88	1.39± 0.66	22.67±9.33

Values represent mean ± SE

KEY: TOEPD: Thickness of epidermis; TOCT: Thickness of cortex; TOVB: Thickness of Vascular bundle; NOTCH: Number of trichomes; LOTCH: Length of trichomes; NOCPA: No of cell per area

The anatomical features of *U. lobata* at site 3 followed different trend compared with other sites (Table 7). The thickness of epidermis and vascular bundles at 0 m were the lowest. Number of cells per area at 20 m (12.67) was higher than those at 0 m (6.33) and at 10 m (4.67). All these anatomical features between the locations were significantly different at $P \leq 0.05$ except thickness of vascular bundle, number of trichomes and number of cells per area. For *H. suaveolens*, the thickness of epidermis at 10 m (0.75 mm) was the highest, while the lowest was at 20 m (0.27 mm). The thickness of cortex, thickness of vascular bundles and number of cells per area increased from 0 m to 20 m. The number and length of trichomes decreased from 0 m to 20 m. All these anatomical features between the road distances were significantly different at $P \leq 0.05$ except length of trichomes and number of cells per area.

DISCUSSION

The use of plants as indicators of air pollution has been widely studied and accepted. Leaves were more susceptible to pollutants due to their conspicuous nature and structures (Majernik and Mansfield, 1970). Considering the structure of a leaf, the epidermis which is the outermost layer is relatively more targeted by air pollutants than other tissues. Some anatomical features like thickness of epidermal cells, stomata frequency, trichomes, idioblasts and cuticular thickening are the traits which could be used to determine the responses of plants to environmental stresses and hence useful as bio-indicators of air pollution (Yunus *et al*., 1979).

In this study, the leaves of *Hyptis suaveolens* and *Urena lobata* at the 0 meter which were observed to be smaller and having dark spots compared to those at 10 and 20 meters away from the road could be attributed to heavy pollutants absorbed from automobiles on the busy roads. This is supported by Otoide (2015) who observed that the leaf area of plants from polluted microhabitats were smaller than those of the non-polluted microhabitats. Microscopic observations of the leaves at 0 meter from the road of *H. suaveolens* and *U. lobata* showed that the stomatal pores were covered a little (sunken). This could be an implication of the effects of air pollutants that inhabit busy roads where these plants are found growing.

Futhermore, the two plants were observed to have more stomata at 0 meter but smaller areas of guard cells. This could be an adaptive strategy of the plants in reducing the surface area to volume ratio in order to limit the amount of pollutants entering into their cells. The relevance of stomata in protecting plants against pollutants has been studied by Mansfield and Majernik (1970), who reported that stomata closure do protect plants from pollution damage. Trichomes or clothing hairs which usually serve as defensive structures were found to be more on the leaves of *H. suaveolens* closer to the roadsides than in *U. lobata*. According to Azmat *et al*. (2009), plants undergoing stress do exhibit higher number of trichomes and reduced stomata sizes than those in normal environmental conditions. Also, higher number of trichomes could also aid the plants from damage caused by solar radiation and oxidative stress (David *et al*., 2017; Skaltsa *et al*., 1994).

Our results also showed that the two plant species exhibited different stem anatomical responses to the air pollutants along the roadsides studied. These variations were of no doubt due to their distinct inherent biological make-ups (Khakwani *et al*., 2012). For instance, while *U. lobata* showed higher thickness of epidermis, thickness of vascular bundles, number of trichomes and length of trichomes far from the roadside, the reverse was the case for *H. suaveolens* which tends to exhibited higher protective covering of its internal structures closer to the roadside. Increase in wall thickness and vascular bundle thickness have been attributed to plants growing in stressed conditions and these features are mainly for protection and adaptability of the plants to such stresses (Guerfel *et al*., 2009; Makbul *et al*., 2011). Our work also agrees with previous reports that cuticle and mesophyll thickness of plants decreased with increase in pollution levels (Stevovi, 2010; Akomolafe *et al*., 2017a).

One of the main functions of trichomes is to act as defensive mechanism for plant against external influences. In this regard, *H. suaveolens* could be described to have developed higher number and length of trichomes closer to roadside to prevent or limit the impact of pollutants on its internal tissues. Similarly, *U. lobata* closer to the roadside exhibited higher rate of cell proliferation represented by the number of parenchyma cells compared with *H. suaveolens*. Parenchyma cells are known to be active and mainly used for storage. This could mean that *U. lobata* was able to adapt better to pollutions along roadside by engaging in more active production of cells than *H. suaveolens*. All these anatomical alterations could be regarded as being caused by modifications in the metabolisms of plants exposed to environmental pollution (Cvetanovska *et al*., 2010).

CONCLUSION

This study has revealed that both leaves and stems of *Urena lobata* and *Hyptis suaveolens* growing along busy roadsides in Lafia, Nigeria were negatively affected, especially with respect to their anatomical features. *Hyptis suaveolens* with high number of trichomes, thick epidermis and thick vascular bundle closer to the roadside can be regarded as well adapted to these automobile pollutants. Also, *U. lobata* exhibited another level of adaptation to the environmental stress as shown by the rate of cell proliferation. These anatomical changes are obviously as a result of cumulative effects of these pollutants from roadsides. The same plants growing far away from the roadsides showed lesser degree of alterations.

REFERENCES

Akomolafe, G.F., Oloyede, F.A. and Onwusiri KC (2017a). Impact of Arsenic Stress on Leaflets and Stipes (Frond Petiole) Anatomy of *Pteris vittata* Linn. and *P. ensiformis* Burm. *International Journal of Plant & Soil Sciences*, 17(2): 1-9

Akomolafe, G.F., Omojola, J., Joshua, E.S., Adediwura, S.C., Adesuji, E.T., Odey, M.O., Dedeke, O.A. and Labulo, A.H. (2017b). Growth and Anatomical Responses of *Lycopersicon esculentum* (Tomatoes) under Microgravity and Normal Gravity Conditions. *International Journal of Biological., Biomolecular, Agricultural, Food & Biotechnological Engineering*, 11(5): 367-370

Azmat, R., Haider, S., Nasreen, H., Aziz, F. and Riaz, M. (2009). A viable alternative mechanism in adapting the plants to heavy metal environment. *Pakistan Journal of Botany*, 41(6): 2729-2738

Cvetanovska, L., Klincharska-Jovanovska, I., Dimeska, G., Srbinoska, M. and Cvetanovska, A. (2010). Anatomic and physiological disorder after intoxication with heavy metals in tobacco (Nicotiana tabacum L.). *Biotechnology & Biotechnological Equipment*, 24 (sup1): 4-9

David, O., Osonubi, O., Olaiya, C., Agbolade, J., Ajiboye, A., Komolafe, R., Chukwuma, D. and Akomolafe, G. (2017). Anatomical response of wheat cultivars to drought stress. *Ife Journal of Science*, 19(2): 323-331

Garner, J. (2002). Air pollutants, plant response, soil microbes and ecosystem biodiversity. *Environmental News*, 8(3): 127-132

Guerfel, M., Baccouri, O., Boujnah, D., Chaïbi, W. and Zarrouk, M. (2009). Impacts of water stress on gas exchange, water relations, chlorophyll content and leaf structure in the two main Tunisian olive (Olea europaea L.) cultivars. *Scientia Horticulturae,* 119(3): 257-263

Güvenç. A. and Duman, H. (2010): Morphological and anatomical studies of annual taxa of *Sideritis* L.(Lamiaceae), with notes on chorology in Turkey. *Turkish Journal of Botany*, 34(2): 83-104

Khakwani, A., Dennett, M., Munir, M. and Baloch, M. (2012). Wheat yield response to physiological limitations under water stress condition. *The Journal of Animal & Plant Sciences*, 22(3): 773-780

Majernik, O. and Mansfield, T. (1970). Direct effect of SO2 pollution on the degree of opening of stomata. *Nature*, 227(5256): 377-378

Makbul, S., Güler. N.S., Durmuş, N. and Güven, S. (2011). Changes in anatomical and physiological parameters of soybean under drought stress. *Turkish Journal of Botany*, 35(4): 369-377

Makbul, S., Türkmen, Z., Coskunçelebi, K. and Beyazoglu, O. (2008). Anatomical and pollen characters in the genus Epilobium L.(Onagraceae) from Northeast Anatolia. *Acta Biologica Cracoviensia Series Botanica*, 50(1): 51-62

Oloyede, F., Akomolafe, F. and Oladipo, O. (2011). Comparative foliar anatomical and morphological studies of *Nephrolepis biserrata* (swartz) Scott and *N. undulata* (Swartz) J. Sm. in Nigeria. *Journal of Science & Technology (Ghana)*, 31(2): 1-10

Otoide, J. (2015). Study of the Activity of Air Pollution on the Leaves of Urena lobata Growing along Busy Roads. *Donnish Journal of Agricultural Research*, 2(8): 071-076

Otoide, J. and Kayode, J. (2016). Presentation of plugged stomatal pores in the leaf of Sida acuta. *Journal of Botanical Papers*, 1(2)

Reddy, A.R., Chaitanya, K.V. and Vivekanandan, M. (2004). Drought-induced responses of photosynthesis and antioxidant metabolism in higher plants. *Journal of plant physiology*, 161(11): 1189-1202

Skaltsa, H., Verykokidou, E., Harvala, C., Karabourniotis, G. and Manetasi, Y. (1994). UV-B protective potential and flavonoid content of leaf hairs of Quercus ilex. *Phytochemistry*, 37(4): 987-990

Stevovi, S. (2010). Environmental impact on morphological and anatomical structure of Tansy. *African Journal of Biotechnology*, 9(16): 2413-2421

Yunus, M., Ahmad, K. and Gale, R. (1979). Air pollutants and epidermal traits in *Ricinus communis* L. *Environmental Pollution*, 20(3): 189-198

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Olugbire et al., 2019

CLIMATE CHANGE ADAPTATION THROUGH CONSERVATION AGRICULTURE: EVIDENCE FROM SMALLHOLDER FARMERS IN ONDO STATE, NIGERIA

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ABSTRACT

This study identifies the factors influencing the adoption of CA among smallholder farmers in Ondo State, Nigeria. To determine the factors influencing the adoption of CA among smallholder farmers, Tobit regression model was used. From the regression results, minimum tillage, crop rotation, mulching, cost of planting materials, cost of equipment's are all positively significant at 1% and a unit increase in them will increase the adoption of CA practices in the study area. The primary occupation of the respondents is positively significant at 5% and a unit increase in primary occupation of the respondentsincreases the rate of adopting CA practices by 0.0570868. Age of the respondents is negatively significant at 10% and this implies that a unit increase in age decreases the rate of adopting CA by 0.0018808. Also, household size is positively significant at 10% and a unit increase in households' size increase the level of adoption of conservation agriculture by 0.0079891. This paper therefore recommends that policies addressing the 3 core principles of CA practices (minimum tillage, crop rotation and mulching) should be re-emphasized so as to improve the food production involve in agricultural value chain activities. Young ones should be encouraged to involve in farming practices especially CA activities. And lastly, cost of equipment and planting materials should be subsidized for farmers so as to foster improved farming, increased food production and hence aid commercialization among smallholder farmers.

Key words: Conservation agriculture, agricultural value chain and smallholder farmers

INTRODUCTION

According to FAO (2013), Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Conservation Agriculture (CA) is increasingly promoted in Africa as an alternative for coping with the need to increase food production on the basis of more sustainable farming practices. CA is specifically seen as a way to address the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil. It aims at higher crop yields and lower production costs. Yet, success with adopting CA on farms in Africa has been limited (Kassam*et al*., 2009). Conservation Agriculture (CA) is increasingly seen as an effective technology to increase farmers' resilience to climatic variability and address soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil, aiming at higher crop productivity with lower production costs. However, the adoption of conservation agriculture (CA) by smallholder farmers in Africa has been limited so far (Giller*et al*., 2009).The low output/low yield associated with conventional agriculture or non-adoption of CA among smallholder farmers has limited their involvement in agricultural value chain activities because much of their production is sufficient for their household with low market accessibility. However, Roger Norton(2014) opinedvalue chain as a set of linked activities that work to add value to a product; it consists of actors and actions that improve a product while linking commodity producers to processors and markets. Value chains work best when their actors cooperate to produce higher-quality products and generate more income for all participants along the chain, as opposed to the simplest kinds of value chains, in which producers and buyers exchange only price information — often in an adversarial mode. Value chains differ from supply chains, which refer to logistics: the transport, storage and procedural steps for getting a product from its production site to the consumer.

IFAD (2011) opined that at the national and sub-Saharan African regional level, efforts are being intensified to promote the technology despite concerns raised about its suitability within the smallholder farming context. Some of these concerns include: the potential decrease in yields due to poor adaptation of CA; increased labour requirements when herbicides are not used; competing uses of mulch for soil cover and livestock feed;and the potential redistribution of farmlabour, placing even more demands onwomen's time. It has also been noted that weak input supply chains in most countries are a major hurdle for smallholder farmers in the proper application of the technology. The critical issue however, is not whether CA works – even strong critics (Giller*et al*., 2009) agree that it works – the question is whether it is the best approach for smallholder farmers in sub-Saharan Africa given the context within which they operate.

Involvement of smallholder farmers in Agricultural food chain

Smallholders live in rural areas of developing countries and they are distinguished by the relatively small amounts of agricultural land that they cultivate. The size of farm considered "small" depends on the quality of local agricultural resources and the specific economic context. In general, smallholder farms are defined as operating two hectares or less (World Bank, 2003). There are approximately 2.5 billion people living on 500 million smallholder farms in developing countries, with the majority living on less than $2 per day (IFAD, 201 3). Based on estimates from Food and Agriculture Organization of the United Nations (FAO) data, the majority of small farms are located in Asia (87 percent), with the next largest number found in Africa (8 percent). There are approximately 33 million smallholder farms in Africa, comprising 80 percent of all African farms (Nagayets 2005).

Kenyan Green Bean Value Chain

(J.E. Austin Associates, inc) reported to the world bank that in the 2000s, as the power of the supermarkets continued to drive the market, many supermarkets began to pursue market segmentation and branding strategies which increased the demand for higher quality standards, different varieties, and organic or "safer "produce. A number of exporters have invested heavily in growing their own high-quality certified vegetables to take advantage of the increased market opportunities for high-quality produce. The effect of these trends has been a much shorter supply chain, a greater degree of vertical integration, fewer active players, and production and exporting on a much grander scale. By the early 2000s, seven of the largest food retailing chains accounted for 76 percent of fresh fruit and vegetable sales and 70 to 90 percent of fresh produce imports from Africa. 63 As of 2004, the total Kenyan vegetable export trade was worth USD 139m, and the country ranked second in Africa in fresh exports vegetables. The industry employs 45,000 to 60,000 people, of whom an estimated 60 percent are women, in commercial farms, processing, and logistics operations; another 7,000 are smallholders. Employees typically earn just under USD 2 per day, while smallholders are reportedly able to earn the equivalent of USD 7 per day.

Impacts of CA on production output of smallholder farmers

The result table below depicts the impact of conservation agriculture on production output of smallholder farmers by comparing the input allocations for CA and conventional farming alongside with the yield (Mazvimavi K*etal.*, 2012)

Rising population has forced farmers to abandon traditional practices that left the land fallow for several years, and to cultivate ever-smaller plots. Intensive tilling and hoeing year after year can produce a hardpan in the soil. That restricts root growth and stunts plants. Rainwater pounds the bare soil, forming a surface crust that the water cannot penetrate. It runs off, taking the valuable topsoil with it. Erosion in some places is so severe that there is little soil left. To get a good yield, farmers often apply more and more fertilizer. With less moisture in the soil, plants are more vulnerable to drought. They start to wilt after a few days without rain. Conservation agriculture enables farmers to reverse this trend. It prevents hard-pans from forming, protects the soil, increases soil moisture, and restores soil fertility, so stabilizing yields and improving production over the long term, thereby improving yields (FAO,2013).

Factors influencing adoption of CA among smallholder farmers

The main barriers to conservation agriculture adoption continue to be, knowledge on how to do it (know how), mindset (tradition, prejudice), inadequate policies as commodity based subsidies (EU, US), availability of adequate machines (many countries of the world) and availability of suitable herbicides to facilitate weed management (especially in developing countries). These barriers must be overcome not only by farmers but also by researchers, extension workers, university professors, politicians and all stakeholders involved in the farming industry if a greater adoption is aimed to be achieved. The widespread adoption of No-tillage under a great range of different conditions on more than a 100 million ha worldwide shows, that the system can be made to work and function, it is only a matter of a firm determination to do so, after recognizing the superiority of this system in relation to unsustainable intensive tillage practices (Rolf *et al*., 2009).Despite the impact of CA in achieving the Millennium Development goals, higher profitability and better productivity of CA on crops and significant effort that has gone in promoting CA in sub-Saharan Africa, yet, the adoption has been limited. This study therefore explores the factors that determine the adoption of CA among the farming households in Ondo state.

MATERIALS AND METHODS

Study Area

This study was carried out in Akure North and South Local Government Area (LGA) of Ondo State, Nigeria. Akure South is a local government area in Ondo state, Nigeria and its headquarter is in the town Akure. It has an area of 331km^2 and a population of 353,211 at2006 census. The postal code of the area is 340. Akure North is also a local government in state. Its headquarters is in the town of Iju/Itaogbolu. It has an area of 660km^2 and a population of 131,587 at the 2006 census. The postal code of the area is also 340.

Population of the study, Sampling procedure and sample size

All the farming households in Akure North and Akure South local Government Area of Ondo state constituted the population of the study.Two stage sampling technique was employed to select the representative sample for the study. In the first stage, 10 villages were randomly selected from identified villages in the study area, 5 villages were selected from Akure North and 5 villages were selected from Akure South. The second stage was random selection of 12 registered farming household from each of the selected villages to arrive at 120 respondents proposed for the study.

Method of data collection and Measurement of variable

Data for the study was collected through the use of a well-structured questionnaire which was developed based on the objectives of the study. Dependent variable (Y) and independent variables (X_{is}) was used for this study. Dependent variable (Y) was adoption of CA practices which took on values of 1 and 0 while independent variables (X_{is}) was selected socio-economic characteristics of the respondents as well as the farming practices employed.

Data analysis and Models specification

Descriptive statistics such as frequency count and percentages was used to describe data on selected socio-economic characteristics of the respondents while tobit regression model was used as inferential statistics tools to test the formulated hypothesis. Household decision to adopt CA will depend on a number of factors like land holding size, access to extension services and information, household characteristics (such as age of household head, and gender), availability of labour and unobservable factors explained by the stochastic term, ε. This study will use the tobit model to assess the determinants of CA adoption. We will assumed a latent variable Yi* representing adoption or non- adoption. Where adoption means the process by which a particular farmer is exposed to, considers and finally practices an innovation. Independent variables Xi will be regarded as factors that affect CA adoption and β will be a -vector of parameters. Then the decision to adopt a technology will be specified as follows:

Tobit Model Specification

$Y_i^* = \beta X_i + e_i$

$Y_i^* = 0$, if $Y_i = 0$

$Y_i^* = Y_i$ if $0 < Y \leq 1$

Where Y_i^* is the observed dependent variable (adoption index)

β is a vector of unknown parameters;

X_i is the vector of independent variables; where i = 1, 2.........................n;

RESULTS AND DISCUSSION

Descriptive Statistics of Secondary Socio-Economic Characteristics of Respondents

Using descriptive statistics, the primary and secondary socio-economic characteristics were analysed and presented in tables 1 and 2. Results from table 1 show that the mean age of the respondents is 48years, majority of the household head (76.04%) are literate, many of them are married (about 76.04%), they have an average household size of 7members which makes them have access to family labour, majority of the respondents engage in farming activities as their primary occupation (about 72.92%). About 66.67% of the respondents have access to labour, 83.33% practice minimum tillage, 34.38% practice crop rotation, 32.29% practice mulching. 65.63% source for their input by purchase while 29.17% have access to government subsidy on inputs.

Table 1: Descriptive Statistics of Primary Socio-economic Characteristics

Variables	Frequency	Percentages
Gender		
Male	72	75
Female	24	25
Age		
≤ 30	13	13.5
31 – 40	19	19.79
41 – 50	24	25.00
51 – 60	26	27.09
61 – 70	13	13.54
Above 70	1	1.04
Mean age	47.9	
Level of education		
No formal Education	23	23.96
Primary Education	36	37.5
Secondary Education	24	25
Tertiary Education	13	13.54
Mean	6.9	
Marital status		
Single	7	7.29
Married	73	76.04
Widowed	10	10.42
Divorced	6	6.25
Households size		
1-5	29	30.21
6-10	47	48.96
11-15	18	18.75
Above 15	2	2.08
Mean household size	7	
Total	**96**	**100**

2: Descriptive Statistics of Secondary Socio-Economic Characteristics

Variables	Frequency	Percentages
Primary occupation		
Farming	70	72.92
Non-Farming	26	27.08
Secondary occupation		
None	23	23.96
Farming	16	16.67
Non-Farming	57	59.37
Access to Labour		
Yes	64	66.67
No	32	33.33
Minimum tillage practices		
Yes	80	83.33
No	16	16.67
Crop Rotation practices		
Yes	33	34.38
No	63	65.63
Mulching practices		
Yes	31	32.29
No	65	67.71
Cost of planting materials(₦)		
≤ 10,000	38	39.58
10,001 – 20,000	36	37.50
20,001 – 30,000	13	13.55
30,001 – 40,000	4	4.16
› 40,000	5	5.21
Cost of equipment**(₦)**		
≤ 3000	83	86.46
3,001 – 6,000	9	9.37
6,001 – 9,000	3	3.13
› 9000	1	1.04
Source of input by purchase		
Yes	63	65.63
No	33	34.38
Source of input by NGO		
Yes	4	4.17
No	92	95.83
Source of input by governmental subsidy		
Yes	28	29.17
No	68	70.83

Determinants of conservation agricultural practices among farming households

The results in table 3 show the conclusive inferences on the exact quantitative relationship between the adoption index and socio-economic characteristics. Each slope coefficient in the equation is a partial slope coefficient and it measures the change in the estimated tobit for a given change in the value of the given regressor (holding other regressor constant). The coefficient shows variable with positive and negative values. Variables with negative values imply a negative relationship between the explanatory variables and the dependent variables. Variables with positive values imply a positive relationship between the explanatory variables and the dependent variables. Among the 11 variables, only 8 variables were significant.

Age of the respondent has a negative and significant relationship which implies that, a unit increase in age decreases the rate of adopting conservation agriculture and this is in line with the a priori expectation that as aging increases, the efficiency of the farmers to work reduces. Also the households' size of the respondent has a positive and significant relationship which implies that, a unit increase in households size increases the level of adoption of conservation agriculture which agrees with the apriori expectation that increase in households' size increases the availability of family labour for farm activities. The primary occupation of the respondent has a positive relationship and is significant which implies that, a unit increase in primary occupation of the respondent will increase the rate of adopting conservation agricultural practices.Since majority of the respondent has their primary occupation to be farming as identified in the socio-economic characteristics, this will therefore enhance the adoption of conservation agricultural practices and this accompany the a priori expectation as identified in the literature.

The minimum tillage practices also has a positive and significant relationship which implies that, a unit increase in minimum tillage practices increases the adoption of conservation agriculture by 0.23 and in accordance with the apriori expectation as identified in the literature, minimum tillage is one of the major components of conservation agricultural practices and majority of the farming households in the sample population practices it as identified in the socio-economic characteristics of the respondents. Likewise the crop rotation practices also has a positive relationship which implies that a unit increase in crop rotation practices increases the adoption of conservation agriculture by 0.17. Mulching also being one of the conservation agricultural practices has a positive relationship and is significant at 1%. All of these practices facilitate the adoption of conservation agriculture.

Furthermore, cost of planting material and cost of equipment has a positive and significant relationship implying that a unit increase in the cost of planting material and cost of equipment increases the adoption of conservation agriculture. According to the literature, conservation agriculture requires investment on equipment and planting material and the more these inputs are added the greater the yield increase is expected to be.

Table 3: Determinants of adoption of conservation agricultural practices among farming households

Adoption index	Coefficient	Standard Error	Z
Constant	0.1785296	0.0803976	2.22
Age	-0.0018808	0.0011258	-1.67***
Years spent in school	0.0000278	0.002256	0.01
Households size	0.0079891	0.0040767	1.96***
Primary occupation	0.0570868	0.0256513	2.23**
Farm size available	0.0013959	0.0081978	0.17
Frequency of extension visit	-0.0211508	0.0164334	-1.29
Minimum tillage	0.2324292	0.0341666	6.80*
Crop rotation	0.1747119	0.0233693	7.48*
Mulching	0.1697304	0.0226834	7.48*
Cost of planting material	1.87e-06	6.90e-07	2.72*
Cost of equipment	0.0000153	4.30e-06	3.57*

Pseudo R^2 = 0.2607; Number of obs = 96; LR chi^2 (11) = 101.07; Prob> chi2 = 0.0000; *Significant at 1%, ** Significant at 5%, *** Significant at 10%.

CONCLUSION

This study concludes that the factors driving adoption of CA practices among the farming households in the study area are: age, household's size, primary occupation, minimum tillage, crop rotation, mulching, cost of planting materials, and cost of equipment. Hence, it is very necessary to develop a suitable policyfor the adoption of conservation agricultural practices among rural farmers in the study area.

Recommendations

Based on the findings of the study, the following recommendations are hereby suggested:

Since age has a negative effect on the adoption of conservation agriculture, young ones should be encouraged to involve in farming practices especially conservation agricultural activities.Household's size has positive effect on the adoption of CA, therefore family labour should be maximally used where possible in the practice of conservation agriculture.Primary occupation which is farming should be expanded among farming households since this is a major determinant of adopting conservation agriculture.Minimum tillage, crop rotation and mulching have a positive effect on the adoption of conservation agriculture therefore these practices should be encouraged so as to enhance increased crop production involved in value chain activities.

REFERENCES

FAO (2013) what is conservation agriculture website:
http://www.fao.org/ag/ca/index.html and http://www.fao.org/ag/ca/AfricaTrainingManualCD/PDF%20Files/01INTRO.PDF

Kassam, A., Friedrich, T, Shaxson, F. and Pretty, J. (2009). The spread of Conservation Agriculture: Justification, sustainability and uptake. *International Journal of gricultural Sustainability:* 7 (4): 292-320.

Giller K.E., Witter E., Corbeels M., Tittonell P.(2009) Conservation agriculture and smallholder farming in Africa: the heretics" view, *Field Crops Research*, 114, 23-24.

IFAD (2011).Smallholder conservation agriculture Rationale for IFAD involvement and relevance to the East and Southern Africa region. *International Fund for Agricultural Development* (IFAD) 9072-262-5 Roger Norton (2014). Agricultural value chains: A game changer for small holders. Available at https://www.devex.com/news/agricultural-value-chains-a-game-changer-for-small-holders-83981

World Bank (2003). *Reaching the Rural Poor: A New Strategy for Rural Development.* Washington, D.C.

IFAD. July 2013. *Smallholders, Food Security, and the Environment*. Rome: International Fund for Agricultural Development.

Nagayets, Oksana. June 2005. *Small Farms: Current Status and Key Trends*. Information brief prepared by the International Food Policy Research Institute for the "Future of Small Farms Research Workshop" at Wye College.Mazvimavi K., Ndlovu P.V., An H. and Murendo C.Productivity and Efficiency Analysis of Maize under Conservation Agriculture inZimbabwe

Rolf Derpsch and Theodor Friedrich (2009): Global overview of conservation agriculture No- till adoption. 4th world congress on conservation agriculture New Delhi, 4-7 February 2009. Available at http://www.fao.org/ag/ca/doc/derpsch-friedrich-global overview-ca-adoption3.pdf

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Arhyel et al., 2019

ASSESSMENT OF VEGETATION COMMUNITY COMPOSITION IN YANKARI GAME RESERVE, BAUCHI STATE, NIGERIA

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ABSTRACT

This study examined vegetation cover composition in Yankari Game Reserve from 1986 to 2015 with the aim of evolving a sustainable forest resource management and biodiversity conservation. Intensive and extensive ground trotting exercise were employed to collect data on ground vegetation characteristics such as species type, number, density and information on landuse history and practice within the study area. Normalized Vegetation Index (NDVI) derived from five near anniversary imageries (November and December) of 1986 (Landsat5-TM), 1999 (Landsat7-TM), 2005 (Landsat 7- ETM), 2010 (Landsat 7- ETM), and 2015 (Landsat-8 OLI) were corrected for atmospheric attenuation using UTM-32 map projection. Quadrant samples were used to generate data on species diversity and distributions of woody plants. The finding reveals that in terms of density, quadrant B shows the lowest value which is as a result of intense pressure on the vegetation cover, while quadrant D shows the highest value. The endangered species recorded in the study area were Eleusine indica and Echinochloa stagnina in quadrant A, Eragrostis tenella in quadrant B. Loudetia annual in quadrant C, and Fuirena ciliaris species in quadrant D. The finding also reveals a decrease in dense woodland vegetation cover over the study period. It is recommended that clear guidelines on the legal activities be developed by the state government with public participation to regulate the use of its resources as well as a balance between utilization of the forest resources and biodiversity conservation.

Key Words: Vegetation community, composition, endangered species, Yankari Game Reserve.

INTRODUCTION

A nation's system of protected areas is designed to suit its own requirements for conserving the resources as a sustainable base for human development (Ejidike, 2008). Conservation practices of natural resources are positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the resources (International Union for Conservation of Nature, 2004). Countries worldwide have designated some land as protected areas that have many benefits. This includes the role they play in socio-economic development of local inhabitants in surrounding rural areas; they contribute to the better lifestyle and standard of living (Ayo, 2006). In national parks, game reserves and other protected areas such as Gashaka Gumti, Kainji and Okomu national Park among others, unique flora and fauna, sceneries and landscape are protected, managed and regulated for human benefit from one generation to another (Ejidike, 2008).

Proper management of natural resources in any nation projects good image and strength of the country because vegetation cover plays indispensable roles in creating and preserving quality environment (Nwoboshi, 2000). Conservation of the resources of a nation environment plays essential role in the development of such country, these intend at revealing different efforts being made by the Federal and State Governments in promulgating new National Parks and Game Reserves in different states in pursuance of conserving wildlife and vegetation of the nation (Nwoboshi, 2000).

Forest areas worldwide have continued to reduce owing to deforestation. According to Food and Agriculture Organization (2008), Nigeria lost an average of 409,700 hectares of forest per year between 1990 and 2000. This amounts to an average annual deforestation rate of 2.98%. Between 2000 and 2005, the rate of deforestation increased to 3.12% per annum. In 1990 and 2005, Nigeria lost 6,145,000 hectares (35.7%) of its forest cover. In other words, Nigeria lost 1,230,000 hectares of its forest cover from 1990 to 2005. This development in land cover change have also raised the concern as to whether the land, be it in natural condition or cultivated, can continue to hold its environmental functions needed to sustain man (Mortimore, 2009).

Monitoring vegetation cover change over time provides important information about the stability of the ecosystem and whether significant changes are taking place or not. The rates and pattern of the changes in vegetation cover could be achieved through trend analysis (Jensen, 2000). Remote sensing techniques have been identified to provide a viable source of data from which updated land cover information can be extracted efficiently in order to monitor these changes (Houghton, 2003; Roy *et al.,* 2009; Mas, 2006; Vasconcelos *et al.*, 2010; Potter *et al.,* 2007). In addition, the importance of indigenous knowledge in natural resource management has, since the beginning of the 21st century, been identified (Wells *et al.,* 2002; Altieri, 2002). In particular, it has been recognized that local farmers around the world are able to manage their lands in a sustainable way (Mazzucato and Niemeijer, 2004).

In northern Nigeria, Game Reserves have presently become dependent on rainfall, human activities such as shifting cultivation, bush burning, lumbering and grazing. Different studies suggest that vegetation index correlates well with leaf area index, green leaf biomass and annual net primary productivity of any given area (Ahlcrona and Solomon, 2006; Viña *et al.*, 2004). Moreover, little is known quantitatively, regarding the degree to which the spatial variation of the vegetation index depends on rainfall seasonality in the tropics at regional scale (Barbosa and Lakshmi, 2011).

Circumstantial evidence from reconnaissance survey shows that Yankari Game Reserve has witnessed severe degradation within 2010-2015, partly due to decline in rainfall from 377 mm in 2005 to 264 mm in 2010 (Muchena and Niemeijer, 2005) but largely due to increased human activities such as; arable farming, grazing and fuel fuelwood harvesting. The implication of a decline on the ecology of the reserve particularly in relation to vegetation cover change, biomass production and wildlife management has not been investigated of recent, particularly since the reported decline in species numbers and the encroachment into the traditional grazing areas by other forms of landuse (Rao and Kasper 2009); therefore the need to examine vegetation cover composition in Yakari Game Reserve.

Thus, evidence suggests Yakari Game Reserve has witnessed severe degradation within the past thirty to forty years due to anthropogenic activities associated with expansion and clearances of arable land for farming to meet the needs of a rapidly growing human population around the reserve (Apeldoorn, 2008). The ecology of the reserve particularly in relation to forage species composition, vegetation cover distribution has not been investigated, particularly since the reported increase in grazing by nomads and the encroachment into the traditional grazing areas by other forms of landuse. However, it is not clear to what extent these activities have affected the vegetation condition of the area (Munyati, 2008). Consequently, this study investigated the spatial composition of vegetation cover change that has occurred as a result of human activities in Yankari Game Reserve from 1986 to 2015.

MATERIALS AND METHODS

Study Area

Yankari Game Reserve occupies an area of about 47.48 km.sq. It is located between latitudes 9° 40' 00" N and 10° 0' 00" N and longitudes 10° 20′ 00" and 10° 40' 00" E which covers Duguri, Pali and Gwana Districts of Alkaleri Local Government Area of Bauchi State, Nigeria (Figure 1).

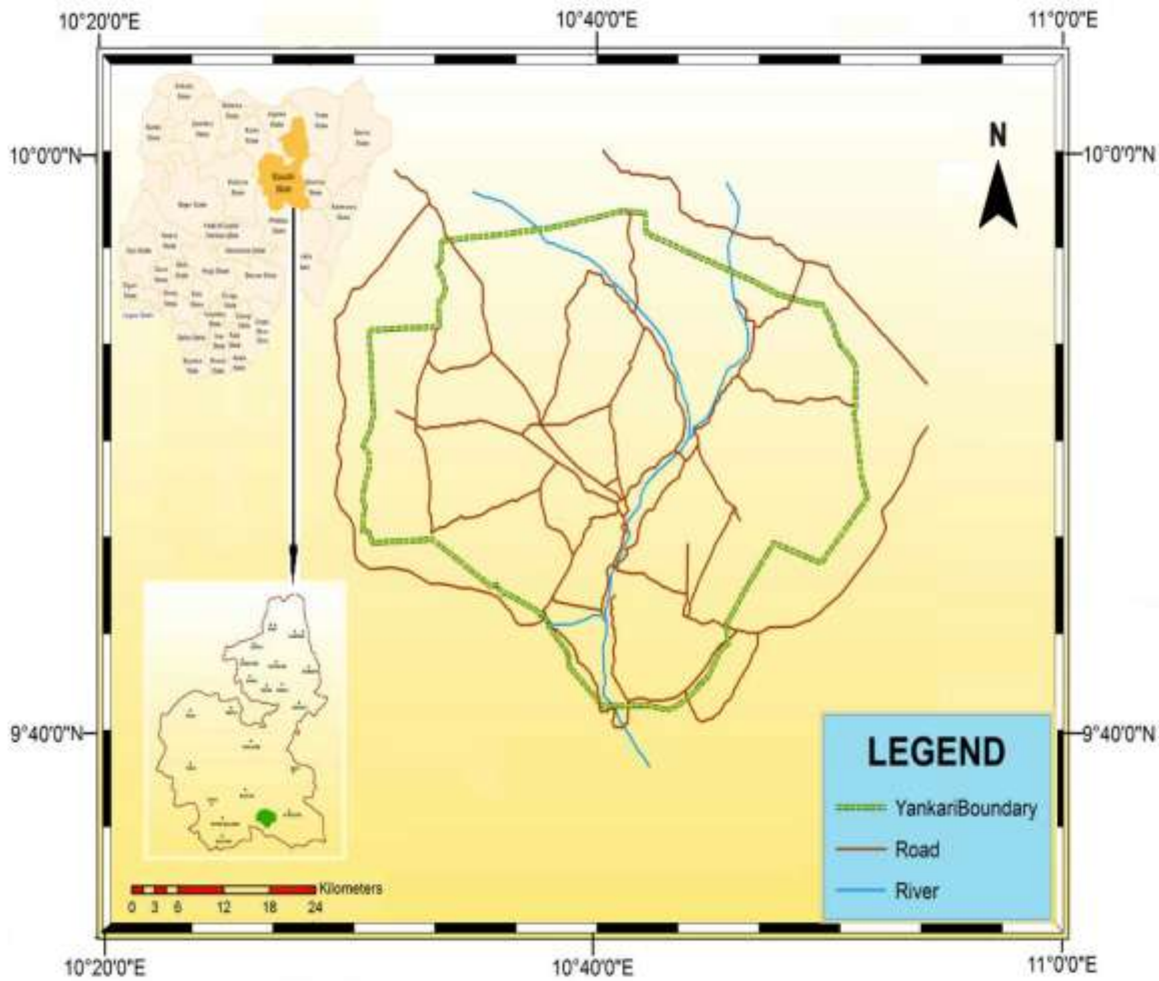

Figure 1: Yankari Game Reserve
Source: National Remote Sensing Centre, Jos (2015)

Rainfall in Yankari Game Reserve ranges between 350 mm and 1300 mm per annum. The rainy season begins around May and ends in November while the dry season begins in early October and lasts until April (Anyadike, 1993). Rainfall in the study area is clearly marked by a monomodal regime, which peaks in August (Areola, 2008). Temperatures in Yankari Game Reserve are relatively high with a mean annual of 32 °C (Ayoade, 2000). Diurnal temperature ranges from 32 to 38 °C, influenced by katabatic (Bora winds) and Anabatic (Foehn winds) of the surrounding hills of the Jos Plateau during the night and morning hours (Ayoade, 2009). Temperature ranges from 18-36 °C in dry season and 20-31 °C in the rainy season (Aondover and Mingko, 2010).

The soils are mainly clay loams, alluvial soils are found around the Fadama. Generally, the soils in Yankari are dark and rich in humus “A horizon” and laterites occur in the “B horizon” (Udo, 2000). The Reserve is almost entirely underlain by the kerri formation, silt stones, kaolinites and grits while on the valleys of the Gaji, Yashi and Yuli rivers are covered with alluvium soils that supports dense vegetation cover (Udo, 2000). Yankari Game Reserve is basically composed of crystalline rock made up of basement complex rocks of Precambrian origin (Barrett, 2001).

The Reserve spans across the Sudan-Sahelian zone of Nigeria. The vegetation is richer towards the south and along the course of the major river (Gaji) as well as communities along its tributaries (Walter, 1997). Nevertheless, the vegetation is less uniform and grasses are shorter than what is in the South (Turner *et al.,* 1999). The Sahel Savanna, also known as the Semi-desert vegetation type, becomes evident from the middle of the State to the north characterized by isolated stands of thorny shrubs. The South-Western part of the area is mountainous as a result of the continuation of the Jos Plateau while the Northern part is generally sandy (Walter, 1997). The vegetation is affected by human activities such as arable farming, fuelwood harvesting, pastoralism, bush burning and selective logging for timber. The adverse effects of these activities include reduction in distribution and species diversity.

During the dry season, the environment gets patchy and dry with trees and shrubs shedding leaves to conserve water and developed resistance against the dry weather and bush burning (Iloeje, 2009). Major trees found in area are locust bean, "*Ashiwali*", tamarind, host of herbs and shrubs (Udo, 1997 and Iloeje, 2009). Yankari Game Reserve is a restricted area with a high density and diverse species of trees (Badamasi, 2014). The dominant species within the Game Reserve includes *Isoberlinia doka*, *Khaya senegalensis*, *Vitex doniana*, *Anogeissus leiocarpus, Tamarindus indica, Detarium microcarpum and Pterocarpus erinaceus* (BirdLife International, 2007; Geerling, 1993; Green and Amance, 1997). On the floodplains of rivers Gaji, Gongola and Jama'are the woody plants are dense and taller than on the hilly spots (Abdullahi, 2010). The vegetation provides essential materials such as fuelwood, fruits and vegetables to the people and serves as a habitat for wildlife's and sources of nutrition.

Data Collection Procedure and Experimental Design

The data used for this study was categorized into the following: Remotely sensed and ancillary data. The primary data for the research was obtained through quadrat samples of vegetation species.

To sample the vegetation distribution and species diversity, sample quadrants were adopted (Dombois and Ellenberg, 2001). The area was divided into four strata as shown on Figure 2. From each stratum, one sample was purposively located in an area where the required data on woody plant stands were available for observation and measurements. Likewise, area devoid of grass and woody plant stands such as bare land surfaces; water body and arable land were purposively sampled out. Equally observation was carryout on the possible usage of each of the plants. Furthermore, the study covered a period of 29 years (1986 to 2015), the sampled years were 1986, 1999, 2005, 2010 and 2015 respectively.

Landsat imageries provide data on Normalized Difference Vegetation Index (NDVI) and landuse landcover changes. Availability, affordability and data quality forms the bases for the choice of landsat imagery used in this study. The landsat data series covering a time frame of 1986 to 2015 with sampled years of 1986, 1999, 2005, 2010 and 2015 selected for the study were acquired freely via the United States Geological Survey (USGS) Global Visualization Viewer (Glo Vis). The imageries were downloaded as a compressed Geotiff files and imported to ArcGIS environment via the Landsat import module.

Data Analysis

The generated data on vegetation distribution and species diversity, Normalize Deferential Vegetation Index (NDVI) was analysed through comparison using statistics such as frequency and percentage calculated for each of the vegetation type observed within each quadrant sampled. Overall cover, density and frequency estimates were then calculated for each species from the entire data set by combining all of the quadrats together.

$$\text{Density} = \frac{\text{Population}}{\text{Area}}$$

To detect the leaf index from satellite images for NDVI comparison, the classes were categorized namely; dense vegetation cover which include areas with distress foliage cover such area are observed on rocky surface; hilly areas and areas that are frequently burnt. Also, to generate statistics for the various attributes on landuse landcover and NDVI, the data were classified and the magnitudes were determined using ArcGIS software. More importantly woody plants dominated by tree species such as *Acacia albida* thorny shrubs that shed leafs during the dry season are identified with red colour. Riparian represent areas that are along river floodplain represented in blue. The vegetation cover is greenish than the adjacent areas because deep, fertile and moist soils are found along the Gaji River, such areas are depicted in green.

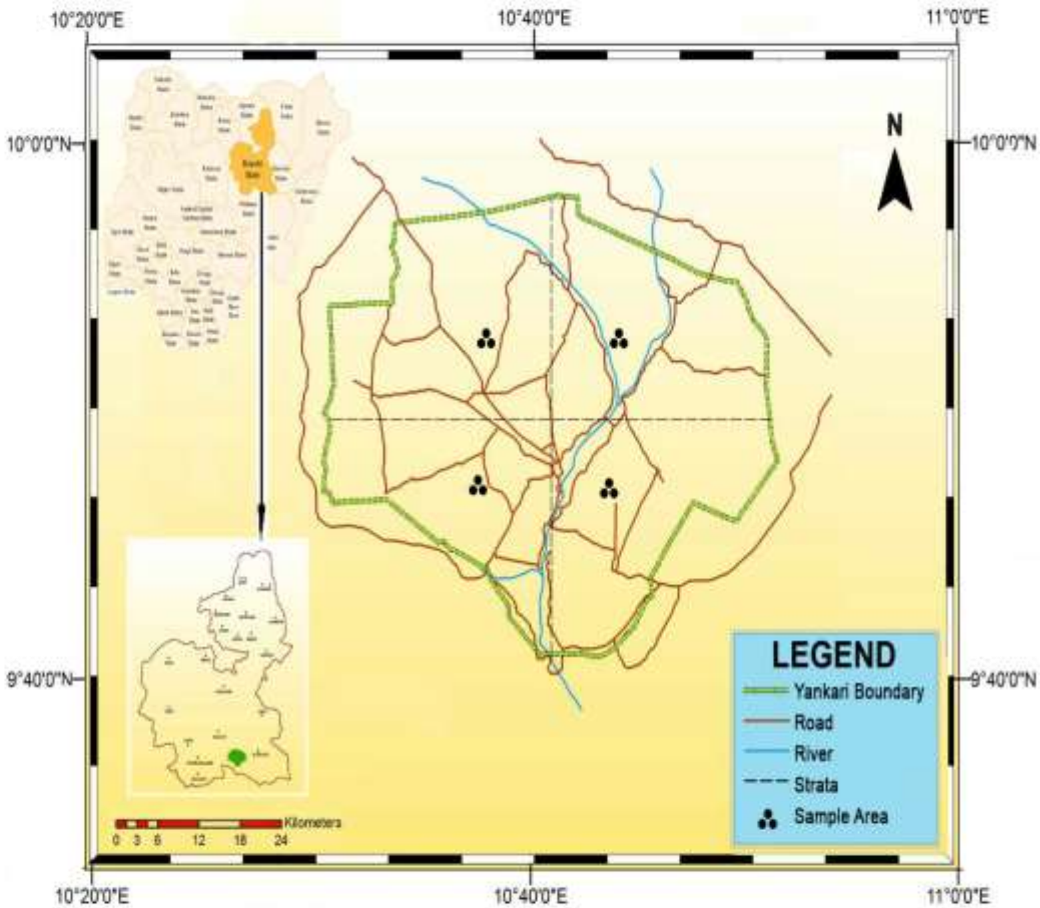

Figure 2: The Study Area Showing Quadrat Samples

Source: Field Work (2016)

RESULTS

Composition of Vegetation Community in Yankari Game Reserve.

Table 1 presents summary of woody plant species observed in quadrant A (25sq.m) using quadrant samples. Table 1 shows there are 11 different species of grass and woody plants observed in quadrant A measuring 25 m^2. *Echinochloa pyramidalis* has the highest species distribution with 17.5% while *Eleusine indica* is the least with 1.8%. The magnitude varies from 1.8 to 17.5% while the density ranges from 0.04 to 0.4. The result implies species such as *Echinochloa pyramidalis* and *Digitaria horizontalis* are the dominant species while *Eleusine indica* and *Echinochloa stagnina* are the rare or endangered species. Thus, *Eleusine indica* (1.8%) and *Echinochloa stagnina* (3.5%) are observed to be used as herbal medicine and fodder for animals respectively which could be the reason why these species did not appear in abundance in quadrant A.

Table 2 shows 11 species of grass plants that were observed from quadrant B. Using a quadrant size of 25m^2; the frequency of the various grass plants was used to calculate the density of species within quadrant B. Furthermore, the results obtained revealed *Fuirena umbellate*, *Hyparrhenia rufa* and *Eragrostis tenella* to be in abundance and rare respectively, the threat to *Eragrostis tenella* (2.13%) also increases when animals graze and feed on them.

Table 1: Grass and Woody Species Diversity of quadrant A (25sq.m.) in Yakanri Game Reserve

Species	Local Names (Hausa)	Frequency	Percentage (%)	Density
Echinochloa pyramidalis (Grass)	Gyaushe	10	17.5	0.4
Digitaria horizontalis (Grass)	Karanin dawaki	9	15.8	0.36
Ctenium newtoni (Grass)	Wútsííyàr ɓééráá	8	14.0	0.32
Cyperus difformis (Grass)	Zaitun	7	12.3	0.28
Rotboellia exaltata (Grass)	Jazama	6	10.5	0.24
Acroceras amplectans (Woody)	Gééron tsúntsààyéé	5	8.8	0.2
Digitaria exilis (Woody)	Firo	4	7.0	0.16
Digitaria gayana (Grass)	Gajele	3	5.3	0.12
Cyperus exaltaltus (Grass)	Kajiji	2	3.5	0.08
Echinochloa stagnina (Grass)	Geron Tsuntsu	2	3.5	0.08
Eleusine indica (Grass)	Ciyawa tuji	1	1.8	0.04
Total		**57**	**100**	**2.28**

Source: Field Work (2016)

Table 2: Grasses Specie Diversity of Quadrant B (25sq.m.)

Grasses Specie	Local Names (Hausa)	Frequency	Percentage (%)	Density
Eleusine indica	Ciyawa tuji	4	8.51	0.16
Eragrostis tenella	Kyasuwa	2	4.26	0.08
Fimbistylis exilis	Gemun Kwudi	5	10.64	0.2
Fimbristylis ferruginea	Rííɗín tùùjìì	3	6.38	0.12
Fuirena ciliaris	Kirni	6	12.77	0.24
Fuirena umbellate	Lállàkí	9	19.15	0.36
Hyparrhenia cyanensis	Tsintsiya	7	14.89	0.28
Hyparrhenia rufa	Badayi	1	2.13	0.04
Imperata cylindrical	Zarenshi	6	12.77	0.12
Eragrostis tenella	Kyasuwa	1	2.13	0.04
Fimbistylis exilis	Gemun Kwudi	3	6.38	0.12
Total		**47**	**100**	**1.76**

Source: Field Work (2016)

Table 3 shows eleven different species of grass and woody plants were observed within quadrant C. Making use of 25 m^2 as the size of quadrant, the various woody plant species percentage and density were calculated from the frequency of distribution. Thus, *Oryza lonistaminata* obtained the highest number of individual stands of 13 and Percentage of 20.64% respectively, while *Loudetia annual* species recorded the lowest individual stand and percentage of 1 and 1.59% respectively. The low occurrence of *Loudetia annual* in quadrant C might be as a result of increased animal grazing and arable farming among other activities on the species as observed in processes of data collection, thereby making it rare while *Oryza lonistaminata* found along Wikki Camp has reached a naturalization stage due to the species ability to adapt to the environment due to the presence of the Gaji River.

Table 3: Grass and Woody Species Diversity of Quadrant C (25sq.m.)

Species (Woody and Grass)	**Local Names (Hausa)**	**Frequency**	**Percentage (%)**	**Density**
Oryza lonistaminata (Grass)	Ɗán ciso	13	20.64	0.52
Fuirena umbellate (Grass)	Lállàkí	9	14.29	0.36
Panicum subalbidum (Grass)	Macara	8	12.70	0.32
Imperata cylindrical (Grass)	Zarenshi	8	12.70	0.32
Pharagmites karka (Woody)	wútsíyàr gííwáá	7	11.11	0.28
Hyparrhenia cyanensis (Grass)	Tsintsiya	6	9.52	0.24
Leersia hexandra (Grass)	Madariki	4	6.35	0.16
Oryza barthii (Grass)	Lállàkíí	3	4.76	0.12
Pennisetum polystachion (Grass)	Daura	2	3.17	0.08
Hyparrhenia rufa (Grass)	Badayi	2	3.17	0.08
Loudetia annual (Grass)	Kajinjiri	1	1.59	0.04
Total		**63**	**100**	**2.52**

Source: Field Work (2016)

Table 4, showed fifteen (15) different woody and grass plant species observed within quadrant D. The data computed from Table 4 were generated from quadrant D which has a total area of 25 m^2. From the analysis it was indicated that species *Oryza lonistaminata* has highest value of individual stand with a percentage cover of 13 and 17.57 respectively while the species *Fuirena ciliaris* has the lowest individual stand and percentage.

Fuirena ciliaris species is rare and it is at a higher risk of extinction than other vegetation cover because of the medicinal quality it offers. Herbal collectors of rare plants are contributing to the recent decline in species number of *Fuirena ciliaris* within the Reserve. The main cause of decline in *Fuirena ciliaris* is as a result of loss of its natural habitat which is mainly due to population explosion which will in turn result to intense harvesting for medicinal purposes. As population increase, vegetation cover tends to decline more and more as a result of construction of roads and development of communities (Mai'ari and Mainamaji villages) along the boundaries of the Reserve.

Normalized Difference Vegetation Index (NDVI) 1986

The satellite imageries were classified into three classes; they include dense woodland, riparian and bare land. The vegetation classification map for 1986 clearly illustrates the spatial patterns of vegetation cover distribution within the reserve as shown in Figure 3.

The spatial distribution of Normalized Difference Vegetation Index (NDVI) based on the analysis of vegetation index from the landsat imagery is as depicted in Figure 4. Dense woodland is the dominant vegetation cover while bare land surfaces were observed along the fringes of the Reserve boundary. Normalized Difference Vegetation Index (NDVI) map of 1999 is classified into three (3) classes.

The classification index overlay was achieved with the aid of the reclassifying tool of spatial analysis in the ArcGIS 10.4 using the maximum likelihood supervised classification method. Three classes were derived by the classification as seen in Figure 5 which ranged from dense woodland, riparian and bare land.

Table 4: Grass and Woody Species Diversity of Quadrant D (25sq.m.)

Species	Local Names (Hausa)	Frequency	Percentage (%)	Density
Fuirena umbellate (Woody)	*Lállàkí*	8	10.81	0.32
Hyparrhenia cyanensis (Woody)	*Tsintsiya*	4	5.41	0.16
Hyparrhenia rufa (Grass)	*Badayi*	2	2.70	0.08
Imperata cylindrical (Woody)	*Zarenshi*	7	9.46	0.28
Leersia hexandra (Grass)	*Madariki*	5	6.76	0.20
Loudetia annual (Woody)	*Kajinjiri*	2	2.70	0.08
Oryza barthii (Grass)	*Lállàkíí*	1	1.35	0.04
Oryza lonistaminata (Grass)	*Ɗán ciso*	13	17.57	0.52
Panicum subalbidum (Grass)	*Macara*	6	8.11	0.24
Pennisetum polystachion (Grass)	*Daura*	9	12.16	0.36
Pharagmites karka (Woody)	*wútsíyàr gííwáá*	2	2.70	0.08
Fimbristylis ferruginea (Grass)	*Rííɗín tùùjìì*	4	5.41	0.16
Acroceras amplectans (Woody)	*Gééròn tsúntsààyéé*	6	8.11	0.24
Fimbristylis ferruginea (Woody)	*Rííɗín tùùjìì*	4	5.41	0.16
Fuirena ciliaris (Grass)	*Kirni*	1	1.35	0.04
Total		**74**	**100**	**2.96**

Source: Field Work (2016)

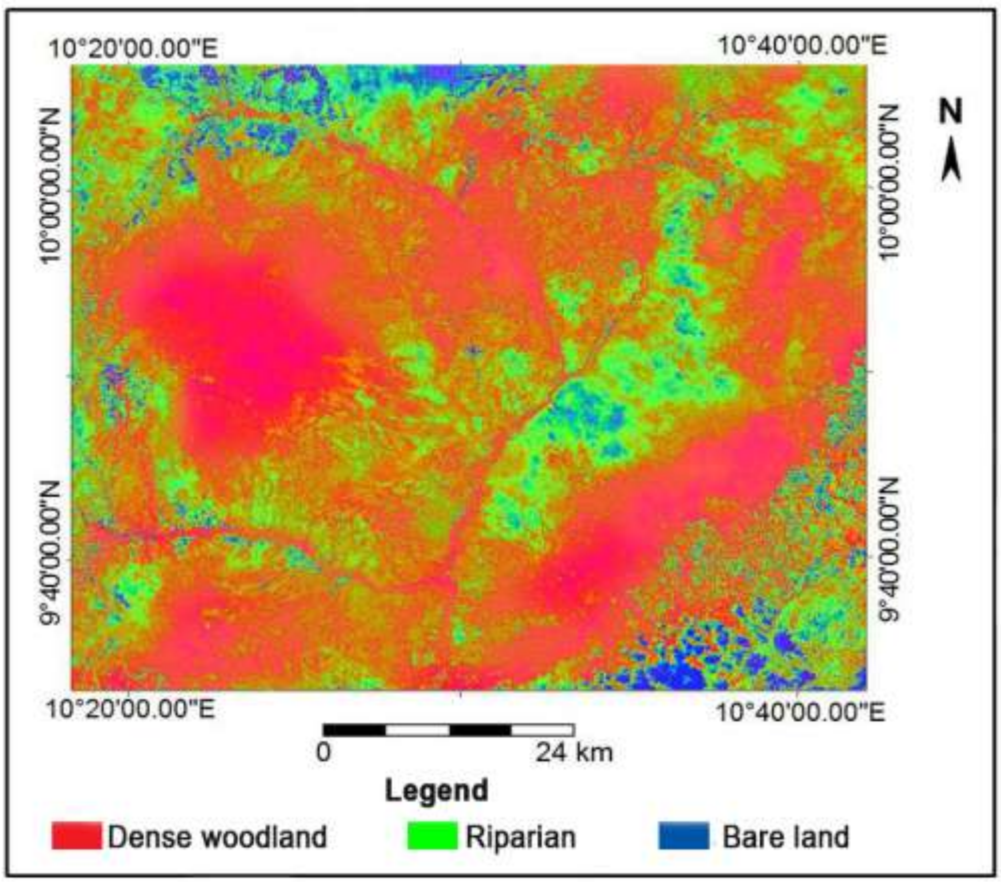

Figure 3: Normalized Difference Vegetation Index (NDVI) 1986
Source: USGS (2017)

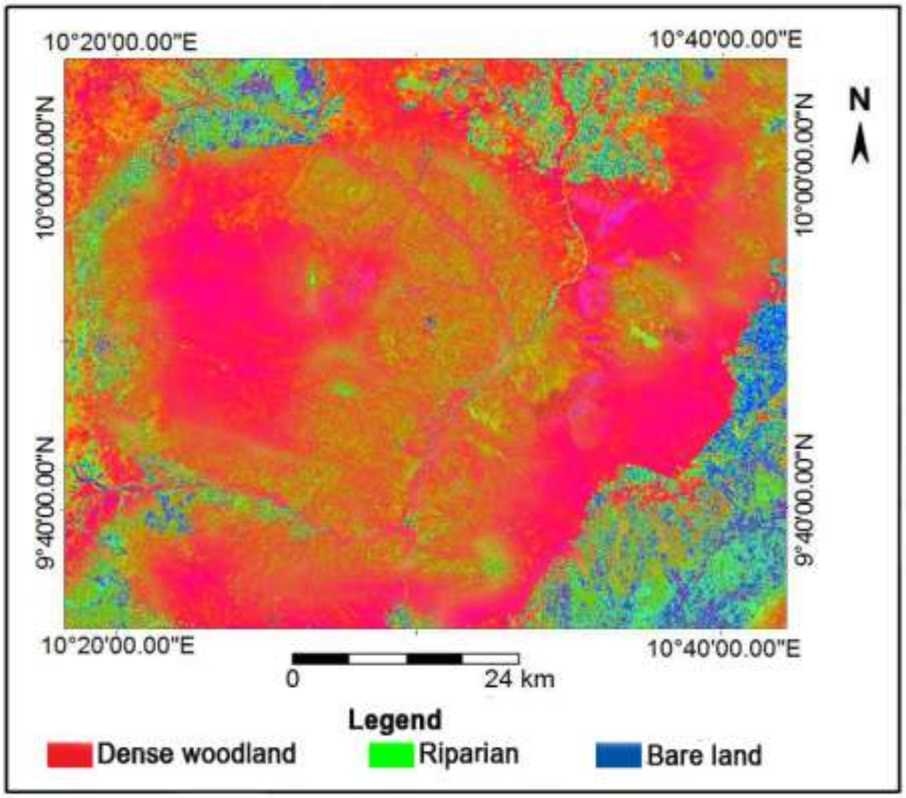

Figure 4: Normalized Difference Vegetation Index (NDVI) 1999
Source: USGS (2017)

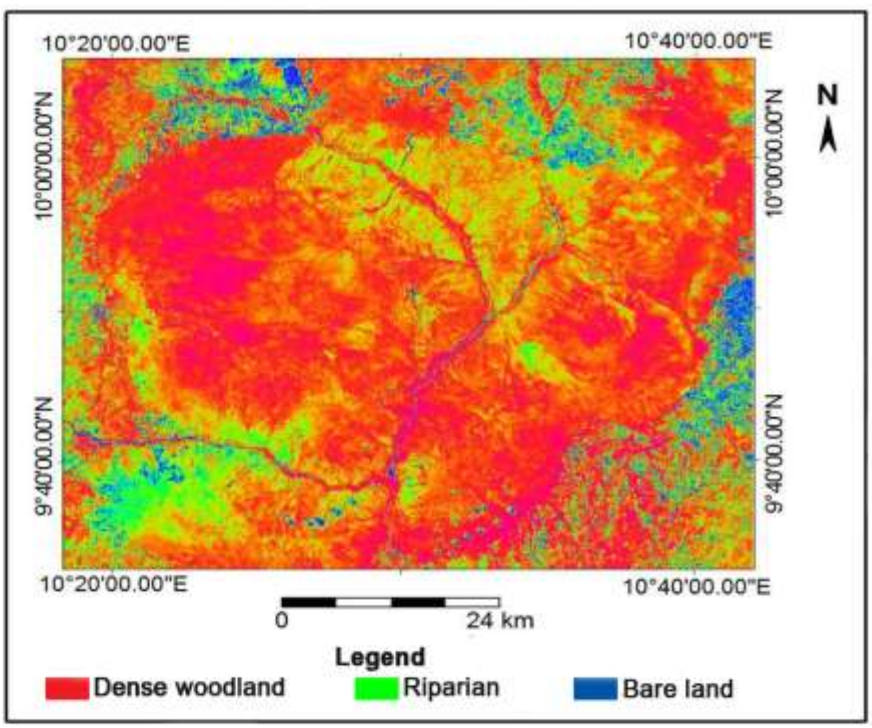

Figure 5: Normalized Difference Vegetation Index (NDVI) 2005
Source: USGS (2017)

The spatial distribution of vegetation cover class within the study area is as shown in Figure 6. Dense woodland is the dominant vegetation cover within the reserve, riparian vegetation cover is the second dominant vegetation cover class in the north eastern part of the study area. Bare land surfaces which stood at 17.84% were found in the north east, south east and north western part of the reserve respectively.

The spatial distribution of Normalized Difference Vegetation Index (NDVI) from landsat-8 Oli, is as presented in Figure 7. Dense woodland is the dominant vegetation cover while bare land surfaces were found at the fringes of the reserve and along the Gaji River, Dauda Usman track, Wiki camp, Kashim Ibrahim road and Bello road.

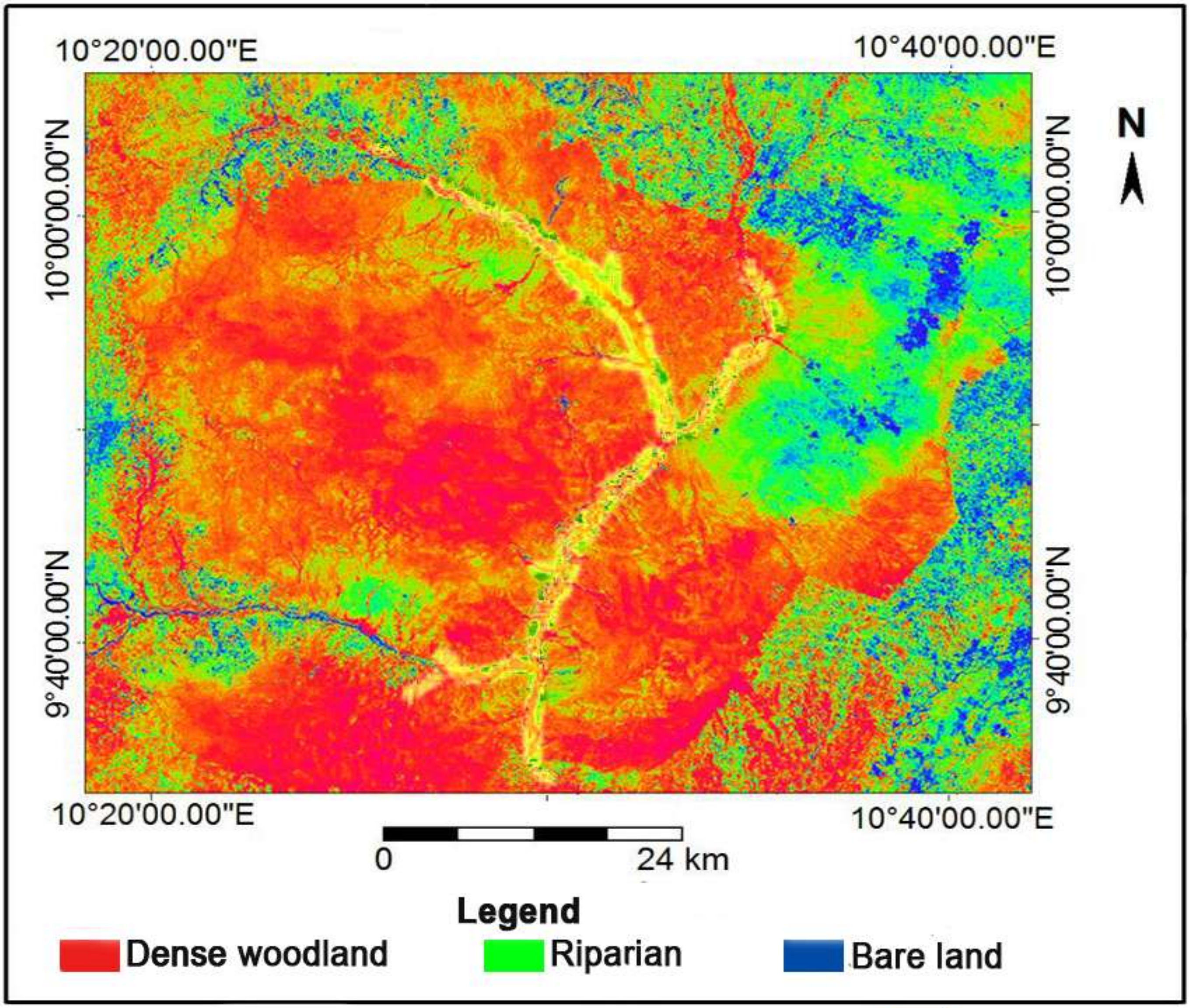

Figure 6: Normalized Difference Vegetation Index (NDVI) 2010
Source: USGS (2017)

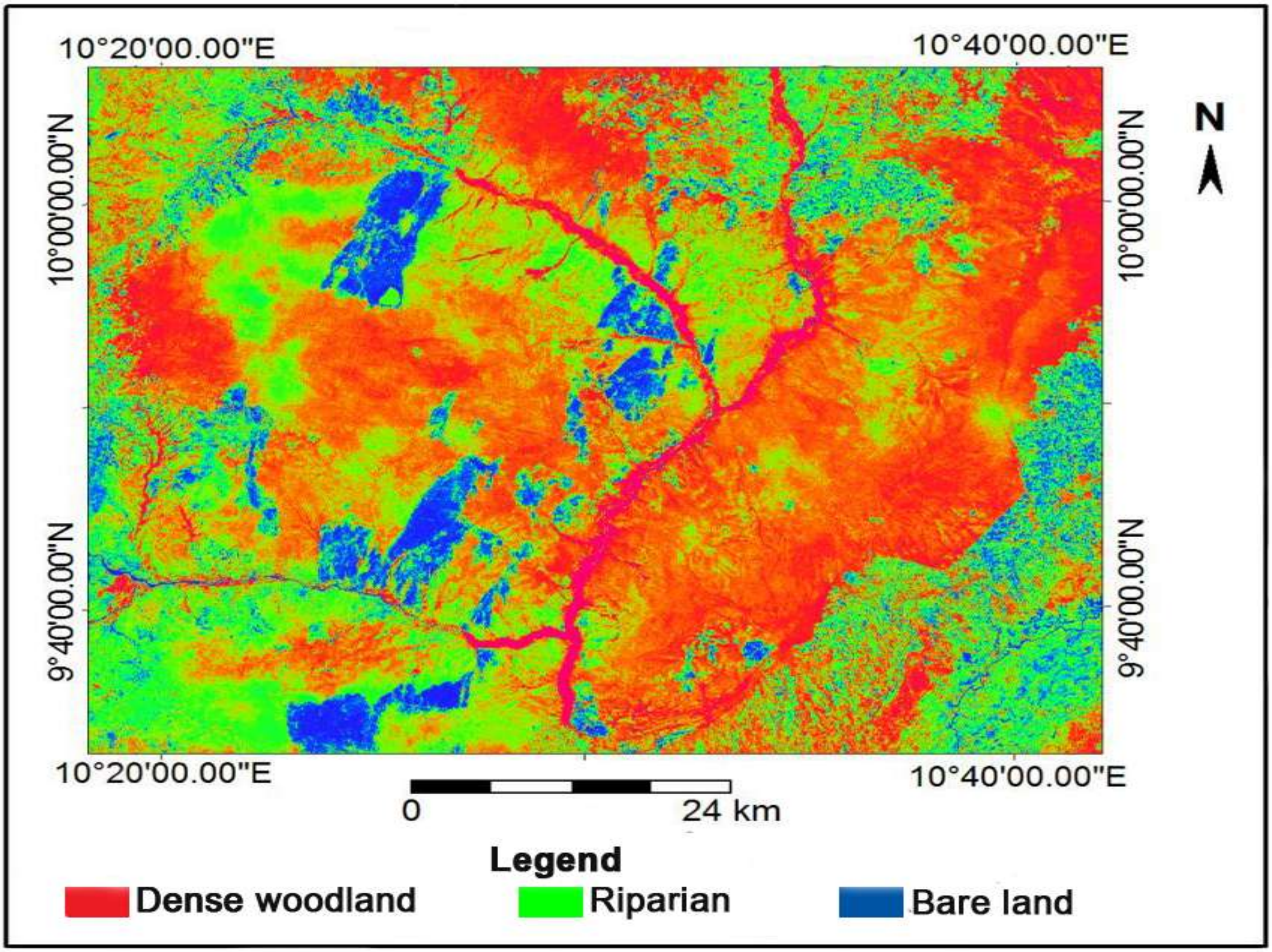

Figure 7: Normalized Difference Vegetation Index (NDVI) 2015
Source: USGS (2017)

The summary of trends detection of the Normalized Difference Vegetation Index (NDVI) from 1986 to 2015 with sample years of 1986, 1999, 2005, 2010 and 2015 landsat imageries, are as shown in Table 5. Thus, the summary revealed that dense woodland vegetation cover class indicated to be stable despite the slight decrease in area coverage of 24.03 km.sq as against the classified images of the base year (1986) 29.10km.sq.

The spatial pattern was entirely different for the 2015 landsat image; the vegetation cover shows an increase in riparian vegetation class which accounted for about 27.80% of the total landmass in 1986 as against the earlier coverage of less than 29.02% in 2015 respectively. The pattern remains relatively similar for riparian vegetation class except for a slight increase in the area coverage of bare land surface which amounted to about 9.46% over the period under study (1986 to 2015).

Table 5: Summary of Normalized Difference Vegetation Index Statistics of Yankari Game Reserve for 1986, 1999, 2005, 2010 and 2015

NDVI Classes	1986		1999		2005		2010		2015	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Dense woodland	29.10	61.29	27.22	57.33	27.13	57.14	25.62	53.96	24.03	50.61
Riparian	13.20	27.80	14.85	31.28	14.35	30.22	13.39	28.20	13.78	29.02
Bare land	5.18	10.91	5.41	11.39	6.00	12.64	8.47	17.84	9.67	20.37
Total	**47.48**	**100.00**	**47.48**	**100.00**	**47.48**	**100.00**	**47.48**	**100.00**	**47.48**	**100.00**

DISCUSSION

Rare species within the study area poses greater risk of extinction which might be as a result of tremendous pressures arising from fuelwood harvesting, rapid population growth, arable farming among others which has led to encroachment into the boundaries of the reserve. It is however apparent from field observation that the rate and intensity of grazing and arable farming is relatively higher in quadrants A, B and C than in quadrant D. In terms of density, quadrant B shows the lowest value which is as a result of intense pressure on the vegetation cover present due to increased human activities along Wikki Camp and Dauda Usman Track which could be explained by the nature and intensity of landuse practices within the Reserve, this concord with the findings of Isaaks and Srivastav (2009) and Chima *et al.* (2011).

The trends detection of the Normalized Difference Vegetation Index (NDVI), revealed that dense woodland vegetation cover class indicated to be stable despite the slight decrease in area coverage of 24.03 km.sq as against the classified images of the base year (1986) 29.10km.sq. Decrease in dense woodland vegetation cover could be as a result of selective logging and illegal forest product harvesting for medicinal purpose by trespassers among other activities within the study area as observed in the process of data collection. Furthermore, analysis of satellite image shows that bare land surfaces are on the increase as a result of pressure on the reserve due to anthropogenic activities and results showed that extremely small populations underwent human disturbances and threats such as construction of roads and buildings as well as cultivation of land for arable farming purposes, this is in agreement with the findings of Kulawardhana, (2008) which reveals that the study area is under pressure as a result of human activities within the reserve.

CONCLUSION

This study found that the vegetation cover of Yankari Game Reserve has changed over time, the changes which could be attributed largely to anthropogenic factors present within the reserve. Quadrant samples showed that the species diversity and distribution of *Fuirena umbellate* and *Oryza lonistaminata* grasses have the highest frequency of occurrence within the quadrant sampled with a number of individual stands of 26 while *Cyperus exaltaltus* and *Echinochloa stagnina* were the least with a density of 0.02 respectively. Thus, rare species within the study area poses greater risk of extinction which might be as a result of tremendous pressures arising from fuelwood harvesting, rapid population growth, arable farming among others which has led to encroachment into the boundaries of the reserve.

According to the Normalised Difference Vegetation Index, the summary of trends detection from 1986 to 2015 indicated a slight increase in the area coverage of bare land class which amounted to 9.46% of the entire study area which might be as a result of encroachment by trespassers, consistent clearance of land for agricultural purpose, construction of roads and building of accommodation for tourists among other activities. The study concludes that there was substantial decrease in Yankari Game Reserve greenness from 1986 to 2015. Furthermore, NDVI analysis shows that Yankari Game Reserve dynamics is reducing in terms of vegetation cover. The study also concluded that anthropogenic activities are the key driving factor of vegetation cover degradation.

Recommendations

In light of the observations in this study the following recommendation were suggested.

i. Government should enforce laws that will discourage the cutting down of trees, and view deforestation in the reserve as a serious ecological disaster to be keenly monitored and addressed by adequately funding for reforestation.
ii. Fuelwood vendors should be included in any forest policy decision making and desertification awareness campaigns.
iii. The reserve boundary should be redefined to prevent farmers from encroaching in to the reserved,

REFERENCES

Abdullahi, M. A. (2010). Survey of Ethno-Soil/Land Classification in the North-West Nigeria, Soil and Water Management for Poverty Alleviation and Sustainable Environment, Proceedings of the 31st Annual Conference of the Soil Science Society of Nigeria, 13th–17th November, 2006, Ahmadu Bello University, Zaria, Pp. 26-30

Ahlcrona, G. U., Mathew, S. A. and Solomon, P. E. (2006). *Displacement, Landuse and the Environment in the Gedaref Region, Sudan*, James Currey Ltd, Oxford, UK and the Red Sea Press Inc, Lawrenceville, USA

Altieri, M. A. (2002). Agroecology: The Science of Natural Resource Management for Poor Farmers in Marginal Environments, *Agriculture, Ecosystems and Environment* 93, Pp.1–24

Anyadike, R. C. N. (1993). Seasonal and Annual Rainfall Variations over Nigeria, *International Journal of Climatology*, 13: 567-580

Aondover, T. and Mingko, W. (2010). Changes in Rainfall Characteristics of Northern Nigeria, *International Journal of Climatology*, 18 (11): 1261-1271

Apeldoorn, G. J. (2008). Early Warning System of Drought in Nigeria, Pp 23-25

Areola,K. F. (2008). Empirical Analysis of Extreme Weather Conditions and Aviation Safety in Nigeria

Ayo, F. O. (2006). The Need for Development of Ecotourism in Nigeria, Pp. 22-27

Ayoade, J. O (2009). Introduction to Physical Geography, New York: John Wiley and Sons, 2: Pp. 34

Ayoade, J. O. (2000). Climate: ITD Movements and Winds, In: Babour, K.M. (ed) *Nigeria in Maps*, Hodder and Stoughton

Badamasi, M. M. (2014). Vegetation and Forestry, In A. I. Tanko and S. B. Momale (eds.) *Kano: Environment, Society and Development*. Adonis and Abbey, London, Pp. 43-64

Barbosa, A. and Lakshmi Kumar, L.O. (2011). Trends and Extreme Value Analysis of Rainfall Pattern Over Homogeneous Monsoon Region of India

Barrett, T. M. (2001). Models of Vegetative Change for Landscape Planning: A Comparison of Land-use and Land-cover of Niger

BirdLife International (2007). BirdLife's Online World Bird Database: the Site for Bird Conservation, *http://www.birdlife.org*

Chima, I. H., Bamiloye, T. S. and Adedire, M. O. (2011). Changes in the Composition and Standing Crop of Salt Marsh Communities in Response to the Removal of a Grazing Greener, *Journal Of Biological Sciences*, 3: 229-237

Dombois, A. and Ellenberg, E. (2001). Vegetation of the Tembe Elephant Park, Maputaland, South Africa, *South African Journal of Botany*, 67(4): 573-594

Ejidike, B. N. (2008). Trends in Wildlife Conservation Practices in Nigeria. *International Journal of Biodiversity and Conservation*, 5 (4):185-191

Food and Agriculture Organization (2008). Biodiversity in Sustainable Diets, Technical Workshop Report, Rome, Pp.19

Geerling, P. O. (1993). The Radiometric Normalization of Multitemporal Thematic Mapper Imagery of the Midlands of Ireland - A Case Study. *International Journal of Remote Sensing,* Pp. 751-766

Green, T. P. and Amance, I. O. (1997). Community Needs and Participation in Resource Conservation in Yankari National Park, Bauchi State, Nigeria, M.Sc. Dissertation, Abubakar Tafawa Balewa University, Bauchi, Bauchi State, Nigeria, Pp. 96

Houghton, R. A. (2003). Releases of Carbon to the Atmosphere from Degradation of Forests in Tropical Asia. *Canadian Journal of Forest Research*, 21: 132-142

Iloeje, N. P. (2009). *A New Geography of Nigeria*, (5th Edition) Longman, Ibadan, Nigeria.

International Union for Conservation of Nature (2004). World Conservation Strategy: Living Resource Conservation for Sustainable Development, Pp. 44

Isaaks, C. I. and Srivastav, P. E. (2009). Vegetation Dynamics on the Fringes of Lowland Tropical Rainforest of Southwestern Nigeria: An Assessment of Environmental Change with Air Photos and Landsat TM, *International Journal of Remote Sensing*, 20 (6): 1169-1182

Jensen, J. R. (2000). Remote Sensing of the Environment: Earth Resource Perspective. Upper Saddle River, New Jersey; Prentice Hall, Pp. 333-378

Kulawardhana, A. M. (2008). Spatial-temporal Analyses of Climate Elements, Vegetation Characteristics And Sea Surface Temperature Anomaly, Pp. 22

Mas, J. F. (2006). Monitoring Land-Cover Changes: A Comparison of change Detection Techniques, *International Journal of Remote Sensing*, 2:139-152

Mazzucato, V. and Niemeijer, D. (2004). Over Estimating Land Degradation, Underestimating Farmers in the Sahel, *IIED Drylands Issue Paper E101*, Pp. 22

Mortimore, M. (2009). *Adapting to Drought: Famines and Desertification in West Africa*, Cambridge University Press, Cambridge

Muchena, F., Anon, K. and Niemeijer, R. (2005). Towards International Classification Systems for Land Use and Land Cover. A Preliminary Proposal Prepared for UNEP and FAO, March 1994, In Annex V, Report of the UNEP/FAO Expert Meeting on Harmonizing Land Cover and Land Use Classifications, 23-25 November, Geneva, Pp. 23-27

Munyati, C. (2008). Wetland Change Detection on the Kafue Flats, Zambia, by Classification of a Multitemporal Remote Sensing Image Dataset, *International Journal of Remote Sensing*, 21 (9): 1787-1806

Nwoboshi, L. C. (2000). *The Nutrient Factor in Sustainable Forestry Conservation*, University Press, Ibadan, Nigeria, Pp. 303-307

Potter, C., Genovese, V., Gross, P., Boriah, S., Steinbach, M. and Kumar, V. (2007). Revealing Land Cover Change in California with Satellite Data, *EOS*, 88 (26): 269-274

Rao, A., Petridges, G. A. and Kok, K. (2009) Forestry in Nigeria: Past, Present and Future. *Niger. Field*. Pp. 58-71

Roy, R. S., Ranganath, B. K., Diwakar, P. G., Vohra, T. P. S., Bhan, S .K., Singh, J. J. and Pandian, V. C. (2009). Tropical Forest Mapping and Monitoring Using Remote Sensing, *International Journal of Remote Sensing*, 11: 2205-2225

Turner D. P., Cohen W. B., Kennedy R. E., Fassnecht K S. and Beriggs, J. M. (1999). Relationships Between Leaf Area Index and LandSat TM Spectral Vegetation Indices Across Three Temperate Zone Sites, *Remote Sensing of Environment*, Pp. 52-68

Udo, R. K. (2000). *Geographical Regions of Nigeria*, California: University Press, USA

Vasconcelos, F., Guison, A. and Thuller, W. (2010) Predicting Species Distributions: Offering more than Simple Habitat models, *Ecology Letters*, 8(9): 993-1009

Viña, A., Gitelson, A. A., Rundquist, D. C., Keydan, G., Leavitt, B., and Schepers, J. (2004). Monitoring Maize (*Zea mays*) Phenology with Remote Sensing. *Agronomy Journal*, 1139–1147

Walter, M. W. (1997). Length of the Rainy Season in Nigeria, *Nigerian Geographical Journal*, 10: 123-128

Wells, U., Cleaver, B., Kevin, M. and Schreiber, G. A. (2002). Reversing the Spiral: The population, Agriculture, and Environment Nexus in Sub-Saharan Africa. Direction in Development Series, Washington, D.C. World Bank Publication, Pp. 12-15

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Nwogwugwu et al., 2019

IN SILICO SEQUENCE ANALYSIS, HOMOLOGY MODELING AND FUNCTIONAL ANNOTATION OF PECTATE LYASE ENZYME FROM *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.

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ABSTRACT

Protein structure is more evolutionary conserved than a DNA sequence. To gain more insight into the molecular mechanisms of Colletotrichum gloeosporioides pathogenesis, we analyzed a pectate lyase gene sequence at molecular level using bioinformatics approaches. We evaluated the sequence information of pectate lyase enzyme retrieved from NCBI database. We also interpreted its homology modeling, functional annotation. Based on homology modeling, three dimensional (3D) structure of the gene was constructed and interpreted. Several validation tests were computed to check the reliability of 3D structure. We found conserved domains in pectate lyase protein. These conserved domains have significant role for plant pathogens that use a set of pectate lyases as their main virulence factor and to initiate the symbiosis activity in different organism. The study has clear implications to annotate the role of pectate lyase gene and linked proteins associated. More insights into the structure of the gene will lead to annotate the role of this gene in different biological pathways.

Keywords: Pectate lyase, *Colletotrichum gloeosporioides*, sequence information, bioinformatics tools

INTRODUCTION

The genus Colletotrichum represents a group of destructive pathogenic fungi causing a variety of diseases on crop plants (Kanto *et al*. 2014, Sharma *et al*. 2014). They are implicated in the anthracnose disease of many plant genera (Liao *et al*. 2012); a disease symptom marked with characteristic sunken necrotic lesions which could be on any part of the plant and the seedling blight and rot of plant's parts (Diao *et al*. 2015, Agrios 2005). The pathogenesis of this fungus offers it an advantage to be widely distributed and able to infect almost plant species as both wind and rain favors the dispersal of the primary inoculum and its ability to overwinter as saprobes on organic matter and weed species. It has assumed the top ten positions in the list of most important fungi in a recent survey by plant pathologists due to its scientific importance and pathogenic interactions due to its diversity as well as the economic implications on many crop plants (Dean *et al*; Crouch, 2012). About 25 plant diseases has been reported to be caused by different species of *Colletotrichum* in India namely, *C. gloeosporioides*, *C. capsici*, *C. falcatum*, *C. truncatum*, *C. sansevieriae*, *C.acutatum* and *C. coccodes*, *C. gloeosporioides were* found more prevalent anthracnose pathogen (Gautam, 2014). The genus employs diverse mechanisms for colonizing host tissues, surviving both as intracellular hemibiotroph to necrotroph but can also have endophytic or saprobic lifestyles (Jayawardena *et al*., 2016). The pathogens develop a series of specific infection structures, including germ tube, appressoria, intracellular hyphae, and secondary necrotrophic hyphae. *Colletotrichum* species are economically important worldwide; the fungi are highly significant for experimental studies of fungal development, infection processes, host resistance, signal transduction, and the molecular biology of plant pathogen interactions (Gautam, 2014). One of the mechanisms employed by microorganisms to overcome host defenses for plant invasion and

nutrition is by the production of cell wall degrading enzymes and among these are the pectin lyase groups (Lara –Marquez *et al*., 2011). This family shares a conserved structure in a parallel β-helix and has been well characterized in many opportunistic fungi such as *Aspergillus* and *Penicillium* and in the pathogen, *C. gloeosporioides.*
Expression of pectate lyase (pl) from *Colletotrichum gloeosporioides* has been reported to promote fungal pathogenicity on hosts (Yakoby *et al*., 2000). Pectate lyase gene is reported as a pathogenic factor required for the penetration and colonization of host tissues by *Colletotrichum* species. The degradative enzymes of plant cell wall such as pectate lyase are increased during the necrotrophic phase of these species (Medeiros LV, *et al*., 2010). Several molecular studies have identified pectate lyase gene as a virulence factor and its expression being strongly affected by alkalization. But little work was done to study its 3D structure. In this study we try to understand the pathogenic pathways of the ubiquitous and economic important pathogen, *Colletotrichum gloeosporioides* using latest bioinformatics tools to describe functional annotation of pectate lyase based on homology modeling which may help to proffering safe management options against the pathogen.

MATERIALS AND METHODS

Sequence Analysis

The amino acid sequences of pectate lyase gene were retrieved from NCBI data base using primary accession name (http://www.ncbi.nlm.nih.gov/). About 332 amino acid sequences were used for sequence analysis.

Homology Modeling of *C. gloeosporioides*

NCBI BLAST tool with non-redundant database was used to search a similarity-based sequence of pectate lyase gene (*http://blast.ncbi.nlm.nih.gov/Blast.cgi*). The raw sequences pectate lyase was translated to amino acid sequences using ExPASy translate tool (http://web.expasy.org/translate). The translated sequence was then processed with Swiss-Model tool (*http://swissmodel.expasy.org*) to build 3D structure. The obtained 3D structure was further functionally annotated.

Functional Annotation

The pectate lyase was analyzed for the presence or absence of conserved domains; NCBI Conserved Domains Database (NCBI-CDD) (Marchler *et al*., 2011), Protein families' database (Pfam) (Aranda *et al*., 2010) and InterProScan (Zdobbnov and Apweiler, 2001). NCBI-CDD is a tool for protein annotation having a huge data of multiple sequence alignment to study full length proteins. Pfam database uses Markov models to annotate multiple sequence alignment while InterProScan combines signatures of different proteins native.

RESULTS

The present study describes homology modeling and functional annotation of pectate lyase gene in *C. gloeosporioides*using different bioinformatics tools.

Homology Modeling

Protein 3D structure was constructed using Swiss model (http://swissmodel.expasy.org/) and SURFNET program (Fig.1). The SURFNET program generates surfaces and void regions between surfaces from coordinate data supplied in a PDB file. A total of 218 templates were found to match the target sequence. This list was filtered by heuristic down to 50 and the top templates are: 3vmw.1A; 1bn8.1A; 2bsp1.A; 5amv.1A and 3krg1A. Sequence alignment was performed to build a reliable 3D structure using BLASTP software. Both template and query sequence were aligned using algorithms of multiple sequence alignment. The sequence homology of pectate lyase of *C. gloeosporioides*.

Cleft analysis for: 3vmv

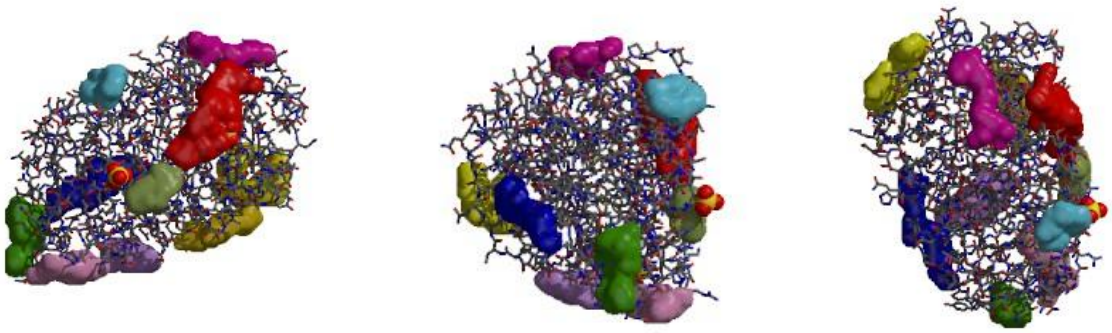
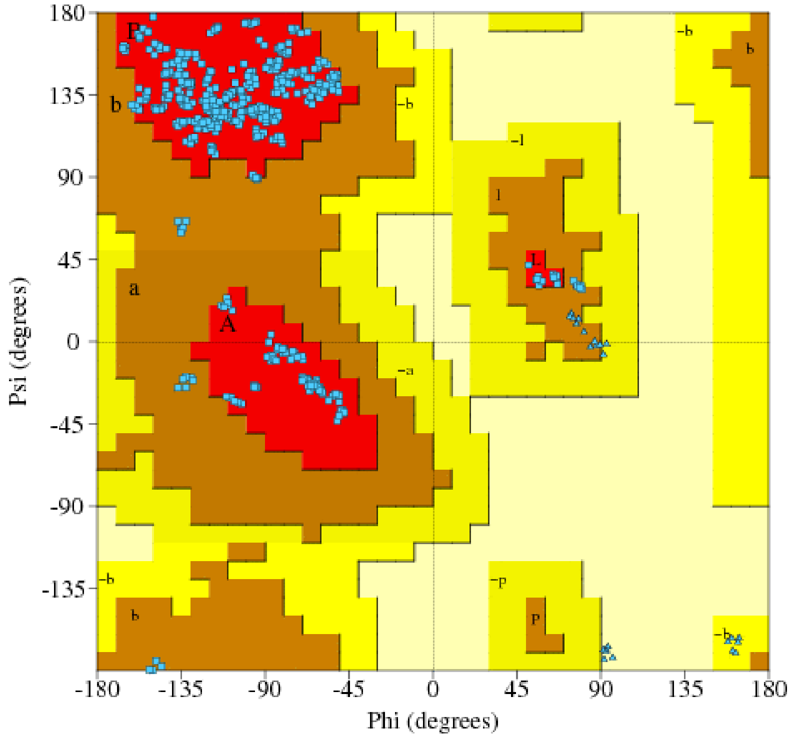


Fig. 1: Predicted 3D structure of pectate lyase and Cleft analysis in PDBSum using SURFNET Program

Functional Annotation

The reliability of *C. gloeosporioides* 3D model was confirmed using Ramachandran plot. The point at which charge on protein becomes zero is called an isoelectric point (PI). The ratio of PI/Mw was estimated by using PROCHECK (*http://www.ebi.ac.uk/thorntonsrv/software/PROCHECK*). The same tool (PROCHECK) was used to construct Ramachandran plot (Fig.2). ProSA was used to calculate Z-score; an indication of the overall model quality and is used to observe whether the input structure lies within the range of scores spotted for native proteins of similar size or not. Z-score for model protein was -4.38 (Fig.3).

The validation of model protein was performed by Ramachandran plot, Ramachandran plot showed 94.2% residues in the most favored region (Fig.2). ProSA-web and ERRAT. PDBsum used Ramachandran plot to check stereochemical quality of 3D structure of template using PROCHECK that analyze residue by residue geometry and overall geometry of the structure. ProSA provides Z-score, an indicative of the overall model quality and is used to observe whether the input structure lies within the range of scores spotted for native proteins of similar size or not. Z-score for model protein was -4.38 indicating that protein is of good quality (Fig.3). The 3D model of pectate lyase revealed different types of structure: Alpha helices, mostly found in cell membranes and play important role in transport, Beta plates sheets which have intracellular localization and Interlopes domain to connect different domains and structures (Fig.4)



		No. of residues	%-tage
Most favoured regions	[A,B,L]	475	94.2%
Additional allowed regions	[a,b,l,p]	29	5.8%
Generously allowed regions	[~a,~b,~l,~p]	0	0.0%
Disallowed regions	[XX]	0	0.0%
Non-glycine and non-proline residues		504	100.0%
End-residues (excl. Gly and Pro)		12	
Glycine residues		24	
Proline residues		24	
Total number of residues		564	

Fig. 2: Structural validation of protein structure via Ramachandran plot

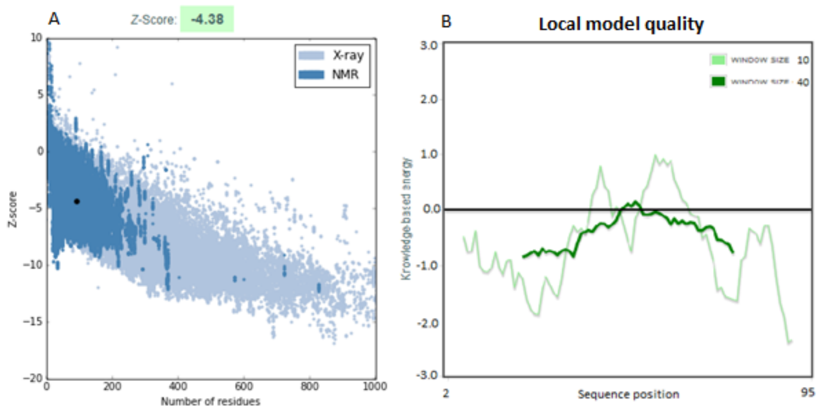
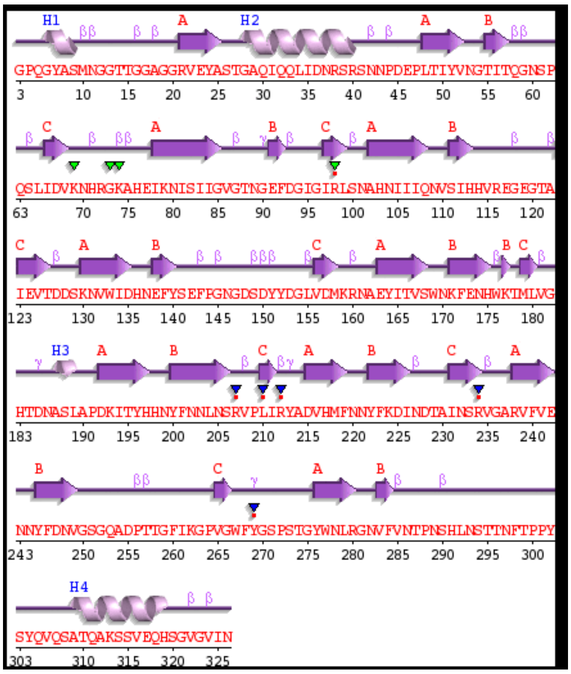


Fig. 3: Z-score of model protein and local model quality determination of pectate lyase 3D structure using ProSA-web



Helices labelled H1, H2, ... and strands by their sheets A, B, ...

Helix Strand

Motifs: beta turn gamma turn

Residue contacts: to ligand

PDB SITE records: AC1 AC2

Fig 4: Secondary structure of protein containing 3 beta sheets, 3 beta hairpins, 2 beta bulges, 8 beta turns, 8 strands and 2 helices generated using PDBsum.

DISCUSSION

Microorganisms produce plant cell wall-degrading enzymes as part of their strategies for plant invasion or plant degradation. Pectinolytic enzymes consist of four classes of enzymes: pectin lyase, polygalacturonase, pectin methylesterase and rhamnogalacturonase. Among pectinolytic enzymes, pectin lyase is the most important in depolymerization of pectin, since it cleaves internal glycosidic bonds of highly methylated pectins, favors pectate, the anion, over pectin, the methyl ester. Many scientists studied the genetic basis of pectic enzymes and its crucial role in microbial plant biomass degradation, such as the saprotrophic/opportunistic *Aspergillus niger* (Kusters-van Somerenet *al.*, 1991; Kusters-van Someren *et al.*, 1992; Harmsen *et al.*, 1990; Gysleret *al.*, 1990), *A. oryzae* (Kitamoto *et al.*, 2001), *P. occitanis* (Trigui-Lahiani and Gargouri, 2007), and the phytopathogenic fungi *Colletotrichium gloeosporioides* (Wei *et al.*, 2002). Evidence of the importance of pectate lyase secretion during *Colletotrichum* colonization on fruits has been found in a number of studies: (i) reduced symptom development of a *C. magna* mutant (Wattad et al. 1995); (ii) inhibition of decay following co-inoculation of *C. gloeosporioides* spores (Wattad et al. 1997); (iii) the activity inhibition of pectolytic enzymes by the host flavonoid epicatechin, which correlated with the inhibition of symptom development (Wattad *et al*. 1994); and (iv) a lack of decay development under conditions that are not permissive to pectate lyase secretion (Yakoby *et al*. 2001). These results suggest that pectate lyase is a limiting factor during the early stages of pathogenesis (Wattad *et al*. 1997; Yakoby *et al*. 2000). The present study describes an organized workflow using latest bioinformatics tools to functionally annotate the pectate lyase gene based on homology modeling from *Colletotrichum gloeosporioides*. The functional annotation of pectate lyase was revealed using different web-based tools: NCBI-CDD (*http://www.ncbi.nlm.nih.gov/cdd)*, Swiss-model (*http://swissmodel.expasyorg/*).

CONCLUSION

In the current study, we have interpreted the results of homology modeling, functional annotation of pectate lyase enzyme, and its associated proteins using latest bioinformatics approaches. Conserved domains were found in amino acid sequence of the pectate lyase sequence. These conserved domains have significant role in promoting fungal pathogenicity on hosts of pectate. However, further bioinformatics analysis is obligatory to explain the structural image and functions of these genes and linked proteins in detail.

REFERENCES

Agrios, G. N. (2005). Plant Pathology. 5th Ed. San Diego: Academic Press, USA.

Aranda B.,Achuthan, P., Alam-Faruque, Y., Armean, I.*et al*. (2010). The IntAct molecular interaction database in 2010. *Nucleic Acids Research*. 38:D525–531. Available from: *https://www.researchgate.net/publication/38030302_The_IntAct_molecular_Interaction_dabase_in_2010* [accessed Jul 16 2019].

Crouch, J. A. (2014). *Colletotrichum caudatum*s.l. is a species complex. IMA *Fungus* 5: 17–30.

Dean, R., Van-Kan, J. A. L., Pretorius, Z. A., Hammond-Kosack, K. E., Di Pietro, A., Pietro, D. S., Rudd, J. J., Dickman, M., Kahmann, R., Ellis, J. and Foster, G. D. (2012). The Top 10 fungal pathogens in molecular plant pathology. *Molecular Plant Pathology* 13: 414–430.

Diao, Y. Z., Zhang, C., Xu, J. P., Lin, D., Liu, L., Mtung'e, O. G. and Liu, X. (2015). Genetic differentiation and recombination among geographic populations of the fungal pathogen *Colletotrichum truncatum* from chili peppers in China. *Evolutionary Applications* 8: 108–118.

Gautam, A.K. (2014). The genera *Colletotrichum*: an incitant of numerous new plant diseases in India. *Journal on New Biological Reports* 3(1): 09 – 21.

Gysler, C., Harmsen, J. A., Kester, H. C., Visser, J. and Heim, J. (1990). Isolation and structure of the pectin lyase D-encoding gene from *Aspergillus niger*. *Gene*. 89:101–108.

Harmsen, J. A., Kusters-van Someren, M. A. andVisser, J. (1990): Cloning and expression of a second *Aspergillus niger* pectin lyase gene (pelA): indications of a pectin lyase gene family in *A. niger*. *Curr Genet*. 18:161–166.

Jayawardena, R. S., Hyde, K. D., Damm, U., Cai, L., Liu, M., Li, X. H., Zhang, W., Zhao, W. S. and Yan, J. Y. (2016). Notes on currently accepted species of *Colletotrichum*. *Mycosphere* 7(8): 1192–1260.

Kanto, T., Uematsu, S., Tsukamoto, T., Moriwaki, J., Yamagishi, N., Usami, T. and Sato, T. (2014). Anthracnose of sweet pepper caused by *Colletotrichum scovillei* in Japan. *Journal of General Plant Pathology* 80(1): 73–78.

Kitamoto, N., Yoshino-Yasuda, S., Ohmiya, K. and Tsukagoshi, N. (2001). A second pectin lyase gene (pel2) from *Aspergillus oryzae* KBN616: its sequence analysis and overexpression, and characterization of the gene products. *J Biosci Bioeng*. 91: 378–381.

Kusters-van Someren, M. A., Harmsen, J. A. M., Kester, H. C. M. andVisser, J.(1991). Structure of the *Aspergillus niger*pelA gene and its expression in *Aspergillus niger* and *Aspergillus nidulans*. *Curr Genet*. 20:293–299.

Kusters-van Someren, M. A., Flipphi, M., de Graaff, L., van den Broeck, H., Kester, H., Hinnen. A., *et al*. (1992). Characterization of the *Aspergillus niger*pelB gene: structure and regulation of expression. *Mol Gen Genet*. 234:113–120.

Lara-Marquez, A., Zavala-Paramo, M. G., Lopez-Romero, E., Calderon-Cortes, N., Lopez-Gomez, R., Conejo-Saucedo, U. and Cano-Camacho, H. (2011). Cloning and characterization of a pectin lyase gene from *Colletotrichum lindemuthianum* and comparative phylogenetic/structural analyses with genes from phytopathogenic and saprophytic/opportunistic microorganisms. *BMC Microbiol*. 11: 260. Doi: 10.1186/1471-2180-11-260.

Liao, C. Y., Chen, M. Y., Chen, Y. K., Wang, T. C., Sheu, Z. M., Kuo, K. C., Chang, P. L., Chung, K. R. and Lee, M. H. (2012). Characterization of three *Colletotrichum acutatum* isolates from *Capsicum spp*. *European Journal of Plant Pathology* 133: 599–608.

Marchler-Bauer, A., Lu, S., Anderson, J. B., Chitsaz, F., Derbyshire, M. K., DeWeese-Scott, C., Fong, J. H., Geer, L. Y., Geer, R. C., Gonzales, N. R., Gwadz, M., Hurwitz, D. I., Jackson, J. D., Ke, Z., Lanczycki, C. J., Lu, F., Marchler, G. H., Mullokandov, M., Omelchenko, M. V., Robertson, C. L., Song, J. S., Thanki, N., Yamashita, R.

A., Zhang, D., Zhang, N., Zheng, C. and Bryant, S. H. (2011). CDD: a Conserved Domain Database for the functional annotation of proteins. *Nucleic Acids Research*. 39: D225-D229.

Medeiros, L. V., Maciel, D. B., Medeiros, V. V., Houllou-Kido, L. M. and Oliveira, N. T. (2010). pelB gene in isolates of *Colletotrichum gloeosporioides* from several hosts. *Genet Mol Res* 9: 661–673.

Sharma, G., Kumar, P. A. and Damodara, S. B. (2014). Infra-specific diversity of *Colletotrichum truncatum* associated with chilli anthracnose in India based on microsatellite marker analysis. *Archives of Phytopathology and Plant Protection* 47: 2509–2523.

Trigui-Lahiani, H. and Gargouri, A. (2007). Cloning, genomic organisation and mRNA expression of a pectin lyase gene from a mutant strain of *Penicillium occitanis*. *Gene*. 388: 54–60.

Wattad, C., Dinoor, A., and Prusky, D. (1994). Purification of pectate lyase produced by *Colletotrichum gloeosporioides* and its inhibition by epicatechin: A possible factor involved in the resistance of unripe avocado fruits to anthracnose. *Mol. Plant-Microbe Interact*. 7:293-297.

Wattad, C., Freeman, S., Dinoor, A., and Prusky, D. (1995). A nonpathogenic mutant of *Colletotrichum magna* is deficient in extracellular secretion of pectate lyase. *Mol. Plant-Microbe Interact*. 8:621-626.

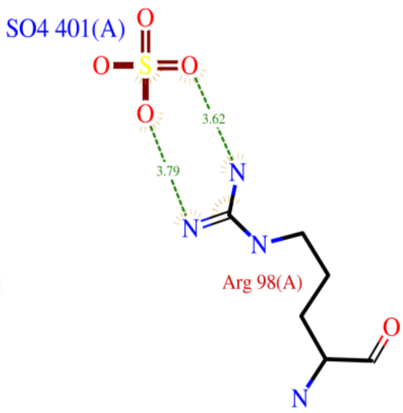
Wattad, C., Kobiler, D., Dinoor, A., and Prusky, D. (1997). Pectate lyase of *Colletotrichum gloeosporioides* attacking avocado fruits: cDNA cloning and involvement in pathogenicity. *Physiol. Mol. Pathol*. 50:197-212.

Wei, Y., Shih, J., Li, J. and Goodwin, P. H. (2002). Two pectin lyase genes, pnl-1 and pnl-2, from *Colletotrichum gloeosporioides* f. sp. *malvae* differ in a cellulose-binding domain and in their expression during infection of *Malvapusilla*. *Microbiol Read Engl*. 148:2149–2157.

Yakoby, N., Kobiler, I., Dinoor, A., and Prusky, D. (2000). pH regulation of pectate lyase secretion modulates the attack of *Colletotrichum gloeosporioides* on avocado fruits. *Appl. Environ. Microbiol*. 66: 1026-1030.

Zdobnov, E. M., Apweiler, R. (2001). InterProScan--an integration platform for the signature-recognition methods in InterPro. *Bioinformatics*.17(9): 847-848.

APPENDIX



Ligand SO4 - Sulfate ion

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Nwoha and Agu, 2019

INCIDENCE OF SCHISTOSOMOSIS IN MONGREL IN COMMUNITIES IN IKWUANO LOCAL GOVERNMENT AREA, ABIA STATE, NIGERIA

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ABSTRACT

Zoonotic infectious agents are among the most prevalent on earth and are thought to be responsible for more than 60 per cent of all human infections and also 75 per cent of emerging human infectious diseases. This study investigated the existence of schistosomosis in dogs in Ikwuano communities as possible source of human infection. Samples were collected from dogs within 20 out of a total of 36 communities in Ikwuano Local Government Area of Abia state. Both faecal and anal swab samples were collected from dogs of various breeds, age bracket and sex. Samples were analyzed using direct microscopy of faecal and anal swab samples, sedimentation and feacal salt flotation techniques. Data obtained was analyzed using descriptive statistics. The incidence of the disease was determined and presented in percentage. Out of a total of 20 communities' sampled only 2 namely Amaoba ime and Afa communities were positive for schistosomosis. Out of 23 dogs sampled in Amaoba ime, 6 were exotic while 17 were Mongrels. All the exotic were negative while 3(13.0%) out of the 17 mongrels were positive. Out of these, 18 were females with 2(8.7%) positive cases and 16 (70.0) negative cases. Out of the 5 males sampled only 1(4.3%) was positive while 4 (17.4%) was negative. A total of 14 adults were sampled with 2(8.7%) positive cases and 14 (61.0%) negative cases. Out of the 9 puppies sampled only 1(4.3%) was positive while 8 (34.8%) were negative. In Afa community, only 2 (14.3%) negative exotic breeds were sampled out of 14 dogs. Out of the 12 mongrels sampled, 11(78.6%) were negative while 1(7.1%) was schistosoma positive. All the 6 females sampled were negative while 1(7.1%) out of the 8 males was positive. Out of a total of 14 adults, only 1(7.1%) was positive while 13(92.9%) were negative. No puppy was sampled within the area.

Keywords: Exotic, mongrel, schistosome, dogs, ikwuano, Abia, State

INTRODUCTION

The World Health Organization further estimated that Schistosome infection and geo-helminths account for over 40% of the world tropical disease burden apart from malaria (Ovelda *et al.,* 2000). In Nigeria, *Schistosoma* infection occurs in all human population with prevalence ranging from 9% to 70 % especially in high poverty stricken rural areas (Okoli and Odaibo 1999; Mafiana *et al.,* 2003; Salawu and Odaibo 2013; Salawu and Odaibo, 2014). Many of these areas had in one time or the other enjoyed mass drug administration either from the local or state government (Okoli and Odaibo 1999; Mafiana *et al.*, 2003; Salawu and Odaibo 2013). The success and widespread epidemiology of these infections can be attributed to a range of human factors including social and dietary changes as well as an increased mobility of the human population (McCarthy and Moore 2000; Vorou *et al.*, 2007). Although the major hosts for *Schistosoma mansoni and Schistosoma haematobium* are humans, a range of animals including sheep, cattle and horses act as natural definitive hosts for *Schistosoma japonicum*

(Gryseels *et al.*, 2006). Similarly, high prevalence of schistosomosis recorded in a study conducted in Ogun State was attributed to presence of snail intermediate host in the natural water bodies and lack of potable water supply (Salawu and Odaibo, 2012). With the increasing incidences of schistosomosis in human populations in different parts of the globe and animals serving as reservoir host, it has therefore become pertinent to ascertain the incidences of schistosomosis in dogs in various communities in Ikwuano, Abia State.

MATERIALS AND METHODS

Study Area

Ikwuano is one of the Local Government Area in Abia State, Nigeria with its headquarters located in Isiala Oboro. It has an area of 281 km² and a population of 137,993 at the 2006 census. It is positioned at latitude 5.4093^{oN} and longitude 7.5897^{oE}. It is made up of 52 villages and 36 communities and is bounded on the West by Ini LGA of Akwa Ibom State and Umuahia on the North, On the East by Umuahia south and Isiala Ngwa North LGA on the South. Ikwuano as the name implies is derived from the coming together of four (4) related brothers namely Oboro, Ibere Ariam-Usaka and Oloko. Ikwu which means "relations/relatives" and Ano which is "four" (4) meaning "four relations". Ikwuano Local Government Area was among the local government areas created on 27th of August 1991 by General Ibrahim Babangida's Administration. It was carved out of the old Ikwuano-Umuahia Local Government Area. It is one of the five Local Government Areas that make up Abia Central Senatorial District (NIPOST, 2009)

Experimental Design

Out of a total of 36 communities in Ikwuano Local Government Area, 20 were randomly selected and sampled for presence of Schistosomosis in dogs including those presented at the Veterinary Teaching Hospital, Michael Okpara University of Agriculture Umudike. Both faecal samples and anal swabs were collected from sampled dogs. Dogs of various breeds, age bracket and sex were sampled in the study.

Method of Sample Collection

The village chief, head or king of each community sampled were notified earlier before the day of sample collection. The town criers inform all dog owners to assembly their dogs at their village square for free deworming given as compensation for sample collection. Some refused while those sampled were dewormed immediately after sample collection.

From each sampled dog anal swab was collected and carefully placed into a container which had few drops of normal saline, to avoid drying. Also, faecal sample was collected directly from each dog (per rectum) with gloved finger and deposited into a faecal sample bottle. The samples were labeled for identification (by, date, numbers, breeds, sex, age, and locations) prior to transportation to the veterinary medicine labouratory for analysis (Urquhart *et al.*, 1996).

Faecal Floatation

Two grams of each of the faecal samples was deposited into a test tube. Saturated sodium chloride solution was added, mixed and then the tube was filled up with the solution. Then a cover slip was placed on the solution for about 30 minutes, before the slip was lifted carefully and placed on to a glass slide and viewed under the microscope at X10 and X40 magnification for *Schistosoma* eggs (Urquhart *et al.*, 1996).

Direct Microscopy of Anal Swab

A drop of normal saline was placed on a glass slide and swab from each dog was streaked onto it. The saline-swab extract mixture was then viewed under X10 and X40 magnification of the microscope (Pal and Sanyal, 2014).

Duration of Study

The study lasted for five months (between August and December 2017).

Data Analysis

The data collected was analyzed using descriptive statistics. The incidence of the disease was determined and presented in percentage using the formula described by Thrusfield and Christley (2018) where P = d/n, where P = percentage prevalence, d = number of positive sample, n = total number of samples collected. The incidence of schistomosis between breeds, sex, and age bracket were compared using independent sample T –test and presented as mean ± SE. The level of significance is accepted at $p<0.05$.

RESULT

From table 1 above, out of 23 dogs sampled in Amaoba ime in Abaa ukwu community, 3 (13.0%) out of the17 mongrels sampled were *schistosoma* positive, while 14 were negative. None of the 6 exotic breeds were *schistosoma* positive. Of the 23 dogs, 18 (78.3%) were females, and 16 (69.6%) were negative while 2 (8.7%) were positive. There were also 5 males sampled among the 23, out which 4 (17.4%) were negative and 1 (4.3%) was positive. In addition, there were 14 adults out of which 12 (52.2%) were negative with 2 (8.7%) positive cases. There were also 9 puppies out of which 8 were negative with 1 (4.3%) positive case.

In table 2 above, zero (0.0%) incidence of schistosomosis was recorded in all the four (4) communities sampled . In Ibere Nkalunta, only two (2) adult female mongrels were sampled and one (1) male mongrel in Umuemelike Community. Twelve (12) mongrels were sampled in Awom na ebo community. Out of which five (5) were females and 7 were males. Eleven (11) adults and one (1) puppy. In Umudike community, sixty (60) dogs were sampled out of which thiry (30) were exotic and thirty (30) mongrels. There were twenty nine (29) males and thirty one (31) females. Forty seven (47) were adults and thirteen (13) puppies.

Zero (0.0%) prevalence of Schistosomosis was recorded in all the four (4) communities represented on table 3 above. Out of five (5) dogs sampled in Usaka azunchai community, three (3) were exotic breeds and two (2) mongrels. There were two (2) adult and three (3) puppies.

Seventeen (17) dogs were sampled in Usaka obugwu out of which nine (9) were exotic breeds and eight (8) were mongrels. There were four (4) females and thirteen (13) males, thirteen (13) Adults and four (4) puppies A total of eighteen (18) dogs were sampled in Oruigwe nnono community, three (3) exotic breeds and fifteen (15) mongrels. There were seven (7) females and eleven (11) males, sixteen (16) adults and two (2) puppies. Of the three (3) dogs sampled in Ibere obohia community, all the three (3) were mongrels with no exotic breed. There were one (1) female and two (2) males, two (2) adults and one (1) puppy.

Table 1: Percentage (%) incidence of Schistosomosis in dogs of various breeds, age, and sex sampled in Amaoba ime in Abaa ukwu community in Ikwuano LGA in Abia State

Variables	Sample size	Positive samples	Negative samples	Total sample collected	Percentage incidence (%)
Type					
Exotic	6	0	6		0.0
Local	17	3	14	23	13.0
Sex					
Female	18	2	16		8.7
Male	5	1	4	23	4.3
Age					
Adult	14	2	12		8.7
Puppy	9	1	8	23	4.3

Table 2: Percentage (%) incidence of Schistosomosis in dogs of various breed, age, and sex sampled in Five (4) communities in Ikwuano LGA in Abia State

Variables	Sample size	Positive samples	Total sample collected	Percentage incidence (%)
		Ibere Nkalunta Community		
Types				
Exotic	0	0		0.0
Local	2	0	2	0.0
Sex				
Female	2	0		0.0
Male	0	0	2	0.0
Age				
Adult	2	0		0.0
Puppy	0	0	2	0.0
		IBERE UMUEMELIKECOMMUNITY		
Type				
Exotic	0	0		0.0
Local	1	0	1	0.0
Sex				
Female	0	0		0.0
Male	1	0	1	0.0
AGE				
Adult	0	0		0.0
Puppy	1	0	1	0.0
		Awom Na Ebo Community		
TYPE	0	0		0.0
Exotic				
Local	12	0	12	0.0
SEX				
Female	5	0		0.0
Male	7	0	12	0.0
AGE				
Adult	11	0		0.0
Puppy	1	0	12	0.0
		Umudike Community		
TYPE				
Exotic	30	0		0.0
Local	30	0	60	0.0
SEX				
Female	29	0		0.0
Male	31	0	60	0.0
AGE				
Adult	47	0		0.0
Puppy	13	0	60	0.0

Table 3: Percentage (%) incidence of Schistosomosis in dogs of various breed, age, and sex sampled in Four (4) communities in Ikwuano LGA in Abia State

Variables	Sample size	Positive samples	Total sample collected	Percentage incidence (%)
		Ibere nkalunta community		
Types				
Exotic	3	0		0.0
Local	2	0	5	0.0
Sex				
Female	2	0		0.0
Male	3	0	5	0.0
Age				
Adult	2	0		0.0
Puppy	3	0	5	0.0
		Usaka obugwu community		
Type				
Exotic	9	0		0.0
Local	8	0	17	0.0
Sex				
Female	4	0		0.0
Male	13	0	17	0.0
Age				
Adult	13	0		0.0
Puppy	4	0	17	0.0
		Oruigwe nnono community		
Type				
Exotic	3	0		0.0
Local	15	0	18	0.0
Sex				
Female	7	0		0.0
Male	11	0	18	0.0
Age				
Adult	16	0		0.0
Puppy	2	0	18	0.0
		Ibere obohia community		
Type				
Exotic	0	0		0.0
Local	3	0	3	0.0
Sex				
Female	1	0		0.0
Male	2	0	3	0.0
Age				
Adult	2	0		0.0
Puppy	1	0	3	0.0

Table 4: Percentage (%) incidence of Schistosomosis in dogs of various breed, age, and sex sampled in Four (4) communities in Ikwuano LGA in Abia State

Variables	Sample size	Positive samples	Total sample collected	Percentage incidence (%)
Amizi community				
Types				
Exotic	2	0		0.0
Local	4	0	6	0.0
Sex				
Female	3	0		0.0
Male	3	0	6	0.0
Age				
Adult	5	0		0.0
Puppy	1	0	6	0.0
Ala ala oboro community				
Type				
Exotic	9	0		0.0
Local	8	0	17	0.0
Sex				
Female	4	0		0.0
Male	13	0	17	0.0
Age				
Adult	13	0		0.0
Puppy	4	0	17	0.0
Oloko community				
Type				
Exotic	0	0		0.0
Local	8	0	8	0.0
Sex				
Female	3	0		0.0
Male	5	0	8	0.0
Age				
Adult	8	0		0.0
Puppy	0	0	8	0.0
Ibere isiala community				
Type				
Exotic	0	0		0.0
Local	12	0	12	0.0
Sex				
Female	7	0		0.0
Male	5	0	12	0.0
Age				
Adult	10	0		0.0
Puppy	2	0	12	0.0

Zero (0.0%) prevalence of schistosomosis was recorded in the four communities represented on table 4 above. Out of the six (6) dogs sampled in Amizi, two (2) were exotice breeds and four (4) mongrels. There were three (3) females and three (3) males, five (5) adults and one (1) puppy.
A total of twenty one (21) dogs were sampled in Ala ala oboro, Ten (10) of which were exotic breed and eleven (11) mongrels, eleven (11) females and ten (10) male, seventeen (17) adults and four (4) puppies. Eight 98) dogs were sampled in Oloko community. Out of these, three (3) were females and five (5) males, eight (8) adults and no puppy. Twelve (12) dogs were sampled in Ibere isiala community. All were mongrels with no exotic breed. There were seven (7) females and five (5) males, ten (10) adults and two (2) puppies.

Seventy one percent (7.1%) prevalence was established in all the four (4) communities represented on table 5 above. Out of the fourteen (14) dogs sampled in Afa community, only one (1) adult mongrel was positive for *schistosoma* eggs. Twelve (12) were mongrels and two (2) exotic breeds. There were six (6) females and eight (8) males, fourteen (14) adults and no puppy. Eight (8) dogs were sampled in Oloko community, Three (3) females and five (5) males, eight (8) adults and no puppy. A total of thirty (31) dogs were sampled in Oru community, out of which twenty nine (29) were mongrels and two (2) exotic breeds. Twenty two (22) were females and nine (9) males. Twenty were (26) adults and five (5) puppies. Three (3) dogs were sampled in Ariam ndiorie out of which two (2) were mongrels and one (1) exotic breed. There were one (1) female and two (2) males, three (3) adults and no puppy.

In table 6 above, zero (0.0%) prevalence was recorded in all the four communities sampled for *schistosoma* eggs. In Ariam Ekelu community, a total of four (4) exotic breeds of dog were sampled and zero mongrels. Out of this, one (1) was a female and the (3) males. There were three (3) adults and one (1) puppy.

In Isiama Ekebiri Community, a total of sixteen (16) dogs were sampled all mongrels with zero exotic. Of this six (6) were females and ten (10) males, sixteen (16) adults and one (1) puppy. In Isiama Okire Community, a total of eighteen (18) dogs were sampled with five (5) exotic breeds and thirteen (13) mongrels, seven (7) females and eleven (11) males, fifteen (15) adults and three (3) puppies.
In Amaoba ikputu in Abaa Ukwu Community, a total of forty one (41) dogs were sampled out of which fourteen (14) were exotic and thirty seven (37) were mongrels. Twenty two (22) were females and nineteen (19) males, twenty eight (28) were adults and thirteen (13) puppies.

Table 5: Percentage (%) incidence of Schistosomosis in dogs of various breed, age, and sex sampled in FOUR (4) communities in Ikwuano LGA in Abia State

		Afa community		
Variables	**Sample size**	**Positive samples**	**Total sample collected**	**Percentage incidence (%)**
Types				
Exotic	2	0		0.0
Local	12	1	14	7.1
Sex				
Female	6	0		0.0
Male	8	1	14	7.1
Age				
Adult	14	1		7.1
Puppy	0	0	14	0.0
		Oru community		
Type				
Exotic	2	0		0.0
Local	29	0	31	0.0
Sex				
Female	22	0		0.0
Male	9	0	31	0.0
Age				
Adult	26	0		0.0
Puppy	5	0	31	0.0
		Oloko community		
Type				
Exotic	0	0		0.0
Local	8	0	8	0.0
Sex				
Female	3	0		0.0
Male	5	0	8	0.0
Age				
Adult	8	0		0.0
Puppy	0	0	8	0.0
		Ariam ndiorie community		
Type				
Exotic	1	0		0.0
Local	2	0	3	0.0
Sex				
Female	1	0		0.0
Male	2	0	3	0.0
Age				
Adult	3	0		0.0
Puppy	0	0	3	0.0

Table 6: Percentage (%) incidence of Schistosomosis in dogs of various breed, age, and sex sampled in four (4) communities in Ikwuano LGA in Abia State

Variables	Sample size	Positive samples	Total sample collected	Percentage incidence (%)
Ariam Ekelu community				
Types				
Exotic	4	0		0.0
Local	0	0	4	0.0
Sex				
Female	1	0		0.0
Male	3	0	4	0.0
Age				
Adult	3	0		0.0
Puppy	1	0	4	0.0
Isiama Ekeberi community				
Type				
Exotic	0	0		0.0
Local	16	0	16	0.0
Sex				
Female	6	0		0.0
Male	10	0	16	0.0
Age				
Adult	16	0		0.0
Puppy	1	0	16	0.0
Isiama Okire community				
Type				
Exotic	5	0		0.0
Local	13	0	18	0.0
Sex				
Female	7	0		0.0
Male	11	0	18	0.0
Age				
Adult	15	0		0.0
Puppy	3	0	18	0.0
Amaoba Ikputu in Abaa Ukwu community				
Type				
Exotic	4	0		0.0
Local	37	0	41	0.0
Sex				
Female	22	0		0.0
Male	19	0	41	0.0
Age				
Adult	28	0		0.0
Puppy	13	0	41	0.0

DISCUSSION

The result of this study confirms the existence of canine schistosomosis in ikwuano local government area despite the near absence of data on the disease condition in dogs in Nigeria. However researchers in Asian countries have identified dogs as reservoir of infection in humans (Carabin *et al.*, 2015). The disease have also been identified in other animal species such as water buffalo, cattle, rodents with high prevalence occurring in goats indicating their importance in the transmission of schistosomosis in humans (Clarf, *et al.*, 2017). Despite involvement of other species of animals in schistosomosis, dogs have shown consistent association in transmission of the disease in humans (Carabin *et al.*, 2015).

Information on canine schistosomosis is of most importance due to the close association of man with dogs and its potential as zoonotic risk to man. Canine schistosomosis produces a debilitating and often a fatal disease in dogs and although the disease manifests as diarrhea it is mostly under diagnosed during disease investigation. *Schistosoma* species often are not detected during routine feacal floatation for nematodes. Such negative samples are positive with fecal saline sedimentation and fecal polymerase chain reaction giving the true incidence of the disease in a population (Harizlicek *et al.*, 2011). The investigation in the existence of schistosomosis in dogs within communities in Ikwuano was strategic towards fostering the collapsed 1988 Federal Ministry of Health and National Schistosomosis program vision on a 5 year for 50% reduction on the prevalence of schistosomosis in profound areas in Nigeria (Ekpo and Mafiana, 2004). It also serve as a form of investigation in the report of high prevalence of estimated number of 20 million people infected with schistosomosis in all the 36 states of Nigeria including Federal capital territory Abuja (Adie *et al*., 2013).

The two communities in (tables 1) Amaoba Ime in Abaa ukwu and Afa in (table 5) where schistosomosis were detected in dogs were known for hunting, a vocation which exposes dogs to dangers in the wild. Such hunting dogs have high risk of exposure to parasitic diseases acquired through contamination with faeces from infected humans (Eileen, 2010). This practice also exposes dogs to areas with schistosome contaminated stagnant or running waters. Dogs and wildlife often are exposed to schistosomosis while swimming or wadding in fresh water areas such as marshes, mudflats and canals (Lee, 1962). In most settings high level of human–dog cross-infection are generally observed which raises great concern (Rudge *et al.*, 2008). Infected humans may develop skin dermatitis known as swimmers itch.

Conclusion Schistosomosis is among the reportable diseases in the world and therefore, knowledge of the prevalence and intensity of schistosomosis in any community is crucial in planning of the disease intervention and control strategies towards prevention of out break to safe communities.

REFERENCES

Adie H. A., Okon O. E., Arong G. A., Braide E. I. and Eko U. F. (2013). Spatial distribution of urinary schistosomiasis in Cross River State, Nigeria using geographical information system and school based questionnaire. *Pakistan journal of biological sciences.* 16(20):1106-1172.

Carabin H., Mcgarvey S.T., Sahlu I., Tarafder M.R., Joseph L., De Andrade B.B., Balolong jr E. and Olveda R. (2015). Schistosoma japonicum in Samar, the Philippines: infection in dogs and rats as a possible risk factor for human infection. *Epidemiology infection,* 143(8): 1767-1776).

Clarf F. Van D., Catherine A. G., Yuesheng Li., Gail M. W., Yuanyuan W., Zhenhua L., Geoffrey N. G., Heng Y., Donald P. M. and Damen J.G. (2017). Rodents, goats and dogs their potential roles in the transmission of schistosomosis in China. *Glasgow encounters with tropical diseases,* 144(12): 1633-1642.

Cunningham A. A. (2005). A walk on the wild side—emerging wildlife diseases. Br. Med. J. 331, 1214–1215 (doi:10.1136/bmj.331.7527.1214)

Eileen M.J. (2010). Canine schistosomosis in North America: An underdiagnosed disease with an expanding distribution. Compendium, vol.32(3).

Ekpo U.F., Mafiana C.F. (2004). Epidermiological studies of urinary schistosomosis in Ogun State, Nigeria. Identitfication of high risk communities. *Nigerian Journal of* Parasitology, 25: 111-119.

GPS Corodinates, 2014. The latitude and longitude gps cordintes of Umuahia (Nigeria). The GPS Corordinates. Net.

Gryseels B., Polman K., Clerinx J., Kestens L., (2006). Human schistosomiasis. Lancent, 368:1106-1118.

Lee H. (1962). Life history of Heterobilharzia Americana. A schistosome of raccoon and other mammals in southeastern united states. *Journal parasitology*, 48: 728-739.

Mafiana, C.F., Ekpo, U.F., Ojo, D.A. (2003). Urinary schistosomiasis in preschool children in settlements around Oyan Reservoir in Ogun State, Nigeria,: implications for control. Trop.Med. Int. Health 8, 78–82.

McCarthy J., Moore T. A. (2000). Emerging helminth zoonoses. *International Journal* for *Parasitology*, 30, 1351–1360 (doi:10.1016/S0020-7519(00)00122-3).

Okoli E.I. and Odaibo A.B. (1999). Urinary schistomosis among school children in Ibadan, an urban community in south western Nigeria, 4(4):308-315.

Rudge J.W. (2008). Population genetics of schistosoma japonicum within the Philippines suggest high level of transmission between humans and dogs. *PLOS Neglected Tropical Diseases*, 2(11):340.

Salawu O. T. and Odaibo A. B. (2012). Preliminary study on ecology of *Bulinus jousseaumei* snail in *Schistosoma haematobium* endemic rural community of Nigeria. *African Journal of* Ecology, 51:441–6.

Salawu O. T.and Odaibo A. B. (2013). Schistosomiasis among pregnant women in rural communities in Nigeria. Int J Gynecol Obstet.122:1–4.

Salawu O. T. and Odaibo A. B. (2014). A Growing Concern In Sub-Saharan Africa. Pathog Glob Health. 108(6): 263–270.

Steveen R. R. and Cinthia F. (2012). Parasitological stool sample exam by spontaneous sedimentation method using conical tubes; effectiveness, practisce and biosaftey. Revista da sociedade Brasileira de medicina Tropical vol 45,no3.

Thrustfield, M.V. and Christley, R. (2018). Veterinary epidermiology:4Th edition, Blackwell science, Oxford, London,888pages.

Urquhart, G. M.; Amour, J.; Duncan, J. L.; Dunn, A. M.; Jennings, F. W. (1996). Veterinary Parasitology, 2nd edition pg 196. Blackwell Science Ltd, Blackwell Publishing Company, Oxford, UK. pg, 1-138.

Vanguard media, (2013). The “Gate of Umuahia”. Vanguardngr. Com.

Vorou R. M., Papavassiliou V. G., Tsiodras S. (2007). Emerging zoonoses and vector-borne infections affecting humans in Europe. Epidemiol. Infect. 135, 1231–1247 (doi:10.1017/S0950268807008527).

ILLEGAL ACTIVITIES IN AGO-OWU FOREST RESERVE IN OSUN SATE AND ITS IMPLICATION ON SUSTAINABLE FOREST MANAGEMENT

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ABSTRACT

This study aimed at assessing illegal activities with a view to enhancing sustainable forest management (SFM) in Ago-Owu reserve. Purposive sampling was used to select four communities from eight communities around the reserves. The major targets were the households. Based on this, 162 respondents (48, 27, 45, and 42) were selected from 480, 266, 447 and 420 households in Mokore, Ejemu, Abaoba and Famuyiwu respectively using 10% sampling intensity. Primary data were collected using questionnaire and analyzed using descriptive statistics, chi-square and logistic regression. Majority of the respondents were male (62.9%), 51-60years (33.3%), married (50.6%), had secondary education (48.1%), had 16-30 years of residency (67.9%), with household size of 4 (32.7%), farmers (58.6%) and indigenes (77.2%). Majority (18.5%) generated income/annum of ₦310000 - ₦400000. Major illegal activities were; collection of fuelwood (96.3%), trespass (96.3%) and illegal felling of trees (89.5%). Illegal activities were dependent on communities (χ^2 =19.30); sex (χ^2 = 6.33); education (χ^2 = 11.59), nativity (χ^2 = 12.30), years of residency (χ^2 = 45.13) and occupation (χ^2 =13.09). Major socio-economic impacts include; damaging of NTFPs (90.1%), loss of revenue (90.1%) and climate change (84.5%). High population was the most significant factor contributing to illegal activities with odds-ratio of 1249218286570. Methods mostly used in monitoring illegal activities include; Use of law enforcement agency (100%), Forest guards (88.3%) and Community vigilante (75.3%). Illegal activities in forest reserves are a major threat to forest conservation. Therefore, strategies aimed at reducing dependence on forest should be established thereby enhancing SFM.

Keywords: Illegal activities, Forest reserve, Households, Conservation, Sustainable forest management.

INTRODUCTION

Over the years, the forests have been known to sustain life on earth (FAO, 2005). They supply food, medicine, energy, shelter, fodder, wood and non-wood forest products and they are a source of economic development for individuals and communities. In Nigeria, majority of the rural dwellers depend on forest for their daily needs (Olaniyi *et al.*, 2013). The first forest reserve in Nigeria was created in 1901 with the sole aim of promoting afforestation, regulating log exploitation and introduction of forest resources management. It was also aimed at controlling logging activities with sole aim of preventing untimely timber deficits. However, due to porosity and believe of the people on the use of the forest, the forest have been vulnerable to destruction in recent times (Azeke 2002).

Illegal activities in forest reserves are far becoming a major threat to biodiversity conservation. Galvin *et al.*, (2009) defined illegal activities as commercial and subsistence use that violates forest regulations. Illegal activities are events carried out in the forest zones without approval from the authorities in control of the reserves. These illegal activities entail violations of ownership rights, such as taking of resources from protected areas or private land without permission, illegal land occupation, and violation of resource-use regulations, including use that is in excess of established limits, out of season and conducted with prohibited extraction methods, without required permits, or in prohibited areas. Illegal resource use also includes extraction of prohibited resources, such as protected species. The impact of illegal activities ranges from biological, economic and social. Biological activities impact range from decline in genetic diversity and species richness to changes in community composition and ecosystem services (Edirisinghe, 2003). On the other hand, economically, illegal resource use can provide alternative livelihood strategies to marginalized people and windfall profits to poachers of prized species (Yonariza and Webb 2007; Tacconi, 2008), but legitimate resource users can suffer significant revenue losses as a result of illegal use of resources (Gutierrez-Velez and MacDicken, 2008). Socially, illegal resource use can reflect and further exacerbate differences in access to resources. Therefore, the study aimed at assessing illegal activities in Ago-Owu forest reserve in Osun state with a view to enhancing sustainable forest management in the forest reserve.

MATERIALS AND METHODS

Study Area

Osun State covers a total area of approximately 8,602km^2 and is bounded in the south by Ogun State, in the north by Kwara State, in the west by Oyo State and in the east by Ondo State. Agriculture is the traditional occupation of the people of Osun State. The tropical nature of the climate favours the growth of a variety of food and cash crops. The vegetation consists of high forest and derived savanna towards the north. The trees and other living components of the area have been disturbed by annual forest fires and other human activities. Sizeable parts of the old Oyo forest reserve are located in the present Osun State. These include Ago-Owu Forest Reserve with 32,116 hectares in the high forest area, the estimate terrain elevation above sea level is 204 metres.

Sampling Procedure and Sample Size

Purposive sampling was used to select four communities from the eight rural communities around Ago-Owu forest reserves. These include Mokore, Ejemu, Abaoba and Famuyiwu. Selection was based on the fact that these communities were noted for their involvement in various forest activities as well as active involvement in other land use practices in the forest reserve. The major target were the households. Based on this, 480, 266, 447 and 420 households were identified in Mokore, Ejemu, Abaoba and Famuyiwu respectively. Furthermore, the sampling intensity adopted by Diaw *et al*., (2002) was used to select the respondents. This stated that a minimum of 10% sampling intensity could serve as a representative figure for a population less than 500 people. Therefore a total of 162 households were selected for this study. Below is an illustration of the sampling procedure and sample size (Table 1).

Table 1: Sampling size of respondents in the study area

Communities	Population of households	10% of household head selected	No of respondents
Mokore	480	48.0	48
Ejemu	266	26.6	27
Abaoba	447	44.7	45
Famuyiwa	420	42.0	42
Total	**1613**	**161.3**	**162**

Source: Field survey, 2018

Data Collection and analysis

Data were collected from both primary sources. Primary data were collected with the aid of structured questionnaire. Data was analysed using descriptive statistics, chi-square and logistic regression analysis. The logistic regression model can be expressed as:

$$Y = exp\,(b0 + b1x1 + b2x2 + \cdots. + b9x9)\,/\,1 + exp\,(b0 + b1x1 + b2x2 + \cdots. + b9x9) - - - -(2)$$

Where:

Y = Factors contributing to illegal activities (FCIA) (Dependent variable).

$b_{0,}\, b_{1,}\, b_2 \ldots b_9$ = regression parameters

Independent variable includes:

X_1 = High population (HP)

X_2= Poverty (P)

X_3 = Low income (LI)

X_4 = Political influence (PI)

X_5 = Non- renewal of property hammer (NPH)

X_6 = Inadequate land for farming (ILF)

X_7 = Lack of provision for forest guards (LPFG)
X_8 = Failure to produce log certificate (FPLC)
X_9 = Inadequate consultation with stakeholders (ICS)

RESULTS AND DISCUSSION

The results on the age distribution revealed that (33.3%) of respondents are within age of 51-60years, this was followed by respondents (27.2%) who are within the age of 31-40years while those within the age range of 71years and above recorded the least with 1.9% (Table 2). This is an indication that the respondents were within the middle age bracket and were still active in carrying out forest activities, this corroborated with the findings of Olaniyi *et al*. (2013) who stated that the highly productive age in agriculture and forestry activities fall within the age group 31-60 years. The sex distribution (Table 2) revealed that majority of the respondents are males with 62.9% while the females had a lower percentage of 37.0%. This implies that the males are more engaged in forestry practices including the illegal forest activities than their female counterpart in the study area. This could be attributed to the socio-cultural milieu which gives males more access to production resources (Tacconi, 2008).

It was further revealed that 50.6% of the respondents were married, while the divorced recorded the least with 6.2%. This showed that the married people are more involved in illegal forest activities in the area. This may also be attributed to the fact that the married in an attempt to cater for the needs of their family indulge in various forest activities to sustain themselves. With reference to educational level of respondents (Table 2), it was revealed that majority (48.1%) of respondents were educated at the secondary level while those that had no formal education recorded the least percentage with 13.0%. This is an indication that the educational level of respondents were low as a result they may not be well informed on the need for protection of forest resources as their utmost concern is the easy, cheap and readily available practices needed to sustain livelihood (Obasi *et al*., 2012). Furthermore, majority (58.6%) of the respondents in the study area were farmers, this was followed by those involved in the collection of non-timber forest products with 18.5%. However, respondents involved in other forms of occupation recorded the least with 1.9%. This is a clear indication that most forest dependent communities with the aim of meeting their daily needs source for various means of generating income for sustaining their families. This they do mostly, though farming activities or the collection of non-timber forest products in forested areas. This therefore corroborated the findings of Azeke (2009) that the forest reserves of Edo state have been greatly reduced during the last decades through various farming activities. Likewise, indigenes recorded the highest percentage with 77.2% while the non-indigenes were few in number with 22.8%. This is also an indication that most illegal forest activities are perpetrated by the indigenes (Table 2).

It was revealed (Figure 1) that majority (67.9%) of the respondents had been living in the area for about 16-30years while a few (0.6%) of the respondents have been living in the area for 45-60years. This implied that most of the respondents have been residing in the area for quite a long time and as a result they depend on the forest resources to meet their various needs. This corroborated the findings of Ladipo (2013) who reported that communities residing within and on fringes of protected areas including forest reserves, use the forest for agriculture, livestock grazing, hunting, firewood and wood products, and non-timber forest products collection. The result on household size of respondents revealed that that majority (32.7%) of the respondents had household size of 4 people while the least was recorded in respondents with household size of 1 and 7 with 0.6% (Figure 2).

Table 2: Socio-demographic characteristics of respondents

Socio-demographic characteristics	Frequency	Percentage
Age (years)		
≥ 30	8	4.9
31 – 40	44	27.2
41 – 50	39	24.1
51 – 60	54	33.3
61 – 70	14	8.6
71 above	3	1.9
Total	162	100.0
Sex		
Male	102	62.9
Female	60	37.0
Total	162	100.0
Marital status		
Single	38	23.5
Married	82	50.6
Widowed	32	19.8
Divorced	10	6.2
Total	162	100.0
Education		
No formal edu.	21	13.0
Primary	34	21.0
Secondary	78	48.1
Tertiary	29	17.9
Total	162	100.0
Occupation		
Farming	95	58.6
Processing	10	6.2
Civil servant	14	8.6
NTFPS collectors	30	18.5
Livestock rearing	6	3.7
Driving	3	1.9
Nativity		
Indigenes	125	77.2
Non- indigenes	37	22.8
Total	162	100.0

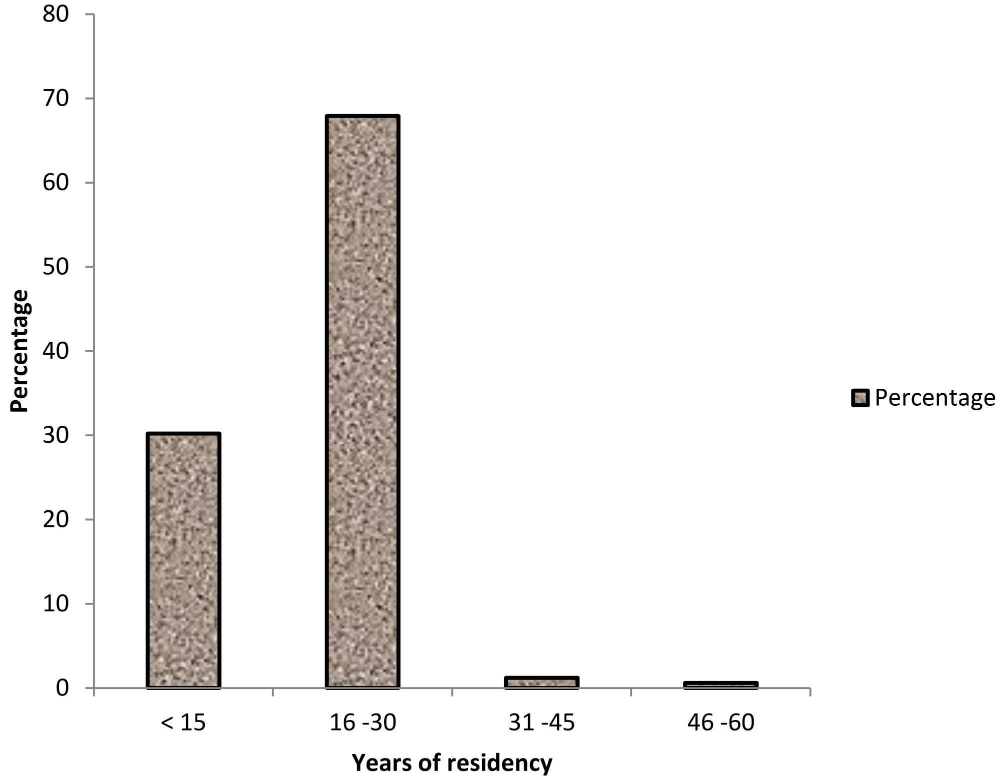

Figure 1: Years of residency of respondents

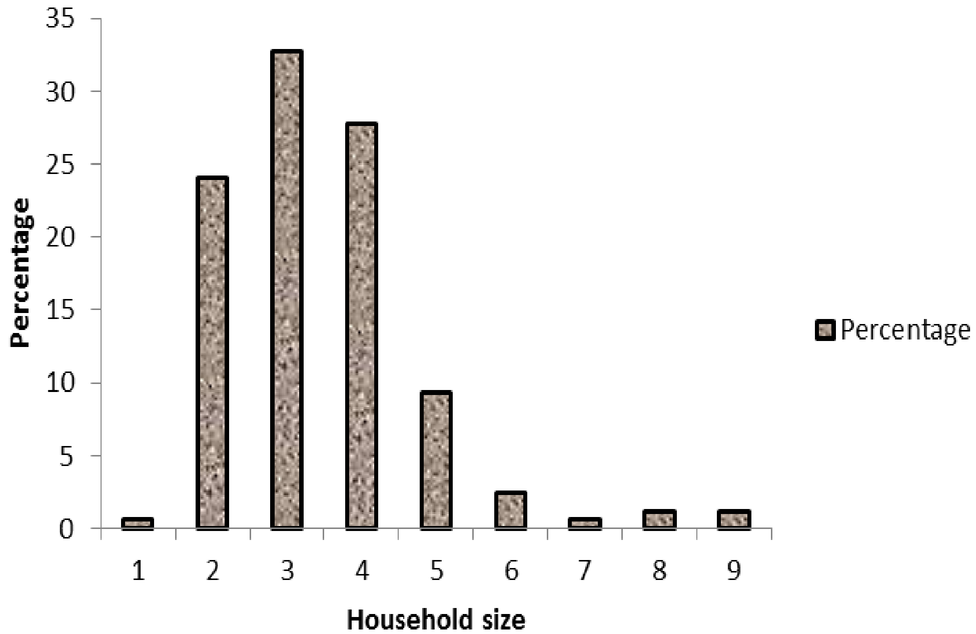

Figure 2: Household size of respondents

Table 3: Income (₦)/ annum of respondents

Income (₦)/ annum	Frequency	Percentage
≥ 100,000	7	4.3
110,000 – 200,000	9	5.5
210,000 – 300,000	23	14.2
310,000 – 400,000	30	18.5
410,000 – 500,000	26	16.0
510,000 – 600,000	26	16.0
610,000 – 700,000	14	8.6
710,000 – 800,000	13	8.0
810,000 – 900,000	8	4.9
900,000 above	6	3.7
Total	162	100.0

Source: Field survey, 2018

The income generated from the various forest activities indulged in by the respondents in the study area as shown in Table 3 revealed that majority of the respondents (18.5%) generated about ₦310,000-₦400,000 yearly from the forest reserve. This was closely followed by those respondents who generated between ₦410,000 – ₦500,000 and ₦510,000 – ₦600,000 per annum with (16.0%) respectively. However, the least percentage (3.7%) of the individuals are respondents who generated ₦900,000 and above. This is an indication that forest activities are profitable venture and because of this the forest dependent communities tend to explore the forest resources not minding the consequences that their actions might cause to the forest itself. This therefore corroborated with the findings of Azeke (2002) that forest reserves in Nigeria have experienced great decline as a result of competition for forest resources to meet daily needs.

Table 4: Illegal activities carried out in the study area

Illegal activities	Yes		No	
	Freq.	**%**	**Freq.**	**%**
Illegal farming	144	88.9	18	11.1
Illegal felling of trees	145	89.5	17	10.5
Poaching	145	89.5	17	10.5
Felling of undersized trees	134	82.7	28	17.3
Non- renewal of property hammer	52	32.1	110	67.9
Failure to produce log certificate	61	37.7	101	62.3
Arson or illegal burning	155	95.7	7	4.3
Trespass	156	96.3	6	3.7
Obtaining fuel wood from the reserve	156	96.3	6	3.7
Hunting in the reserve	61	37.7	101	62.3

Source: Field survey, 2018

Table 4 showed various illegal activities carried out within the reserves. These include; obtaining fuel wood from the reserve (96.3%), trespass (96.3%), illegal felling of trees (89.5%), poaching (89.5%), illegal farming (88. 9%), felling of undersized trees (82.7%) etc. This is an indication that the forest dependent communities explore the forest resources through various illegal means to sustain themselves. This therefore corroborated with the findings of Azeke (2002) that forest reserves have experienced great decline as a result of competition for forest resources to meet daily needs. Ladipo (2013) therefore reported that if the forest resource base is to improve then various illegal activities militating against the sustainable forest development in the nation must be properly addressed.

Table 5: Relationship between socio- economic characteristics and illegal activities in the study area

Socio-economic characteristics	Chi-square value	Df	p-value
Communities	19.30	3	0.002*
Age	40.90	5	0.56
Sex	6.33	1	0.008*
Marital status	5.98	3	0.50
Education	11.59	3	0.009*
Nativity	12.30	1	0.000*
Years of residency	45.13	29	0.029*
Occupation	13.09	6	0.042*
Household size	13.07	9	0.16

Source: Field survey, 2018

The relationship between socio-demographic characteristics of respondents and illegal activities in the study area (Table 5), revealed that there was significant association between communities (χ^2 =19.30, df =3, p = 0.002); sex (χ^2 = 6.33, df =1, p = 0.008); education (χ^2 = 11.59, df =3, p = 0.009), nativity (χ^2 = 12.30, df = 1, p = 0.000), years of residency (χ^2 = 45.13, df = 29, p = 0.029), occupation (χ^2 =13.09, df = 6, p = 0.042) and illegal activities in the study area but there was no significant association between age (χ^2 = 40.90, df =5, p = 0.56); marital status (χ^2 = 5.98, df =3, p = 0.50), household size (χ^2 = 13.07, df = 9, p = 0.16) and illegal activities in the study area. This implied that communities around the reserve depended on it for sustenance and as a result carry out several activities such as illegal felling, illegal farming etc. thereby negating the aim of sustainable forest management (Azeke, 2009).

Table 6: Socio-economic impact of illegal activities on forest dependent communities in the study area

Socio-economic impact	Yes		No	
	Freq.	%	Freq.	%
Displacement of people	45	27.8	117	72.2
Death of family members	42	25.9	120	74.1
Damaging of non-wood forest products	146	90.1	16	9.9
Loss of revenue by government	146	90.1	16	9.9
Reduction in soil fertility	133	82.1	29	17.9
Reduction in crop output	131	80.9	31	9.1
Loss of biodiversity	135	83.3	27	16.7
Rural-urban migration	58	35.8	104	64.2
High cost of living	34	21.0	128	79.0
Increased cost of timber and non-timber products	135	83.3	27	16.6
Climate change and global warming	137	84.5	25	15.4

Source: Field survey, 2018

The socio-economic impact of illegal activities on forest dependent communities include; damaging of non-wood forest products (90.1%), loss of revenue by government (90.1%), climate change and global warming (84.5%), increased cost of timber and non-timber products (83.3%), loss of biodiversity (83.3%), reduction in soil fertility (82.1%) reduction in crop output (80.9%), etc. (Table 6). This therefore implied that if the various illegal activities in the forest reserve are not checkmated, this can militate against the sustainable forest development in the nation (Ladipo, 2013).

Factors contributing to illegal activities in the study area

The binary regression model obtained for factors contributing to illegal activities in the study area

Odds- ratio (Unit change): Constant (0.00); HP (1249218286570); P (9692847390.80); LT (153.88); PI (0.00); NPH (1.33); ILF (137012.93); LPFG (0.00); FPLC (7139406841.30); ICS (0.15)
Where: High population (HP), Poverty (P), Low income (LI), Political influence (PI), Non-renewal of property hammer (NPH), Inadequate land for farming (ILF), Lack of provision for forest guards (LPFG), Failure to produce log certificate (FPLC), Inadequate consultation with stakeholders (ICS)

Model 1 presented above for factors contributing to illegal activities in the study area gave overall significant fit to the data judging from Chi-square value that was significant at $p<0.05$. High population (HP) was the most significant variable with odds-ratio of 1249218286570 followed by poverty (P), failure to produce log certificate (FPLC), inadequate land for farming (ILF), low income (LI) with odd-ratios of 9692847390.80, 7139406841.30, 137012.93, 153.88, respectively (Table 8). The logistic regression analysis implied that there was sufficient evidence that the estimated coefficient for the factor was not zero. This also implied that the regression parameters in the model were statistically significant. In other words, the higher the value of odds- ratio, the more likelihood the factors contributed to illegal activities in the study area. The implication was corroborated by Deeks (1996) that the logistic model provides information on the consequences of one variable on the other. Methods used in monitoring illegal activities in the study area include; Use of law enforcement agency (100%), Forest guards (88.3%), Community vigilante (75.3%), etc. (Figure 3)

Table 7: Logistic binary nature for factors contributing to illegal activities in the study area

Independent variables	Coefficient	Odds-ratio
High population (HP)	37.06	1249218286570.00*
Poverty (P)	23.00	9692847390.80*
Low income (LI)	5.04	153.88*
Political influence (PI)	-30.56	0.00
Non- renewal of property hammer (NPH)	0.29	1.33
Inadequate land for farming (ILF)	11.83	137012.93*
Lack of provision for forest guards (LPFG)	-19.41	0.00
Failure to produce log certificate (FPLC)	22.69	7139406841.30*
Inadequate consultation with stakeholders (ICS)	-1.93	0.15
Model χ^2(df = 11) = -56.025* p=0.000		

***= significant at p < 0.05**

Dependent variable (FCIA) = Factors contributing to illegal activities in the study area (Yes =1; No = 0)

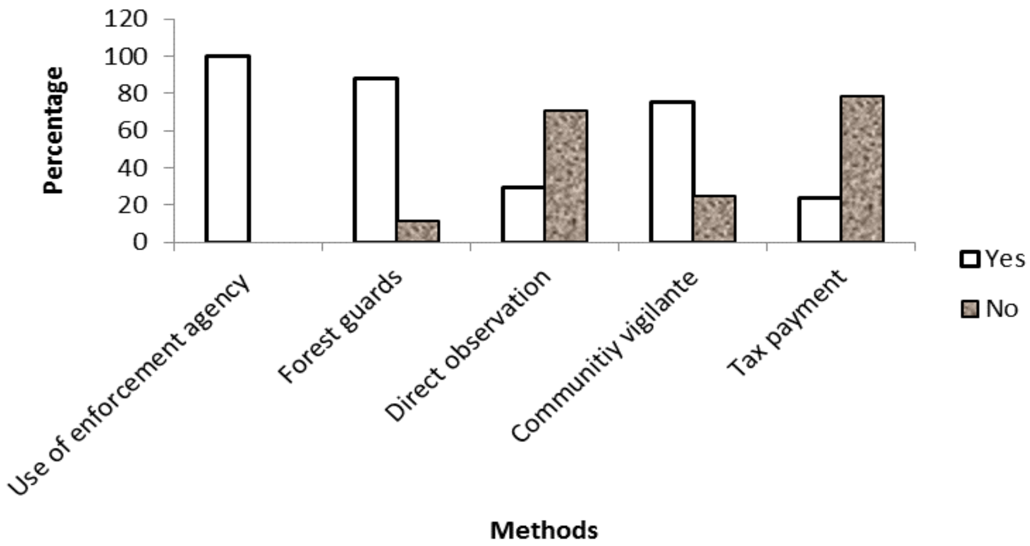

Figure 3: Methods used in monitoring illegal activities in the study area

CONCLUSION

The study indicated that location of communities, sex, education, nativity, years of residency and occupation are major determinants contributing to illegal activities in the study area. They also have a significant relationship with illegal activities which contributed a great deal to loss of forest resources in the study area. Therefore, the more respondents source for means of generating income to meet their daily needs, the more they will put pressure on the forest areas and this in turn will hinder effective sustainable forest management in the study area. The major socio-economic impact of illegal activities on forest dependent communities include; damaging of non-wood forest products, loss of revenue by government, climate change and global warming, increased cost of timber and non-timber products, loss of biodiversity, reduction in soil fertility and reduction in crop output.

Factors contributing to illegal logging in the study area gave overall significant fit to the data judging from Chi-square value that was significant at $p<0.05$. High population (HP) was the most significant factor followed by poverty (P), failure to produce log certificate (FPLC), inadequate land for farming (ILF) and low income (LI). Methods mostly used in monitoring illegal activities in the study area include; use of law enforcement agency, forest guards and community vigilante.

REFERENCES

Azeke (2002). Forestry Contribution to Edo State Economy. Proceedings of the 2nd National Workshop Organized by FANCONSULT and Edo State Chapter of Forestry Association of Nigeria, Sept. 5-6, Benin City, pp: 27-41.

Azeke, I. E. (2009). Brief on Forestry Administration (Forest Management, Exploitation and Utilization) in Edo State. Pp5.

Deeks, J. (1996). Swots Corner; what is an Odd Ratio? Bandolier, 3 (3), issue 25, 6-7.

Diaw, K., Blay, D. and Adu-Anning, C. (2002). Socio-economic survey of forest fringe communities: Krokosua Hills forest reserve, a report submitted to the Forestry Commission of Ghana, 2002, pp. 1-86.

Edirisinghe, U. (2003). Sustainable Aquatic Resources Management in the 21st Century: Some important issues. *Tropical Agriculture Research and Extension* 6:122–127.

Food and agricultural Organisation, FAO (2005). Impacts of Policies on Poverty. The Definition of Poverty and Agriculture Organization of the United Nations, FAO, Italy.

Gavin, C. M, Jennifer N. Solomon, Ó. Sara, G,. Blank, Ô. (2009). Measuring and Monitoring Illegal Use of Natural Resources. *Journal of Conservation Biology*. 24(1):89-100

Gutierrez-Velez, V. H., and K. MacDicken. (2008). Quantifying the Direct Social and Governmental costs of illegal logging in the Bolivian, Brazilian, and Peruvian

Amazon. Forest Policy and Economics 10:248–256.

Ladipo, D.O. (2013). Forest, Human Nutrition and Food Security in Nigeria: Strategies for Achieving our Millennium Development Goals; In Eyo Okon, Deni Brown, Augustine Isichei (Eds): Nigerian Forests; Protection, Sustainable Development. Pp 14- 28. JABU, 2013.

Obasi, P. C, Okparadim, G. I. and Henri-Ukoha, A. (2012). Economics of agroforestry in Imo State, Nigeria. *International Journal of Agricultural and Food Science, 2*(1), 7-13.

Olaniyi, O.A., Akintonde, J. O. and Adetumbi, S.I. (2013). Contribution of Non-Timber Forest Products to Household Food Security Among Rural Women in Iseyin Local Government Area of Oyo State, Nigeria. *Research on Humanities and Social Sciences*. 3(7): .41-49.

Tacconi, L (2008). The problem of Illegal Logging. In: Tacconi, L. (ed.): Illegal logging: law enforcement, livelihoods and the timber trade. London: Earthscan

Yonariza, and E. L. Webb. (2007). Rural household participation in illegal timber felling in a protected area of West Sumatra, Indonesia. Environmental Conservation 34:73–82.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ikyaagba et al., 2019

AWARENESS, PERCEPTION AND ATTITUDE OF GBOKO RESIDENTS ON URBAN FORESTRY, BENUE STATE, NIGERIA

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ABSTRACT

The study was carried out to assess the level of awareness and perception of urban forestry among residents of Gboko town, Benue State, Nigeria. Stratified Random Sampling Technique was adopted for the study. Descriptive and inferential statistical methods were used for data analysis. The results showed that majority of the respondents' (56.6%) were male, 65.1% were married and 52.6% had tertiary education. The results also showed that a good number of the respondents-(36.2%) were within the age bracket of 31- 40 years. Edible fruits/leaves/seeds/oils was ranked as number one perceived benefit of urban forestry, fallen leaves and flowers was ranked as number one perceived risk posed by trees. Majority (52%) of the respondents identified lack of proper care for urban trees as the major problem faced by urban trees in the area. Most of the respondents (65.1%) were willing to volunteer time for urban tree planting enlightenment/campaigns. The results also showed that 68.1% of the respondents have never participated in urban forestry activities, (44.7%) agreed they visit parks/gardens once or twice a month and (61.3%) said they visited Parks for relaxation purposes. There was no significant difference (p>0.05) on the relationship between respondents' sex and their awareness of urban trees and between respondents' sex and their perceived problems posed by urban trees. However, there was significant difference (p<0.05) between male and female respondents' perceived aesthetic value of urban trees. It was established that urban trees in the area not well cared for. It was recommended that local and state governments should reawaked interest in urban forestry.

Key words: perceived benefit, ecosystem services, perceived problems, perceived risk, volunteer

INTRODUCTION

The past 50 years has witnessed rapid increase in the rate urbanization across the globe. Scholars have stated that this increase in likely to continue (Ritchie and Roser, 2018). FAO (2016) reported that this increase is happening due to rural-urban migration. Studies have shown that more than half of the world population live in urban areas, this figure is projected to rise to 68% by the year 2050 (Ritchie and Roser, 2018).

Cities normally reshape the natural environment during their expansion, bringing about environmental challenges (FAO 2016). According to Ajewole (2015), rapid urban growth often has negative consequences on the environment. Scholars believed that urban environment are often harsh with many threat and pressure, due to environmental degradation (Lin *et al.,* 2017).

Onkunlola (2013) observed that population growth out tripped the capacity to maintain acceptable environmental safety in urban areas. In Nigeria, like many other developing countries, rapid urban development has caused lack of green space in many urban areas (Poopola *et al.,* 2016). Fuwape and Onyekwelu, (2010). observed that the growing urban population in Nigeria has outstretched current urban forestry facilities. Studies have over the years suggested sustainable urban forestry development within cities as the way forward (Ajewole, 2013; FAO 2016; Sundara *et al.*, 2017). This is because the roles, values and perception of urban forestry have changed (Zhao *et al.*, 2017). However, Oyebade *et al.* (2013) opined that planting of trees has been an integral and important part of human settlement. In Nigeria, the concept of urban forestry is poorly understood and often neglected. Gboko is one of the fastest in Benue State growing cities with its environmental problems. However, little is known about the residents' awareness and perception of urban forestry. The study was therefore conducted to assess the residents' awareness and perception about urban forests.

MATERIAL AND METHODS

Study Area

The research was carried out in the Gboko town, Benue State Nigeria. It lies on the geographical coordinates of 7^o 23´47´´N, 3^o 55´0´´E, and is bounded by Tarka Local Government Area (LGA) to the North, Buruku LGA to the east, Gwer East and Konshisha LGAs to the west and Ushongu LGA to the south. The topography of the area is mostly characterized by several plains and a few hilly areas. The town enjoys a tropical climate with two distinct seasons namely the raining season (May-October) and the dry season (November-April). Temperature ranges between 22 ^{o}C and 38 ^{o}C (Akpen *et al.*, 2018). The climate of the area favours cultivation and extraction of agricultural and forest products such as yam, cassava, potatoes, palm, rice, plantain, banana, maize and general timber produce. Its vegetation type is typically guinea savannah. Gboko had a population of 361,325 as at the 2006 population census (Akpen *et al.*, 2018). Gboko is considered to be one the most important commercial towns in Benue State due to the present of Benue Cement Company (now Dangote Cement).

Sampling Technique and Data Collection

Stratified Random Sampling Technique (SRST) was adopted for data collection in the study. The study area was stratified into four Strata namely: Gboko North, Gboko South, Gboko East and Gboko West. Each of the four regions was further divided into three sub-strata namely: Commercial areas, Residential areas and Educational Institutions areas. Random Sampling Technique was used in the selection of sample from each of three strata (samples here include Streets, schools and shops). In each of the four strata, 3 streets, 10 shops and 1 school were randomly selected. In each of the selected streets, 10 households were systematically selected at the pre-determined interval of 5 households. In each of the selected households, one member of the houses who was willing to talk to the researcher was interviewed. Also in each of the selected the selected schools, 5 members of staff were selected based on their wiliness to interact with the researcher. For the shops, owner of the shop or shop attendants were interviewed. This gave a total number of 180 copies semi-structured questionnaire administered in the entire study area. With 45 administered within each of the four strata, 120 copies of questionnaire were used in residential areas, 40 questionnaire in commercial areas and 20 questionnaire in educational areas. Oral interviews were conducted on a random sample to the general public to develop final valid and reliable questionnaire. The information on―demographic parameters and the perception of the respondents concerning the potential benefits and management options of urban trees was also captured using the questionnaire.

Data Analysis

The statistical package for social science (SPSS version 20.0) was used for the quantitative and qualitative data analysis; both descriptive and inferential statistical methods were used to analyze the quantitative data. Descriptive statistics such as frequency and percentage were used to analyze the socio economic characteristics of the respondents, benefits of urban trees, problems and other attributes of urban forest. The Mann-whitney test was used to determine the significant differences between the factors influencing respondents' perception and attitudes towards urban trees in the study area. While the results were presented using tables and charts.

RESULTS

The Demographic Characteristics of the Respondents

The demographic characteristics of the respondents as presented in Table 1 showed that 56.6% were male, while 43.45 were females. Also most of the respondents (36.2%) were within 31-40 years of age. Christians were 90.8%, 3.3% were Muslims, while 5.9% belonged to traditional religion. The results also revealed that 52.6% had tertiary education, 32.9% had secondary education while 14.9% had primary education. A good number of the respondents (32.9%) were civil servants, 28.3% were farmers, and 28.3% were traders while 16.4% were students. Also 65.1% were married, 29.6% were single, while 5.3% were widows. Majority of the respondents (80.9%) were Tiv, 10.5% were Idoma while 8.6% were Igbo.

Table 1. Demographic Characteristics of the Respondents

Variable	Category	Frequency	Percentage (%)
Sex	Male	86	56.6
	Female	66	43.4
Age	0 - 20 years	6	3.9
	21 - 30 years	36	23.7
	31 - 40 years	55	36.2
	41 – 50 years	36	23.7
	Above 50 years	19	12.5
Religion	Christianity	138	90.8
	Traditional	9	5.9
	Islam	5	3.3
Total			
Educational Level	Tertiary	80	52.6
	Secondary	50	32.9
	Primary	22	14.5
Total			
Primary Occupation	Civil Servants	50	32.9
	Farmers	43	28.3
	Business Men	34	22.4
	Students	25	16.4
Marital Status	Married	99	65.1
	Single	45	29.6
	Widow	8	5.3
Total			
Ethnicity	Tiv	123	80.9
	Idoma	16	10.5
	Igbo	13	8.6

Perceived-Benefits of Trees

Respondents outlined 12 benefits they derived from trees (Table 2). First among these benefits–trees as sources of edible fruits/seeds/nuts/leaves was the highest benefit (95.4%), followed by fresh air (94.1%) then provision of shade (94.1%) as the third benefit. Erosion control (80.3%) ranked fourth on respondents perceived benefit while medicine (78.3%) ranked fifth benefit. Other benefits derived from trees as perceived by the respondents included: wind break (75.7%), relaxation such as sitting under the tree (74.3%), fuelwood (74.3%), enhances aesthetic beauty of the city (71.7%), and source of timber (70.4%). A few respondents also believe trees reduce noise pollution (56.6%), and provides habitat for wildlife (44.1%).

The results (Table 3) of the difference between male and female perception of the individual tree benefits did not differ significantly except on their view of "Trees providing aesthetic value" which differed significantly at 5% level of significance (X^2=4.217, p<0.04).

Table 2: Perceived Tree Benefits in the Study Area

Perceived Benefits	Agree		Disagree		Rank
	Frequency	Percentage (%)	Frequency	Percentage (%)	
Edible fruits/seeds/nuts/leaves	145	95.4	7	4.6	1
Fresh air	143	94.1	9	5.9	2
Shade	143	94.1	9	5.9	2
Erosion control	122	80.3	30	19.7	4
Medicine	119	78.3	33	21.7	5
Wind break	115	75.7	37	24.3	6
Relaxation like sitting under trees	113	74.3	39	25.7	7
Fuel wood	113	74.3	39	25.7	7
Enhance aesthetic beauty of the city	109	71.7	43	28.3	9
Timber	107	70.4	45	29.6	10
Reduce noise pollution	86	56.6	66	43.4	11
Providing wildlife habitat	67	44.1	85	55.9	12

Table 3: Mann-Whitney results on the relationship between respondents' sex and Perceived Tree Benefits of urban trees

Variable	H	Df	P value
Trees provide fresh air versus sex	0.394	1	0.530
Trees provide fuel wood versus sex	0.595	1	0.440
Trees provide edible fruits/seeds/nuts/leaves versus sex	2.519	1	0.112
Trees provide habitat for wildlife versus sex	2.798	1	0.094
Trees serve as wind break versus sex	0.126	1	0.723
Trees provide shade versus sex	0.394	1	0.530
Trees provide timber versus sex	0.272	1	0.602
Trees provide medicine versus sex	0.849	1	0.357
Trees provide aesthetic beauty versus sex	4.217	1	0.040**
Trees help to control erosion versus sex	0.000	1	0.991
Trees serve relaxation value versus sex	3.396	1	0.065
Trees reduce noise pollution versus sex	2.349	1	0.125
Trees serve as idol worship site versus sex	0.684	1	0.408

Kruskal wallis test grouping variable: sex

Perceived Problems Pose by Trees in the Study Area

Respondents identified a total of eleven problems posed by trees in Gboko town (Table 4). Highest among these challenges is fallen leaves and flowers which litter the environment (94.1%), damage of plant roots to roads (67.1%), blocking of roads by tree branches (65.8%), damage to utility lines (62.5%), reduction of personal safety by limiting visibility (57.2%) excess shading of the interior buildings (53.3%), creation of hideout for criminals as source of insecurity (49.3%), and danger to lives and property (42.5%).

The results (Table 8) also revealed male and female respondents differed in their views on the problems posed by trees in the area. At 5% level of significance, the difference in their views of the problems caused by trees was not statistically significant. ($p>=0.005$).

Attitude towards Urban Forestry Activities in Gboko town

Results of the attitude of respondents as recorded in Table 5 showed that 68.4% of the respondents said they take care of trees around them. A good number of the respondents (60.5%) said they would like to plant trees around them. Majority of the respondents (65.1%)were willing to volunteer time for urban tree enlightenment/campaigns. However, only (48.7%) of them have had environmental awareness/education.

Table 4: Perceived Risk Posed by Trees in Gboko town

Perceived Risk	Yes		No		Rank
	Frequency	Percentage (%)	Frequency	Percentage (%)	
Fallen leaves and flowers litter the environment	143	94.1	9	5.9	1
Roots damage houses	129	84.9	23	15.1	2
Attracts annoying insects and birds	129	84.9	23	15.1	2
Roots damage roads	102	67.1	50	32.9	4
Trees block roads	100	65.8	52	34.2	5
Trees damage utility lines	95	62.5	57	37.5	6
Blocks view from property	93	61.2	59	38.8	7
Reduces personal safety by limiting visibility	87	57.2	65	42.8	8
They shade the interior of buildings	81	53.3	71	46.7	9
Creates insecurity	75	49.3	77	50.7	10
Danger to lives and property	65	42.5	87	57.2	11

Table 5: Attitude of respondents Towards Urban Forestry Activities in Gboko town

Attitude	Yes		No	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Do you maintain trees around you?	104	68.4	48	31.6
Would you like to plant trees around/within your compound/house?	92	60.5	39	25.7
Are you willing to volunteer time for tree planting/enlightenment campaign?	99	65.1	53	34.9
Have you ever had environmental awareness?	74	48.7	78	51.3

Attitude of the Respondents Towards Parks and Gardens in Gboko town

Results revealed in Table 6 pertaining the attitude of respondents towards Parks and Gardens. the result indicates that (61.84%) visit parks and gardens occasionally, (50.00%) of the respondents visit Parks and Gardens once or twice a month whereas (25.0%) admitted they do not visit such places. Nineteen point eight percent said they visited weekly while (10.5%) of the respondents say they visited such areas daily. When asked why they visited Parks and Gardens, (62.30%) of the respondents indicated they went there for relaxation, (26.9%) said they visited such areas with friends and family members for get together while (11.7%) said they took children there to play (Table 5).

Table 6: Attitude of the Respondents Towards Parks and Gardens in Gboko town

Frequency of Participation	Frequency	Percentage (%)
Not at all	30	19.74
Occasionally	94	61.84
Often	28	18.42
Frequency of Visit		
Once or twice a month	76	50.00
Do not visit	30	19.74
Once a week	17	11.18
Everyday	16	10.52
Weekly	13	8.56
Reason for Visitation		
Relaxation	76	62.30
Get together with friends/family	32	26.23
Bring children to play	14	11.47

Problems associated with trees in Gboko town

The respondents admitted that trees within Gboko town were exposed to a number of problems including lack of proper care/maintenance (52.60%), illegal removal of branches (41.45%) or face other forms of vandalism such as bark slashing (4.61%) as well as injury from cars, trucks and animals (1.31%) (Table 7).

Table 7. Problems associated with trees in Gboko town

Problems associated with trees	Frequency	percentage %
lack of proper care/maintenance	80	52.63
Illegal removal of branches	63	41.45
Vandalism such as bark slashing	7	4.61
Injury from cars, trucks and animals	2	1.31

DISCUSSION

Demographic Characteristics of the Respondents and their effects on the perception

The higher number of male respondents recorded in the study area was not strange as many studies (Wolf 2004, Etim *et al.*, 2012, Ezeabasil *et al.*, 2015, Shirazi and Kazmi, 2016) have also recorded high percentage of male compared to female. However, Schroeder *et al.* (2006) recorded more females; they however, stated that the value was not significant. The high proportion of respondents below the ages of 41 years shows that the respondents were dominated by youths. Flannigan (2005) also found a significant correlation between increasing age and negative perception of trees.

The result of the study is consistent with the studies of Sommer *et al.* (1989) who reported that perception of trees within their study did not relate to any demographic variable except for age, in which older householders had a lower perception of tree value than younger residents.

The findings of this study are similar to the work of Stiegler (1990) who found in his study that awareness was improved with education. All the respondents had some level of formal education. The results agree with the findings of Escobedo *et al*. (2009), in Broward, where younger, more highly educated HOA leaders were more likely to support increases in urban forests.

The result shows almost negligible diversity of 80% of the respondents shared common ethnicity. Schroeder *et al*. (2006) in their study suggested that research to investigate the possible role of culture in tree attitudes might be worth pursuing stating categorically that the species composition of urban trees varied along cultural and climatic lines. Dwyer *et al*. (1992) also suggested ties between people and trees are associated with traditions. This could be the possible underlying factor for the ranking of tree benefits.

Perceived Benefits of Urban Trees in Gboko town

The high number of perceived benefits of urban trees listed by respondents in this study is an indication that the people are aware of the value of urban trees. Many studies like that of Wolf (2004), Ajewole (2005), Joseph *et al.* (2010), Etim *et al.* (2012) and Popoola *et al* (2016) have shown that urban forestry has a lot of material, health and environmental benefits. The benefits mentioned in this study are similar to the benefits recorded by other studies (Schroeder, *et al.*, 2006; Fuwape and Onyekwelu, 2010; Etim *et al.*, 2012; Popoola *et al*., 2016; Shirazi and Kazmi, 2016, Le Tran *et al.*, 2017). Respondents' perception of trees being sources of edible fruits, fresh air and shade as highest benefits is consistent with the submissions of Fuwape and Onyekwelu, (2010) who documented that the planting and management of trees around settlements in West Africa are largely based on their nutritional, social, cultural and spiritual values other than aesthetic benefits. Study by Westphal (1993) indicates that volunteers involved in tree programs were motivated by "deep" values, such as spiritual benefits and bringing nature closer, more than by practical benefits, such as reducing noise and increasing property value. Austin (2002) however showed a shift in awareness to tangible products like fruits and timber whereas more recent studies like that of Lohr (2004) showed higher recognition of ecosystem values. According to Babalola (2010), whereas the major focus of urban forestry in developing countries was to manage urban forests for aesthetic purpose, current urban forestry is now majorly managed for ecosystem service. Ecosystem values like provision of shade and fresh air ranked high in the results. This study however showed that benefits such as "noise reduction" and "wildlife habitat" were scarcely known by the residents. Benefits generally outweighed perceived problems. The no variation in awareness about the benefits of urban forestry in the study was consistent with the study of Sommer *et al.* (1989) who reported that perception of trees within their study did not relate to any demographic variable except for age, in which older householders had a lower perception of tree value than younger residents.

Problems Posed by Trees in Gboko town

Respondents' perception of problems posed by trees was generally low compared to benefits, indicating that residents generally did not consider them to be reasons enough not to have trees in their neighborhoods. This is similar to findings of Lohr *et al.* (2004) in USA. Other studies like Sommer *et al.* (1994) and Schroeder *et al.* (2006) have also admitted there are problems associated with trees, but they all consistently considered these problems to be inconsequential- the problems are insufficient to justify not having trees in urban areas. The number of problems listed in this study area is similar with other works by Lohr *et al.*, (2004); Faleyimu *et al., (*2014); Ezeabasil *et al.,* (2015). The ranking of "roots to damage houses" as one of the most perceived problems is similar to the work of Lohr *et al.* (2004). This could be attributed to the fact that people attach much value to their homes and anything that threatened their houses will form a major problem to them. Roose (1986) as cited Ezeabasil *et al.*, (2015) however argued that the magnitude of damage attributed to urban forestry will depend on the proximity of trees to properties/foundation, land clearing and post clearing soil management methods employed. Schroeder *et al.* (2006) also suggested proximity of trees to houses may contribute to variation in attitudes towards trees. This could be the possible reason for the respondents' ranking of 'fallen leaves littering the environment' as a more highly perceived problem than "roots damages houses" the second possible reason being that while the later occurs slowly probably in years, the former is a frequent challenge that requires daily labour.

Attitude of Respondents towards Urban Forestry in Gboko town

Despite perceived problems, Gboko residents showed positive attitude towards trees around them. Contrary to the "*I love trees but…"* phenomenon described by the UK arborists Dobson and Patch (1997) as Cited by Schroeder *et al.* (2006) who characterized the public's attitude with one of the most heard UK cries 'I like trees, but not in front of my house'. Gboko residents did not only advocate for more trees within their town, but desired more trees in their neighborhoods, calling for better maintenance of existing ones. They expressed willingness to volunteer time to participate in public enlightenment campaigns and similar urban forestry activities. This is similar to the work of Le Tran *et al.* (2017) in Atlanta USA where respondents were willing to pay various sum of money to promote urban forestry. Adekunle and Agbaje (2012) in their study in Ogun State Nigeria report that people were willing to contribute their income to development of forest. Zhang and Zheng, (2011) in their study revealed that people were willing to pay for the development of urban forestry, this was however depends on their level of awareness of the benefits of urban trees. This is however, contrary to the finding of Ajewole (2015) in Lagos, Nigeria where most of the respondents were not willing to get involved in urban forestry development.

The study however showed residents' attitude towards other forms of urban forestry such as Parks and Gardens was not encouraging as good number of the respondents admitted they have never visited a Parks and Gardens. This could be because there is only one Park in the town which at present lies dilapidated, also this could be due to the fact that the National Urban Park Development Programme, only pay attention to capital cities at detriment of other fast growing cities like Gboko.

Problems Faced by Trees in Gboko town

The listed problems faced by trees in the study area as recorded in this study were similar to those state by in the work of Ajewole, (2008) in Nigeria. Vandalism through bark slashing mentioned as one of the problems is an indication of limited availability of certain species with special uses such as those for medicinal purposes. Whereas the damage from cars/animals as well as lack of proper care/maintenance can be attributed to lack of environmental law enforcement.

CONCLUSION

The study has shown that Gboko residents are aware of the benefits and challenges associated with urban forest. However, their knowledge is limited as greater percentage of them seems not to be aware of the more recently considered benefits such as noise pollution reduction and habitats for wildlife. It was established that urban trees in the area like other cities in Africa are not well cared for. Local Government Areas, State and Federal Governments in Nigeria should rise to their duties in urban forestry development in the study area.

REFERENCE

Adekunle, M. F and Agbaje, B. M. (2012). Public willingness to pay for ecosystem service functions of a peri-urban forest near Abeokuta, Ogun State, Nigeria. *Journal of Development and Agricultural Economics* 4(2): 45-50, 26

Ajewole, O.I.(2008) Prospects and challenges for incorporating trees into urban infrastructural developments in Nigeria, *International Journal of Sustainable Development & World Ecology*, 15:5, 419-429, DOI: 10.3843/SusDev.15.5:3

Ajewole, O.I. (2015). Public Willingness to Commit Time to Urban Forestry Development in Lagos Metropolis, Nigeria . *Journal of Agriculture and Social Research (JASR)* 15(1) 46-68

Akpen, G. D. Kpoghol, I. S. and Oparaku, L. A. (2018). Quality Assessment of Sachet and Bottled Water Sold in Gboko, Benue State, Nigeria. *Nigerian Journal of Technology*, 37(1): 241 – 248

Austin, M.E. (2002). Partnership opportunities in neighborhood tree planting initiatives: Building from local knowledge. *Journal of Arboriculture* 28:178–186.

Babalola F.D (2010): Issues and option for appropriate management strategies of campus tree at university of Ibadan, Nigeria. Nigerian *Journal of Ecology*. 11:33-42.

Dwyer, J. F., McPherson, E. G., Schroeder, H. W.and Rowntree, R. A. (1992). Assessing the benefits and costs of the urban forest. *Journal of Arboriculture*, *18*(5), 227-234.

Escobedo, F.J., Luley, C.J., Bond, J., Staudhammer, C. and Bartel, C. (2009). Hurricane debris and damage assessment for Florida urban forests. *Journal of Arboriculture*, 35(2): 100–106

Etim, J. D., Umazim U. A. and Ufot, I.N. (2012). Awareness and Perception of Urban Forestry among Urban Dwellers in Sahel Savannah Region of Nigeria. *Journal of Biodiversity and Ecological Sciences*, 2(4):236-243

Ezeabasili, A. C. C., Iloghalu, . I. E., Okoro, B. U. and Manafa, I. F. (2015). Sustainable Urban Forestry in Nigerian Built Environments, *Journal of Scientific Research and Reports*, 5(7): 524-531.

Faleyimu, O. I. (2014). Public perceptions of Urban Forests in Okitipupa Nigeria: Implication for Environmental Conservation. *Journal Applied Science and Environmental Management* 18(3):469-478

FAO, (2016). State of the World's Forests 2016. Forests and agriculture: land-use challenges and opportunities. Rome

Flannigan, J. (2005).. An evaluation of residents' attitudes to street trees in southwest England. *Arboricultural Journal* 28:219–241.

Fuwape, J.A. and Onyekwelu J. C. (2010) Urban Forest Development in West Africa: Benefits and Challenges. *Journal of Biodiversity and Ecological Science*, 1(1): 76-94

Le Trana, Y., Sirya, J. P., Bowker, J.M. and Poudyal, N. C.(2017). Atlanta households' willingness to increase urban forests to mitigate climate change. *Urban Forestry and Urban Greening*, 22: 84–92

Lin, S. Sun, J. Marinova, D. and Zhao, D. (2017). Effects of Population and Land Urbanization on China's Environmental Impact: Empirical Analysis Based on the Extended STIRPAT Model. *Sustainability* , 9, 825; doi:10.3390/su9050825

Lohr, I. V., Pearson-Mims, C. H., Tarnai, J., & Dillman, D. A. (2004). How urban residents rate and rank the benefits and problems associated with trees in cities. *Journal of Arboriculture*, 30(1), 28-34.

Okunlola, A. I. (2013). Sustainable Environmental Management through Urban Public Park in Southwestern Nigeria. *Journal of Agricultural Science*, 2(3): 074-079

Poopola, A.A., Medayese, S.O. , Olaniyan, O.M , Onyemenam, P.I and Adeleye, B.M (2016). Users' Perception of Urban Parks and Green Networks in Ibadan. *Singaporean Journal of Business Economics, and Management Studies*,4(10)16-30

Oyebade, B.A., Popo-ola, F.S. and Itam E.S. (2016). Perception of Urban Dwellers about the Benefits and Management of Urban Trees in Uyo Metropolis, Akwa Ibom State, Nigeria. *ARPN Journal of Science and Technology*, 3(7): 767-772

Ritchie, H. and Roser, M. (2018). Urbanization. Accessed on 8/09/2019 from *ourworldindata.org.*

Schroeder, H., Flannigan, J. and Coles, R. (2006). Residents' attitudes toward street trees in the UK and U.S. communities. *Arboric. Urban For.* 32, 236–246

Shirazi, S.A. and Kazmi, J.H. (2016) Analysis of socio-environmental impacts of the loss of urban trees and vegetation in Lahore, Pakistan: a review of public perception. *Ecological Processes* 5:5 DOI 10.1186/s13717-016-0050-8

Sommer, R., Barker, P.A., Guenther, H. and Kurani. K. (1989) . Householder evaluation of two street tree species. *Journal of Arboriculture 15:99–103.*

Sundara, D. M., Hartono , D. M., Suganda , E, and Herman Haeruman J.S (2017). Urban Forests for Sustainable Urban Development . Proceedings of the 3rd International Conference on Construction and Building Engineering (ICONBUILD) 2017 AIP Conf. Proc. 1903, 040002-1–040002-5; https://doi.org/10.1063/1.5011521 Published by AIP Publishing. 978-0-7354-1591-1/$30.00

Westphal, L.M. (1993). Why trees? Urban forestry volunteers values and motivations. pp. 19–23. In: P.H. Gobster (Ed.). Managing Urban and High-use Recreation Settings. USDA Forest Service General Technical Report NC-163. North Central Experiment Station, St. Paul

Wolf, K.L.(2004). Public value of nature: economics or urban trees, parks and open space. In: Miller, D., Wise, J.A. (Eds.), Design with Spirit: Proceedings of the 35th Annual Conference of the Environmental Design Research Association. Environmental Design Research Association, Edmond, OK, . 88–92.

Zhang, Y. and Zheng, B. (2011). Assessments of Citizen Willingness to Support Urban Forestry. *Arboriculture and Urban Forestry*, 37(3): 118–125

Zhao, J.; Xu, W.; Li, R. (2017). Visual preference of trees: The effects of tree attributes and seasons. *Urban For.Urban Green* 25, 19–25.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Adeniji et al., 2019

SEED GERMINATION AND SEEDLING GROWTH OF *Ceiba Pentandra* (L) AS INFLUENCED BY DIFFERENT SOIL TYPES IN IBADAN, SOUTHWEST NIGERIA

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ABSTRACT

Ceiba pentandra is a fast growing multipurpose tree with great socio-economic potentials. It is known to be used majorly for timber and its fibre. Lately, it has been documented to have medicinal properties as it has been used to treat leprosy, conjunctivitis, fever, trypanosomiasis among others. Its high value in plywood manufacturing has caused its increased rate harvesting. Natural regeneration efforts have been found to be insufficient and minimal information is available on its nursery requirements. This study was conducted to evaluate the effort of sowing media on its germination and early seedling development. Viable C. Pentandra seeds were sown in polythene bags filled with 5kg each of topsoil (TS), Clay soil, Humus Soil (HS) and Sterilized river sand (RS). The sterilized river sand (RS) served as control. Four weeks after sowing (4WAS), thinning was done and data taken up to a period of 6 months. Pots filled with sterilized River Sand (RS) showed the first radical emergence 3 days after sowing (DAS) followed by the topsoil (TS) which emerged on the 4th day. The first 1radical emergence occurred in clay soil (CS) 7 days after sowing (DAS) while it occurred in humus soil (HS) on the eighth day. All the sowing media gave 100% germination at the end of 14 days. This study showed that both humus and top soils are the best media to use in the nursery establishment of C. pentandra.

Keywords: seed germination, sowing media, effect, nursery,

INTRODUCTION

Ceiba pentandra is a deciduous, gigantic, fast-growing tree, it can grow up to 25-70m in height with a diameter of 100-300 cm; it was reported to be among the largest trees in the world.The most used common name for the tree is Kapok or white silk-Cotton tree. In Nigeria it is called *Araba* in Yoruba, *Rimi* in Hausa and *Akpu-ogwu* in Igbo language (Mojica *et al*., 2002; Chaiarrekij *et al*., 2011).

Ceiba pentandra has two main uses, being an important source of fibre and of timber. Formerly, it was best known for the fibre produced by its fruit. The floss derived from the inner fruit wall is used for stuffing cushions, pillows and mattresses, and for insulation, absorbent material and tinder (Bates 2004; Orwa*et al*., 2009; Chairrekij*et al*., 2011). The use of kapok fibre declined in the late 20th century after the introduction of synthetic substitutes. However, there is a renewed interest in the potential of kapok. Currently, the main use of *Ceiba pentandra* is as a source of timber. The wood trade name is *fuma ceiba* and is mostly used in plywood manufacturing, but also for making boxes and crates, and for lightweight joinery.(Orwa*et al*., 2009). *Ceiba pentandra* finds wide application in African traditional medicine, The root forms part of preparations to treat leprosy, Stem bark decoctions are used in mouth washes for treating toothache and mouth problems, A decoction of the leaves is applied to treat conjunctivitis and wounds in the eye, and is used for bathing and massaging to treat fever, In veterinary medicine a decoction of the leaves is given to treat trypanosomiasis among others (Friday *et al*., 2011). *C. pentandra* has a place in folktale, it is considered to be a sacred plant and its image is used as the national emblem of Guatemala, Puerto-Rico and Equatorial Guinea. It appears on the coat of arms and flag of Equatorial Guinea.

Ceiba pentandra has high value in plywood manufacturing which caused increased rates of harvesting and the use of the tree will probably intensify in the near future. Natural regeneration may be insufficient to sustain its increased use as a source of timber, while minimal efforts have been undertaken to develop plantations in tropical Africa. Young plants can be grown in a nursery and be transplanted into the field when they are 4–10 months old. However, there is dearth of information on its requirement in the nursery. Therefore an experiment was carried to evaluate the effects of sowing media on germination and early seedling development of *Ceiba petandra.*

Plate 1: *Ceiba pentandra* Seeds and Fruits

MATERIALS AND METHODS

Processed seeds of *Ceiba petandra* obtained from the Seed Store of Forestry Research Institute of Nigeria were used for the experiment. Floatation method was used to determine the viability of the seed before sowing (Pleters, 1954). Five kilogram capacity polythene bags were filled with 5 kg each of different sowing media of topsoil (TS), clay soil (CL) and humus soil (HS) while sterilized river sand (RS) served as the control. The experiment was laid in a Completely Randomized Design (CRD) and it was replicated four times.

Media were watered to field capacity and five seeds were sown per pot. The experimental set up was monitored daily and number of days to first seedling emergence, interval between first and last emergence and percentage germination were recorded and /or calculated .At four weeks after sowing (WAS), seedlings in polypots were thinned to one seedling per pot leaving the most vigorous seedling in the pot. Growth parameters assessed included: stem height, number of leaves, stem circumference were hence forth accessed for six months. All data obtained were analysed and significant means were separated using Duncan multiple range test (DMRT) at 5% level of probability.

RESULTS

Seedling Emergence: Result showed that first seedling emergence was observed in river sand on the 3rd day after sowing and the interval between 1st and last emergence of seedling emergence was 7days with 100% germination count. Emergence was observed in top soil on the 4th day after sowing; seedling emergence lasted for 9 days also with 100% germination count. At 7 days after sowing, emergence was observed on clay soil. The internal between the 1st and last emergence was 13 days with 100% germination count. Emergence on humus soil was on the 8th day after sowing and lasted for 11 days with 100% germination count (Table 1).

Growth parameters

Stem Height: The greatest height was recorded for top soil in the first month of observation (23.95cm) but without significant difference compared to height observed in other treatments (Table 2).-A similar trend was observed in the 2nd month of observation in which topsoil had the greatest height (29.28cm) but with a significant difference between the heights obtained from other treatments. In the third month of observation, plant height was still highest in top soil (47.05 cm) but without significant differences between the heights observed in humus soil (29.10 cm) and that of river sand (26.30 cm). Height observed in river sand and humus were also not significantly taller than—those observed in seedlings planted on top soil and river sand which were similar at 4th month of observation. The least height was observed in seedlings raised on clay soil and river sand. This trend was observed on the 5th and 6th month of observation (Table 2).

Number of Leaves: The highest mean number of leaves was produced from seedlings raised on top soil (7.50) and the least number of leaves was recorded from seedlings raised on clay soil (2.75). The leaf count from seedlings raised on river sand and top soil were not significantly different from each other but significantly differed and were lower than that of top soil and higher than clay soil. A similar trend was observed in the 2nd month of observation but without significant difference in leaf count of seedlings from river sand and clay soil. By the 6th month of observation, the highest leaf count was observed from seedlings raised on top soil (22.25) followed by humus soil (18.50). The least leaf count was from seedlings raised on clay soil (Table 3).

Stem Circumference: The result obtained on stem circumference showed that top soil produced plant with the largest stem circumference (1.13cm) which was significantly higher than other treatments (Table 4).A similar trend was observed in the 2nd month. By the 3rd month of observation, seedlings grown in river sand and humus soils had also increased in their circumference significantly but this was lower than seedlings from top soil and higher than clay soil. At 4 months after sowing, seedlings grown in top soil and humus had the highest stem circumference while those in river sand and clay soil had the least with significant difference at 5% probability level (Table 4).

Table 1: Effect of sowing media on germination of *Ceiba petandra*

Treatment	Number of days to first seedling emergence	Interval between first and last germination	Percentage germination (%)
RS	3	7	100
CS	7	13	100
HS	8	11	100
TS	4	9	100

Means with the same alphabet are not significantly different from each other at 5% probability level
CS= Clay soil RS= River Sand HS= Humus soil TS= Top soil

Table 2: Effect of sowing media on stem height of *Ceiba petandra*

Treatment	Months of Assessment					
	1	2	3	4	5	6
CL	13.47a	18.30a	21.08a	26.75a	26.55a	28.63a
RS	17.70a	20.90a	26.30ab	30.25a	35.70a	40.45a
HS	17.70a	21.13a	29.10ab	49.25b	66.76b	75.00b
TS	23.95b	29.28b	47.05b	57.00b	70.63b	84.00b

Means with the same alphabet are not significantly different from each other at 5% probability level
CL= Clay soil RS= River Sand HS= Humus soil TS= Top soil

Table 3: Effect of sowing media on number of leaves *Ceiba petandra*

TRT	Months of Assessment					
	1	**2**	**3**	**4**	**5**	**6**
CL	2.75a	5.25a	7.50a	9.75a	11.50a	12.25a
RS	4.50b	6.75ab	9.75ab	10.00a	12.50a	14.00a
HS	4.50b	7.25b	11.75bc	13.75b	16.50b	18.50b
TS	7.50c	10.00c	13.75c	17.75c	20.75c	22.25b

Means with the same alphabet are not significantly different from each other at 5% probability level
CL= Clay soil RS= River Sand HS= Humus soil TS= Top soil

Table 4: Effect of sowing media on stem circumference (cm) of *Ceiba petandra*

Treatment	Months of Assessment					
	1	**2**	**3**	**4**	**5**	**6**
CL	0.73a	0.95a	1.43a	1.90a	2.18a	2.30a
RS	0.75a	1.05a	1.60ab	2.18a	2.38a	2.65a
HS	0.88a	1.13a	1.93b	3.13b	4.10b	4.50b
TS	1.13b	1.75b	3.05c	3.40b	4.18b	4.65b

Means with the same alphabet are not significantly different from each other at 5% probability level
CL= Clay soil RS= River Sand HS= Humus soil TS= Top soil

DISCUSSION

The earliest seeds emergence observed on river sand may be attributed to the fact that river sand which is a sandy soil are loose in nature which permits easy penetration of water and easy of emergence of plumule. (Jawayria *et al.*, 2018). The relatively late emergence and longest interval between germination observed on clay soil may be attributed to the compact nature of clay and humus soil used for the experiment.

The greatest height was observed in top soil and humus maybe due to the fact that fertilised soil significantly promote growth of plant compared to soil with less fertility This was corroborated by Fashina *et al*. (2002) and Roy *et al*., (2010) who reported that fertilised plants performed better than unfertilised ones. The increase in number of leaves observed from seedlings raised on top soil and humus may be been due to the nutrients availability to the plants. As stated by Garg and Kumar (2012), favourable soil environmental conditions increased the nutrient availability and water holding capacity of the soil resulting in enhanced plant growth.

CONCLUSION

The study revealed that 100 percent germination was recorded for all soil types used in the experiment. Earliest seeds emergence was on river sand and shortest interval between germination was also on river sand. *Ceiba petandra* sown in topsoil displayed the best performance in seedling growth.

Recommendations

It is therefore recommended based on this study that for optimum performance, the seeds of *Ceiba petandra* should be sown in either

i. topsoil and/or
ii. humus , because these soil types displayed the best performance in seedling growth and can be adopted for *Ceiba petandra production* in the nursery

REFERENCES:

Bates, D.M. (2004). Malvales. Encyclopaedia Britannica 2004, CD version

Chaiarrekij, S., Apirakchaiskul, A., Suvarnakich, K. and Kiatkamjornwong, S. (2011). Kapok: Characteristics fibre as a potential pulp source for paper making. Bio resources, 7(1): 475-488.

Fashina, A. S., Olatunji, K. A. and Alashiri, K. O. 2002. Effect of different and poultry manure on the yield of ugu (*Telfaira occidentalis*) in Lagos state Nigeria. *In. Proceedings of the Annual Conference of Horticultural Society of Nigeria.* 75-82s

Friday E.T., Omale J., Olupinyo O, Adah G. (2011). Investigations on the nutritional and medicinal potentials of Ceiba pentandra leaf:

A common vegetable. *International Journal of Plant Physiology and Biochemistry*, vol 3, pp 95-101.

Garg, J and Kumar,A.(2012). Effects of different soil types on growth and productivity of *Euphorbia larthyris:*A hydrocarbon plant.*International Journal of life science*, 2.164-173.

Jawayria, A. R., Muhammad, ,Z. I. and ,Muhammad,S.(20118).Effects of soil types on seedling growth of *Pisium sativum. Insight Botany*,8;1-5

Mojica, E.R.E.; Merca, F.E., Micor, J.R.L. (2002). Fiber of kapok (Ceiba pentandra) as component of a metal sensor for lead in water samples. Philippine Journal of Crop Science, 27(2): 37-42

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Anthony, S. (2009). Agroforestree Database: a Tree Reference and Selection Guide Version 4.0. World Agroforestry Centre, Kenya.

Pleters A.J. 1954, Testing Seeds At Home. Divisio of Botany, U. S. Department of Agriculture, https://naldc.nal.usda.gov

Roy, S. S. and Hore, J. K. (2010). 'Vermiculture can be practice in all plantation crop' A report of the Department of Spices and Plantation Crop, Faculty of Horticulture, University of Agriculture Nadia, West Bengal. I6

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Kolade and Adejumo, 2019

EVALUATION OF REVENUE CHANNELS AND CHALLENGES IN OSUN STATE FORESTRY SERVICE, NIGERIA

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ABSTRACT

Forest revenue system is a tool for obtaining maximum benefits from the management of forest resources, meanwhile its collection has been inadequate and lack proper coordination of achieving sustainable production of forest resources in Osun State. Therefore, various tapped and untapped revenue channels, challenges associated with effective collection and remittance were investigated. A total of 113 forest officials were identified and reached (100%) in all the forestry administrative zones in Osun State, including the headquarters through a set of questionnaire: Ilesa (21), Ile-ife (26), Ikirun (14), Ikire/ Iwo (28) and Headquarters in Osogbo (24). Secondary data were also collected. Data were analyzed using descriptive statistics and logit regression at $\alpha_{0.05}$. The average age of the respondents was 35±8.4 years, mostly male (67%) and had tertiary education (44%). Identified tapped revenue channels included timber tariff and firewood permit, while untapped revenue channels identified were gravel/sand's evacuation and harvesting of Non-Timber Forest Products. Challenges confronting effective collection included improper law enforcement, location of resources and executive fiat with odds-ratio of 8.60, 3.52 and 1.70 respectively. Problems facing adequate revenue remittance included printing of fake receipts, improper remittance by the account staff, and inadequate mobility of field staff and lack of incentives for field officers with odds-ratio of 13.10, 3.30, 3.13 and 2.62 respectively. The study revealed various untapped revenue channels; it is therefore necessary for the State forestry service to utilize these sources to improving the revenue inclination in the State and also address the identified challenges facing collection and remittance.

Keywords: Revenue channels, Revenue Collection, Revenue remittance, untapped sources, Tapped sources

INTRODUCTION

A Variety of resources abound in the forests and they include soil and its mineral deposits, water sources, rocky outcrops, rare landscapes and in the biological sense, plant and animals in all their various forms. The forest is therefore an important component of man's environment and if properly managed, can provide myriad benefits like sources of foreign exchange earnings, employment, housing materials etc. (Arifalo, 1990). These resources are important because of the value that society attaches to them.

Timber, for example, is universally enjoyed for its varying and various functions. Although fruits, fungi, herbs, bees and other non- timber do not enjoy the universality and the versality of Timber but they are also important. There is therefore, a wide range of demand for these resources and consequently, differences in the sales level and the charges attached to them. The sale of forest resources is one of the major ways in which government interacts closely with the people through the generation of economic, social and cultural activities. These activities become the source of employment for timber contractors, tree takers, saw millers, timber lorry drivers, machine operators, log rolling crew, timber clerks and gatherers of non-wood forest products (Ajayi and Omoluabi, 1993).

The forest revenue system is an instrument used by government to achieve various goals and objectives in forest management. The objectives of the forest revenue system play a significant role in the choice of models for fixing charges on forest products and services (FAO, 2001). FAO, (2001) also stated that the first forest charges were introduced into Nigeria during the colonial era, with the aim of discouraging farmers from destroying trees as part of their shifting cultivation activities. The various states in Nigeria operate different types of charges, the main ones of which are; stumpage fees; out-turn volume fees and unit area charges. There are also charges levied on different types of machinery used in the forest industry and charge on the production of non-wood and minor forest products. The level of these charges varies from state to state and from species to species.

Other charges on forestry sector include; development levies, contractors' registration fees, application fees, ground rent and property hammer (pass hammer/registration fees, charge on pole production, non-wood fuel wood charges, license fees and forest recreation fees and penalty for -food offences. Some revenue is also derived from fines and auctioning of confiscated products and minor forest product charges. The administration of forest charges is the responsibility of the state forestry services, while the government has the power for approval.

In Nigeria, Osun State can be considered as one of the States endowed with large quantum of forest resources which when harnessed could support a wide range of economic activities in the state in particular and Nigeria in general; hence the importance of forestry in the state is extensive. The historic Shasha forest reserve in the State has made valuable contributions to the development of the economy of the State. Therefore, this paper revealed both the tapped and untapped promising revenue channels in Osun State forestry service, identified challenges confronting effective revenue collection and problems facing adequate remittance, with a view to suggesting mitigations' strategy towards adequate revenue generation in the state.

MATERIALS AND METHODS

Study Area

The study area is Osun State, located in the Southwestern geo-political zone (Figure 1). The state had eleven legacy forest reserves which fell within her boundaries, after she was carved out of the then Oyo state. Only eight of these reserves are still in existence. It borders to Kwara state to the North and Ogun state to the south, Oyo to the West and Ekiti to the East. Osogbo is the capital of the state. Osun State lies within Latitude $7^{o}\,0^{'}\,0^{''}$ N and $8^{o}\,0^{'}\,0^{''}$ N, and Longitude $4^{o}\,10^{'}\,0^{''}$ E and $5^{o}\,10^{'}\,0^{''}$ E. The State has population of about three million, four hundred and twenty-three thousand, five hundred and twenty-five people (3,423,525) (NPC, 2006). The climate of the area is a tropical type with two prominent seasons, the rainy and dry seasons. The dry season is short, usually lasting 4 months from November to March and the longer rainy season prevails during the remaining months. The annual rainfall averages 1413 mm in a 5-year survey.

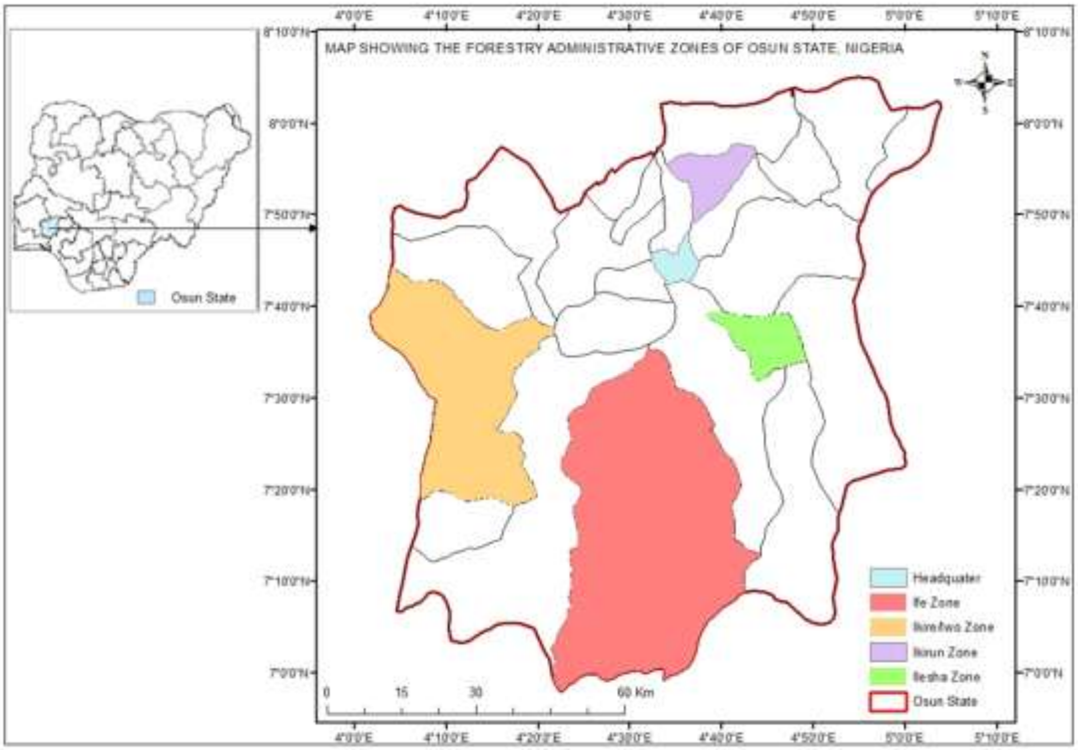

Figure 1: Map Showing the Forestry Administrative Zones of Osun State, Nigeria

Sampling Procedure

The target population for the study was core forestry officials in the Headquarters and all the forestry administrative zones in Osun State forestry service. This included the uniform, technical and professional staff.

A total of 113 forest officials were identified in all the forestry administrative zones and headquarters in Osun State: Ilesa (21), Ile-ife (26), Ikirun (14), Ikire/ Iwo (28) and Headquarters in Osogbo (24). A complete enumeration (100%) was done in which a total of 113 structured questionnaire were administered to the respondents in the study area. However, 110 copies questionnaire were retrieved from the field which represents 97.3% returns. Secondary data were also collected where necessary. Precisely, data on tapped forest revenue channels in the state.

Data Analysis

Data collected were subjected to descriptive statistics and Logit regression analysis (Inferential statistics).

Logistic regression

The binary logistic models are very useful in a situation whereby the dependent or response variable is binary in nature. This implies that they can have only two possible values. The models therefore describe the relationship between one or more continuous independent variable(s) to the binary dependent variable. The two common binary models are the logit and probit. The logistic model is particularly preferred because of the unique information it provides. Distinct information provided by logit is the odds ratio. It is defined as the ratio of the odds of an event occurring in the group to the odds ratio of it occurring in another group (Deeks, 1996 and Davies, 1998). The logistic model of a response p between 0 and 1 is given as:

$$\text{Logit}(p) = \log\left(\frac{p}{1-p}\right) = \log(p) - \log(1-p) \text{ ---1}$$

The simplest form of logistic model is expressed as:

$$\text{Logit}(p_i) = a + bx_1 + \ldots + bx_8 \text{ ---------------- 2}$$

Challenges Confronting Effective Revenue Collection

Where:

P_i = Probability of an effect on challenges confronting effective revenue collections in Osun State (Dependent variable)

x_i = vector of predictor or independent variables

a and b = regression parameters

The independent variables are:
X1= dummy variable indicating whether payment of cash (PC) has been a challenge responsible for ineffective revenue collection in the study area or not.
X2= dummy variable indicating whether insincerity of field staff (IFS) has been a challenge responsible for ineffective revenue collection or not.
X3= dummy variable indicating whether transportation of field officers (TFO) has been a challenge responsible for ineffective revenue collection or not.
X4= dummy variable indicating whether inadequate communication networks (ICN) has been a challenge responsible for ineffective revenue collection or not.
X5= dummy variable indicating whether inability of field officers to withstand armed illegal fellers (AIF) has been a challenge responsible for ineffective revenue collection or not.
X6= dummy variable indicating whether the location of resources (LR) has been a challenge responsible for ineffective revenue collection or not.
X7= dummy variable indicating whether executive fiat (EF) has been a challenge responsible for ineffective revenue collection or not.
X8= dummy variable indicating whether lack of proper law enforcement (LPLE) has been a challenge responsible for ineffective revenue collection or not.

Problems Facing Adequate Revenue Remittance
Pi = Probability of an effect on problems facing adequate revenue remittance in Osun State (Dependent variable). The independent variables are:
X1= dummy variable indicating whether remittance by field staff (RFS) has been a problem responsible for inadequate revenue remittance or not.
X2= dummy variable indicating whether remittance by account staff in the headquarters (RAS) has been a problem responsible for inadequate revenue remittance or not.
X3= dummy variable indicating whether involvement of field officers in printing of fake receipts (PFR) has been a problem responsible for inadequate revenue remittance or not.
X4= dummy variable indicating whether lack of provision of incentives for running cost by the government (LPI) has been a problem responsible for inadequate revenue remittance or not.
X5= dummy variable indicating whether lack of provisions for mobility of field staff (revenue collector) so as to remit collected revenue on time (MFS) or not.
X6= dummy variable indicating whether inaccessibility of banks by field officers (BEA) has been a problem responsible for inadequate revenue remittance.

RESULTS
Table 1 showed the demographic characteristics of the respondents. Information on gender revealed that 67% of the respondents were male, while 43% were female. The average age of the respondents was 35± 8.4 years. The study on marital status of the respondents revealed that more than half of the population of the respondents were married (51.8%) while 43.6% were single. Information on the respondents' educational status revealed that 44% of them had tertiary education, while 40% had primary education. Lastly, it was gathered that majority of the respondents had worked for a period of 1-5 years (48.2%) and 6-10 years (48.2%).

Table 1: Demographic Characteristics of Respondents

Demographic Characteristics	Frequency	Percentage (%)
Sex		
Male	67	60.9
Female	43	39.1
Total	**110**	**100**
Age		
21-30	36	32.7
31-40	50	45.5
41-50	18	16.4
51-60	6	5.5
Total	**110**	**100**
Marital Status		
Single	48	43.6
Married	57	51.8
Divorced	3	2.7
Widowed	2	1.8
Total	**110**	**100**
Educational Distribution		
No Formal Education	7	6.4
Primary Education	40	36.4
Secondary Education	19	17.3
Tertiary Education	44	40.0
Total	**110**	**100**
Work Experience (Years)		
1-5	53	48.2
6-10	53	48.2
>10	4	3.6
Total	**110**	**100**

Source: Field Survey, 2019.

Tapped Revenue Channels

Below is the list of tapped revenue channels in Osun State Forestry Service.

List of Tapped Revenue Channels in Osun State Forestry Service

1. Tarriff on timber exploitation (Both in free areas and forest reserves).
2. Payment for tariff on plot allocation basis.
3. Tariff on bamboo extraction
4. Issuance of permit for firewood collection.
5. Tariff on Taungya farming.
6. Issuance of hunting permit.
7. Sales of application form for property hammer (Timber mark)- For log and flitching
8. Registration and Renewal of property hammer.
9. Registration and renewal of sawmill license of operation (Yearly renewal fee).
10. Registration and renewal of planing/ circular machine (Yearly renewal fee).
11. Registration and renewal of power saw.
12. Evacuation schedule- It varies from one place to another, depending on quantity loaded.
13. Revenue made from interstate wood transportation.
14. Payment of fines by the offenders (Penalties for breaking of laws).
15. Revenue generated through Central Log Control (CLC) unit- A monitoring unit for evacuated logs charged with the responsibility of seizure and imposition of fine on certified logs.
16. Revenue generated through State Task Force (STF) - A general monitoring unit for law enforcement empowered to seize illegally evacuated forest products and imposition of fine accordingly.

17. Control post (checking) within the State and Inter-state.
18. Sales of seedlings.

Source: Osun State Forestry Service, 2019.

Untapped Revenue Channels

The responses of the respondents towards untapped revenue channels in Osun State Forestry Service were indicated in Table 2. The table showed that harvesting of Non-Timber Forest Products (60%), Timber extraction, processing and marketing (30%) and conversion of wood charcoal (10%) were the prominent ones among them.

Table 2: Untapped Revenue Channels in Osun State Forestry Service

Untapped Revenue Channels	Frequency	Percentage (%)
1. Evacuation of gravel and sand in the reserves.	5	4.54
2. Conversion of wood to charcoal.	10	9.10
3. Harvesting of Non-Timber Forest Products (NTFPs).	60	54.55
4. Timber extraction, processing and marketing	30	27.27
5. Effective monitoring of fishing activities in the water bodies in forest reserves.	5	4.54
Total	**110**	**100**

Source: Field Survey, 2019.

Challenges Confronting Effective Revenue Collection

Logit Regression Model for Challenges Confronting Effective Revenue Collection in Osun State Forestry Service

The binary models

Binary regression models obtained for the challenges confronting effective revenue collection in Osun State Forestry Service (Table 3).

$CCERC = 3.07 - 3.13PC - 2.07IFS + 0.17TFO - 0.79ICN - 0.43AIF + 1.26LR + 0.50EF + 2.15LPLE$---------- 3

Model presented above for Osun State Forestry Service gave overall significant fit to the data judging from χ^2 value that was significant at p<0.05. Lack of Proper Law Enforcement (LPLE) had the highest odd-ratio of 8.60 followed by Location of Resources (LR) with the odd-ratio of 3.52 and Executive Fiat (EF) with the odd-ratio of 1.70 respectively. Therefore, the factors identified to be responsible for ineffective revenue collection in Osun State were Lack of Proper Law Enforcement (LPLE), Location of Resources (LR) and Executive Fiat (EF) i.e undue political influence.

Table 3: Logit Binary Nature of Challenges Confronting Effective Revenue collection in Osun State Forestry Service

Dependent variable	Coefficient	Odds-ratio
PC	-3.13	0.04
IFS	-2.07	0.13
TFO	0.17	1.20
ICN	-0.80	0.45
AIF	0.43	0.65
LR.	1.30	3.52*
EF	0.50	1.70*
LPLE	2.15	8.60*
Model χ^2 (df, 8) = 79.72, Final loss= 36.31; P<0.05		

*Significant at p<0.05; ns= Not significant; Dependent variable (CCERC) = Challenges Confronting Effective Revenue Collection in Osun State Forestry Service (Yes= 1), (No= 0)

Problems Facing Adequate Revenue Remittance

Logit Regression Model for Revenue Remittance Adequacy in Osun State Forestry Service

The binary models

Binary regression models obtained for the Revenue Remittance Adequacy in Osun State Forestry Service (Table 4)

ARRP= -3.17- 1.80RFS+ 1.18RAS+ 2.60PFR+ 1.00LPI+ 1.14MFS- 0.80BEA ---------- 4

Model presented above for Osun State Forestry Service gave overall significant fit to the data judging from χ^2 Value that was significant at p<0.05. Printing of Fake Receipt (PFR) by field officers had the highest odd-ratio of 13.10 followed by Remittance by the Account Staff (RAS) with odd-ratio of 3.30, Mobility of Field Staff (MFS) with the odd-ratio of 3.13 and lastly, Lack of Provision for Incentives (LPI) for field officers with the odd-ratio of 2.62 respectively.

Therefore, the factors identified to be responsible for inadequate revenue remittance in Osun State forestry service were Printing of Fake receipt (PFR) by field officers in-charge of revenue collection, improper Remittance by the Account Staff (RAS), Lack of adequate Mobility for Field Staff (MFS) and Lack of Incentives (LRI) for field officers.

Table 4: Logit Binary Nature for Revenue Remittance Adequacy in Osun State Forestry Service

Dependent variables	Coefficient	Odds-ratio
RFS	-1.80	0.02
RAS	1.18	3.30*
PFR	2.60	13.10*
LPI	1.00	2.62*
MFS	1.14	3.13*
BEA	-0.80	0.50
Model χ^2 (df, 6) = 16.11, Final loss= 22.56; P<0.05		

***Significant at p<0.05; ns= Not significant; Dependent variable (ARRP) = Problems Facing Adequate Revenue Remittance (Yes= 1), (No=0).**

DISCUSSION

Most of the studies conducted in the past on manpower in forestry service in the South-West Nigeria had reported lower percentage of female participation in forestry jobs than male. For instance, Adejumo *et al*., (2018) reported the low involvement of female in Ogun State forestry service to be 8.5% and attributed it to risk associated with women working in difficult terrain. With respect to age, it could be inferred that most of the respondents were in their economic active age. This conforms to the report of NSSC, (2011) which observed that economic active age is anticipated within the age bracket 35-50.It can be inferred from the information gathered on marital status that most of the respondents were people of high responsibilities in which their level of commitment is expected to be high. Hence, it is expected that they should guide their jobs jealously considering the fact that they have numerous family obligations to meet. Taphone, (2009) had earlier identified that married people have more responsibilities (provision of foods, education, health, well-being of their spouse and children) than singles and this may be reason why this occupation is dominated by them so as to be able to meet these responsibilities. The percentage of single is also quite encouraging because their agility is guaranteed and this is a pointer to the fact that one could easily inferred that the Osun State government might have recruited new hands in the recent years to ensuring anticipated good succession of the old ones. In terms of educational level, it is understandable that in most cases uniformed men are being recruited with minimum of primary 6 Certificate. Yet, high level of education has been identified by ILO, (2000) to be leading to more skilled and productive workforce, producing more efficiently a higher standard of goods and services, which in turn forms the basis for faster economic growth and rising living standards.

The years of experience of the respondents counts a lot on the information provided. Therefore, it is presumed that reliable information must have been gotten from them. The study revealed the diverse ways in which revenues are being generated into the government account through the state forestry department. It is interesting to note that certain percentage of revenue are gotten from payment of fine by the offenders, this is a pointer to the fact that enforcement of forest laws is being given top priority in the State. The seriousness of the state forestry department is evident in her mechanisms put in place to ensure total compliance. For instance, the inauguration of Central Log Control (CLC) unit, State Task Force (STF) and Control post checking would go a long way in checkmating the movement of uncertified logs and planks, and at the same time secure lost revenues through imposition of appropriate fines. Other mechanisms put in place to checkmate the activities of the stakeholders in timber trade and other products extraction included issuance of various permits, registration and renewal of sawmill licence, registration and renewal of planning/ circular machine, registration and renewal of power saw and issuance of property hammer (Timber mark). According to Adejumo *et al*., (2018), the use of Timber mark is a common system used in regulating timber exploitation in Nigeria, especially in the South-Western Nigeria. This is popularly referred to as property hammer. Timber contractors are thereby charged with a lump sum of money to get the hammer after proper application and documentation. The hammer is iron made with the inscription of number at both ends. Therefore, the surfaces of the harvested logs are hammered so that the number could appear as a mark indicating that the logs are duly certified by appropriate authority. Of course, it is also mandatory for the timber contractors to renew the hammer yearly. This would in turn serve as another means of revenue generation apart from the money paid for its application. It is also observed that Osun State still generates revenue from the Taungya system. This system has been used as a method of establishing forestry plantation.

Taungya farming involves the growing of annual agricultural crops alongside tree species during the early years of establishment of forest plantation. Usually, the land belongs to the forestry department or large scale leases who allow subsistence farmers to raise arable crops on their land for the mutual benefit of helping raise tree seedlings. The farmers are required to tend the tree seedlings and in return, retain a part or all of the arable crops. It is an agreement that would last for two or three years, during which time the tree species would have grown and expanded its canopy (Adekunle and Bakare, 2004). It was described as a way of complete utilization of forest is an avenue for farmers to participate in tree planting and be directly involved in government afforestation projects nations. It was revealed that after allocating portion of land to the farmers, they are being expected to pay some tokens in appreciation of the gestures. It could also be inferred from the study that the age long practice of plantation establishment (Taungya) is still in use in the study area up till now despite the introduction of agroforestry which afforded the farmers better advantages than Taungya system. Adejumo *et al*., (2018), reported that collection of NTFPs as a means of revenue generation is just being given attention recently, although a lot have been said on its revenue potentials in the past. Therefore, categorizing NTFPs as promising untapped revenue channels in Osun State may be traced to the fact that a lot of them are yet to be harnessed to the fullest. The use of charcoal as energy source is recently gaining popularity in Nigeria and it has been observed that private people venturing to its production and sales illegally are making a lot of money from it. So, it is very important that government pay attention to this area so as to improve on her forest revenue. Also, Agbeja, (2016) observed that state forestry services have very little to do with extraction, conversion, processing and marketing. Essentially, state forestry services have been concerned largely with the growing of wood and protection of forest estate.

In considering revenue generation potentials of processing and marketing, it would be a good idea if forestry service equally be involved beyond growing and protection of forest resources i.e. they should embark on extraction, haulage, conversion and marketing. It is also important to note that because forestry services have regarded the protection and afforestation scheme as their preserve, there has been little or no effective private forestry in Nigeria. In the light of this, the two categories of functions i.e. protection and growing of forest produce at one hand, and haulage, exploitation, processing and marketing by private on the other hand should not be regarded as sacrosanct. Indeed, this set of activities by public forestry services i.e. creation and protection of resources should not deter forestry services from engaging in exploitation, transportation, processing, marketing, etc. There is no reason why government should only create resources and leave the profit oriented aspect to the private sector in an era of privatization and commercialization, it seems urgent that forestry service should examine the possibility of competing with the private sector in the traditional area of exploitation, haulage and marketing so as to improve on her revenue propensity.

There was sufficient evidence that the estimated coefficients for the factors identified to be responsible for ineffective revenue collection were not zero. This implies that the regression parameters in the model were statistically significant. In other words the higher the value of odds-ratio, the more likelihood the factors responsible for ineffective revenue collection in Osun State Forestry Service. Hence, it clearly indicated the variable (s) i.e factors that mostly influence effective revenue collection in the study area. The implication was corroborated by Deeks, (1996); Bland and Altman, (2000) that the logit model provides information on the consequences of one variable on the other. Therefore, existence of these factors poses serious challenges to effective revenue collection in the study area.

There was also sufficient evidence that the estimated coefficients for the factors responsible for inadequate revenue remittance were not zero. This implies that the regression parameters in the model were statistically significant. In other words the higher the value of odd-ratio, the more likelihood the factors responsible for inadequate revenue remittance in Osun State forestry service. Hence, it clearly indicated the variable (s) i.e. factors that mostly influence adequate revenue remittance in the study area. Therefore, existence of these factors poses serious challenges to adequate revenue remittance in the study area.

CONCLUSION

The study established the various kinds of revenue channels in the study area in which timber exploitation and its movement feature prominently among other sources. Various untapped revenue channels that could improve the revenue propensity of the forestry department in the state were also identified. However, identified factors responsible for ineffective revenue collection in the study area were lack of proper law enforcement, location of resources and executive fiat (undue influence) while the identified factors responsible for inadequate revenue remittance were indulgent of field officers in printing of fake receipts, improper remittance by the account staff, lack of adequate mobility for field staff to facilitate prompt remittance and lack of incentives for field officers.

Therefore, identified untapped revenue channels should be looked into urgently by the state forestry service so as to boost the revenue inclination of the state forestry department. It is also important that efforts should be intensified by the government to enforce forest laws generally while special attention should be paid to those laws that would highly prevent loss of forest revenue in the state. Undue influence by the political office holders should be curtailed as that poses serious challenges to effective revenue generation. Field staff indulging in printing of fake receipts to defraud the government should be identified and brought to book while the fraudulent activities of account staff should be checked. Field staff must be properly remunerated and mobilized appropriately so as to encourage them and ease their movement as well as facilitating their prompt remittance.

REFERENCES

Adejumo, A. A., Faleyimu, O. I. and Geply, J. J. (2018). Revenue Channels and Challenges Associated with Effective Collection in Ogun State Forestry Service. *Agricultural*

Science Research Journal, Vol (8) issue (6): 132-139.

Aekunle, V. A. J and Bakare, Y. (2004). Rural Livelihood Benefits from Participation in Taungya Agroforestry System in Ondo State, Nigeria. *Journal of Small-scale Forest Economic, Management and Policy* 3 (1), Pp. 131-138.

Agbeja, B.O. (2016). Forest Policy Law and Administration (FRM 514). A Lecture Note in the Department of Forest Resources Management, University of Ibadan, Ibadan. Pp 17-18.

Arifalo, E.I. (1990). Forest Ecosystem Stability in Nigeria, The New Nigerian Newspaper, Kaduna. Saturday 16th June, 1990.

Bland, J. M. and Altman, D. G. (2000). "The odds ratio" *British Medical Journal* 230, 1468.

Davies, H. T. O., Crombie, I.K. and Tavakoli, M. (1998). When can Odd-Ratios Mislead? *British Medical Journal* 316: 989-991

Deeks, J. (1996). Swots Corner; What is an Odd Ratio? Bandolier, 3 (3), issue 25, 6-7.

FAO, (2001). Forest Finance. The Forest Revenue Systems and Government Expenditure of Forestry in Nigeria. Working Paper: FSFM/WPO2, Accra, Ghana Pp 1-6.

ILO, 2010. A G20 Training Strategy: A Skilled Workforce for Strong, Sustainable and Balanced Growth. 9p.

NPC, (2006). National Population Comission 2006, Abuja, Nigeria.

NSCC, (2011). A Survey of Citizens Report 2011. (https:www.moh.gov.sg>home>reports). Accessed 13th June, 2019.

Taphone, B.G. (2009). Resource Productivity and Efficiency of Groundnut Farming in Northern Part of Taraba State, Nigeria. M.Sc. Dissertation. Department of Agricultural Economics and Extension, Federal University of Technology, Yola, Adamawa State.

GROWTH EVALUATION OF IN-VITRO PROPAGATED SEEDS AND SHOOT TIPS OF *Mansonia altissima* (A Chev.) A Chev

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ABSTRACT

This research work aimed at developing protocol for in-vitro propagation of Mansonia altissima. Culture-initiation experiment involved four treatments (Control (distilled water), 25 %, 50 % and 100 % Murashige and Skoog (MS) basal medium) with ten replications. The shoot regeneration involved 2 x 3 x 2 factorial treatments with five replications. Factors were two MS media strengths (Half and Full), three Benzyl Amino Purine (BAP) levels (0, 1.0 and 2.0 mg/L) and two explant types (shoot tips and lower stem). Root induction experiment consisted four treatments (0, 1.0, 2.0 and 3.0 mg/L Naphthalene Acetic Acid) with five replications in MS medium. All treatments were laid out in completely randomised design. The results showed that 100 % seed germination was obtained in distilled water only and 100 % MS basal medium at 2 weeks after inoculation (WAI). However, 25 % MS medium gave highest support for shoot growth of the seed plantlets in terms of shoot length (6.22 cm) and adventitious roots (33.5) at 3 WAI. The explants were best regenerated using full strength MS medium, 1.0 mg BAP/L and shoot tips with highest average number of leaves (3.2) at 8 WAI. None of the rooting treatments induced any root on the plantlets at 12 WAI. It could be inferred that culture of M. altissima could be initiated in-vitro using seeds on sterile distilled water or 25 % MS basal medium while its shoot-tips could be best regenerated when sub-cultured on 100 % MS basal medium supplemented with 0.1 BAP mg/L.

Keywords: Culture-initiation, Protocol, Root induction and Shoot regeneration

INTRODUCTION

Mansonia altissima of the family Sterculiaceae is commonly found in West Tropical Africa countries like Benin, Cameroon, Cote d'Ivoire, Ghana and Nigeria (Maku *et al.,* 2014). It is a deciduous forest species growing up to 37 m in height and girth of 2.5 m, bearing a dense canopy in dry season (Maku *et al*., 2014). The species is classified as a non – pioneer light demander with high economic importance (Gyimah *et al*., 2003; Beet, 1989). Its wood is of medium weight, moderately hard, very durable and resistant to fungi, borers and termites. These qualities made its wood useful for different purposes including general and high-class joinery, cabinet work, furniture, turnery, decorative veneer and handicrafts (Ken, 2019). Because of its usefulness, the species is over exploited, making it vulnerable and facing the dangers of extinction. (Myers, 2000; IUCN, 2008). Hence, the urgent needs for its conservation and reforestation. However, *M. altissima* like other several candidate species for domestication have some challenges ranging from short periods of seed viability, damage from pests and pathogens to irregular flowering (Bonner, 1990). This in turn results into unavailability of materials for both commercial forestry and provenance testing. According to Osunlaja *et al*., (2017), researchers over the years have exploited various means of determining the best factors that will support the early growth of *M. altissima* and its plantation establishment. The existing challenge of lack of dependable supply of planting material can be overcome through micro-propagation techniques. This entails rapid vegetative propagation of plants under in vitro conditions of high light intensity, controlled temperature and a defined nutrient medium.

Consequently, the aims of this study was to evaluate the growth of in-vitro propagated seeds and shoots tips of *M. altissima* with a view to evolve methods required for provision of elite clones and mass multiplication of the species.

MATERIALS AND METHODS

Study Area

The investigation was carried out in the Biotechnology section of Department of Bioscience, Forestry Research Institute of Nigeria. The Institute is located on the longitude $07^{o}23'18''$ to $07^{o}23'43''$N and latitude $03^{o}51'20''$ to $03^{o}23'43''$E (FRIN, 2018).

Treatment and Experimental design

The culture initiation experiment consist of four treatments with ten replications. The treatment were control (distilled water) and three concentrations (25 %, 50 % and 100 %) of Murashige and Skoog (MS) medium basal salts. The shoot regeneration experiment involves three factors. They were two media strengths (Half and Full Murashige and Skoog (MS) basal salts), three levels of Benzyl Amino Purine (BAP) (0, 1.0 and 2.0 mg/l) and two explant types (shoot tips and basal stem). These were combined in a factorial arrangement making up twelve treatments with five replications. Rooting experiment was designed with four treatments which were MS medium supplemented with four levels of Naphthalene Acetic Acid (NAA); 0, 1.0, 2.0 and 3.0 mg/l with five replications**.** All treatments were laid out in completely randomised design (CRD).

Media preparation and Explant sterilization

The various MS media enumerated above were prepared following standard procedures **(**Murashige and Skoog, 1962). The media for experiment 1 was basally supplemented with 0. 3% Activated charcoal. All the media pH were adjusted to 5.8 and gelled with 8.5g/l of agar (Sigma Aldrich, Lot 83112). 20 ml was dispensed per tube, cocked and sterilized at 121 °C and 15 *psi* for 15 minutes in the autoclave.

Freshly collected seeds of *M. altissima* were obtained from the Seed Section of Sustainable Forest Management Department in FRIN. The seeds were de-coated and surface sterilized as follows. The seeds were dipped in the combination of antibiotics (5 g/l Z-force + 5 g/l Cibaplus + 0.4 g/l Ciproxamed) under sterilized air laminar hood for 60 minutes, Then dipped in 70 % ethanol for 5 minutes, and 10 % hypochlorite solution + 2 drops of Tween 20 for 15 minutes. Each steps was preceded with 3 times rinse using sterile distilled water while it was finally rinsed four times. The tubes were inoculated at one seed each positioned flat at the media surface. Four Weeks after Inoculation (WAI), the plantlets were sub-cultured into freshly prepared MS media specified for shoot regeneration (Experiment 2) above. All inoculated tubes were kept at 18 ± 2 °C and 16/8 hours light/dark photoperiods in the growth room.

Data collection and analysis

Germination attributes which include percentage germination, radicle and shoot emergence were collected at 2 WAI while shoot and root lengths, and number of adventitious roots were collated at 3 WAI on seed growth. Shoot lengths and number of leaves were collected on the sub-cultured plantlets at 4 weeks interval, starting from 4 WAI. The quantitative data were analysed descriptively while others were subjected to analysis of variance using GenStat 4th edition. Significantly different means were separated at $P \leq 0.05$ with Duncan multiple Range Test.

RESULTS

Seed germination attributes

Figure 1 showed the growth attributes of in-vitro propagated seeds of *M. altissima* on MS media of varying concentration of basal salts at 2 WAI. It was observed that 100 % of the seeds inoculated on distilled water only and full strength media (0 % and 100 % MS basal salts) germinated while 85.7 and 57.1 % were obtained from half and quarter (50 % and 25 % MS basal salts) strength media. Similarly, 71.4 % radicle emergence was obtained from both distilled water only and full strength media whereas, 42.9 and 14.3 % were obtained from half and quarter strength media. Conversely, shoot emergence of 42.9 % was similar in both half and quarter strength media but higher than 28.6 % obtained from only distilled water and full strength media at 2 WAI.

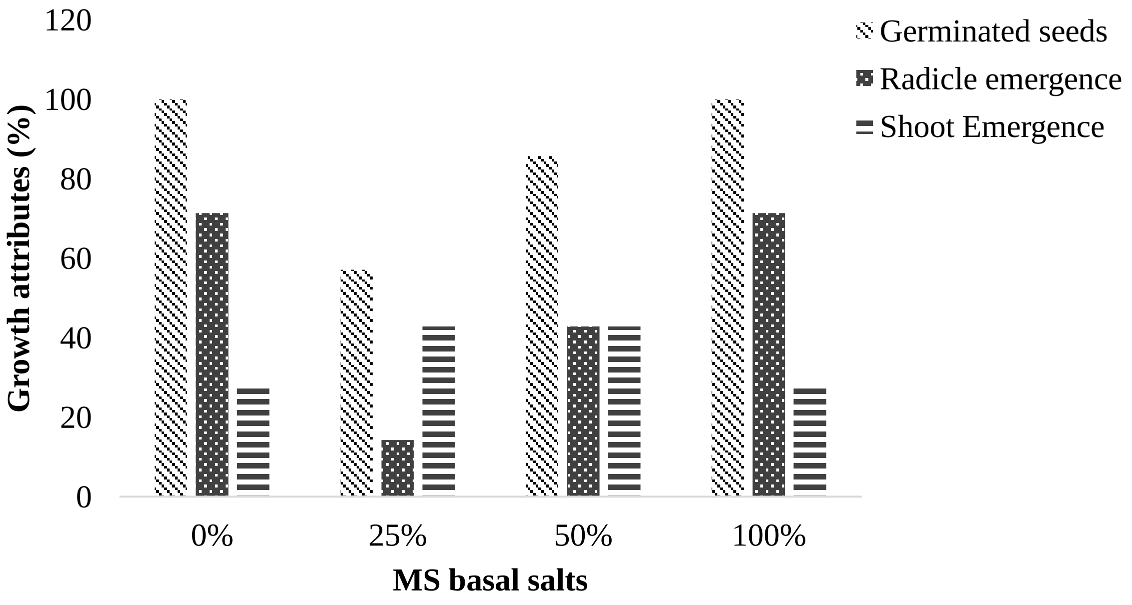

Figure1. Growth attributes of in-vitro grown seeds of *Mansonia altissima* at 2 Weeks after inoculation

Seed Shoot and Root lengths (cm), and Number of adventitious roots

The results of the growth attributes of the in-vitro inoculated seeds of *M. altissima* at 3 WAI showed that there was no significant difference ($p > 0.05$) among the average shoot lengths of the plantlets (Table 1 and Plate 1 A-D). The shoot length ranges from the highest (6.22 cm) in medium B (25 % MS basal salts) to the lowest (4.0 cm) in control (distilled water only).

Analysis of variance performed on the root lengths of the plantlets indicated that there was significant difference $p \leq 0.05$) between the treatments. Root lengths of plantlets obtained from media C, B and D (50, 25 and 100 % MS basal salts respectively) were significantly higher than those of medium A (Distilled water only). Meanwhile those of medium C was higher than medium D but similar in values to medium B (Table 1 and Plate 1 A-D).

Similar results were obtained in the number of adventitious root of the species at 3 WAI. There was significant difference among the average number of adventitious roots of the plantlets as supported by the growth media. Media B (25 %) and C (50 %) were higher than Medium A. Moreover, medium B was higher than C and D (100 %). Whereas, C was not different from D. Similarity was observed between number of adventitious root from Media D and A (Table 1 and Plate 1 A-D).

Table 1. Growth response of in-vitro germinated *Mansonia altissima* seeds at 3 WAI

Treatment Code/ MS basal salts (%)	**Growth parameters**			
	Shoot length (cm)	**Root length (cm)**	**Number of leaves**	**Number of adventitious roots**
A/0	4.0	2.84	2	4.9
B/25	6.22	5.55	2	33.5
C/50	5.91	5.63	2	18
D/100	5.17	4.47	2	13.9
L.S.D@P≤0.05	ns	1.14	ns	12.47

ns: means difference not significant at $P \leq 0.05$.


A **B**


C **D**

Plate 1. Growth of in-vitro germinated seeds of *Mansonia altissima* at 3 WAI
A: 0 % MS basal salts; **B**: 25 % MS basal salts; **C**: 50 % MS basal salts and **D**: 100 % MS basal salts

Shoot regeneration of *Mansonia altissima*

In-vitro shoot regeneration of *Mansonia altissima* was examined using two media strengths (Half and full MS basal salts), three BAP levels (0.0, 1.0 and 2.0 mg/l) and two explant types (shoot tip and lower-stem).

Shoot length (cm)

The results of the analysis of variance performed on shoot length data showed that there was significant difference ($p \leq 0.05$) between the explant types whereas other treatment factors and all interactions did not indicate any significant difference ($p > 0.05$) at 4 Weeks after inoculation (WAI) (Table 2). The inoculated shoot tips responded better to treatments than the use of lower-stem. The average shoot length of 1.62 cm obtained using shoot tips was higher than non-responsive lower-stems at 4 WAI.

At 8 WAI, there was significant different in the effect of media strengths (MDS), explant types and their interaction on shoot length while BAP levels and other interactions did not show significant difference (Table 2). Average shoot length of 0.97 cm obtained from MS medium with full basal salts was higher compared with 0.84 cm obtained from half strength MS medium. In relation to results at 4 WAI, average shoot length (1.81 cm) from shoot tip explants was higher than that of lower stem at 8 WAI.

The interaction between media strengths and explant types revealed that inoculation of shoot tips in full strength MS medium gave higher shoot length (1.94 cm) compared with when inoculated on half strength MS medium (1.68 cm). Inoculation of lower stem either in full or half strength medium did not show any shoot induction and growth at 8 WAI (Figure 2 and Plate 2 G).

Number of leaves

The results of number of leaves of sub-cultured *M. altissima* plantlets followed similar trend at both period of observations. There was significant difference ($p \leq 0.05$) in the effect of the factors and their interactions except media strengths and MDS by explant type interaction (Table 2). In terms of BAP levels, supplementing the media with 2.0 mg/l BAP gave the most significant effect on number of leaves with the value of 0.65 similar to 0.50 obtained from 1.0 mg/l BAP and higher than 0.35 from control media (0.0 mg/l BAP) at 4 WAI. However at 8 WAI, higher number of leaves (1.25) was obtained from media added 1.0 mg/l BAP, comparable to 1.15 from 2.0 mg/l BAP media while 0.0 mg/l BAP media gave the least (0.75) (Table 2). Considering the explant types, average number of leaves produced by shoot tips explant (1.0, 2.10) was higher and better than nonresponsive lower-stem at 4 and 8 WAI respectively (Table 2 and Plate 2).

Table 2. Effect of Media strengths, BAP levels and Explant types on growth of sub-cultured *Mansonia altissima.*

Factors	**Shoot length (cm)**		**Number of leaves**	
	4 WAI	**8 WAI**	**4 WAI**	**8 WAI**
MS media strengths (MDS)				
Half	0.77	0.84	0.47	0.93
Full	0.85	0.97	0.53	1.17
BAP levels (BAPL) (mg/l)				
0.0	0.74	0.81	0.35	0.75
1.0	0.84	0.99	0.50	1.25
2.0	0.85	0.92	0.65	1.15
Explant types (EXPT)				
Shoot tip	1.62	1.81	1.0	2.10
Lower stem	0.0	0.0	0.0	0.0
LSD @ $P \leq 0.05$				
Media strengths (MDS)	0.10	0.13*	0.19	0.32
BAP levels (BAPL) (mg/l)	0.13	0.16	0.23*	0.39*
Explant types (EXPT)	0.10*	0.13**	0.19**	0.32**
MDS x BAPL	0.18	0.22	0.33*	0.56**
MDS x EXPT	0.14	0.18*	0.27	0.46
BAPL x EXPT	0.18	0.22	0.33*	0.56*
MDS x BAPL x EXPL	0.25	0.32	0.47*	0.79**

* and ** indicates means difference significant at $P \leq 0.05$ and $P \leq 0.01$

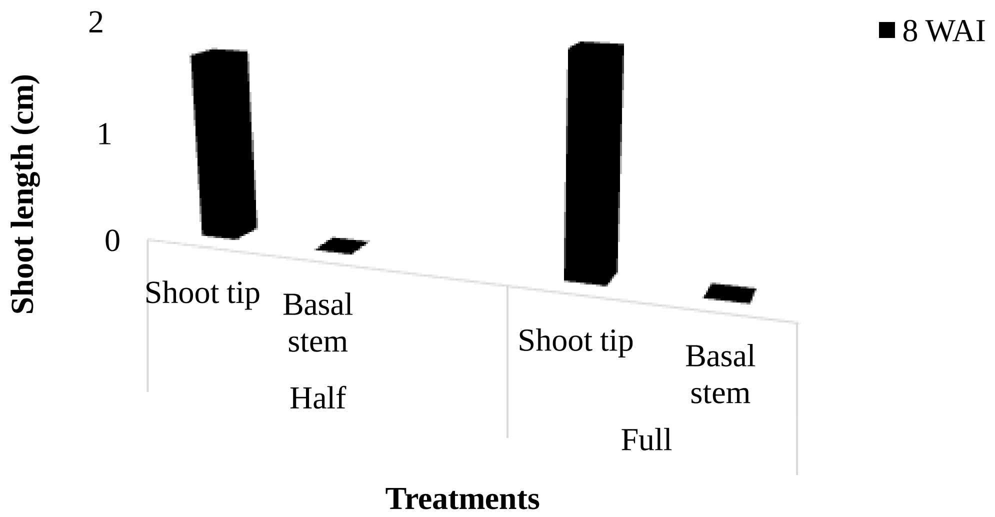

Figure 2. Interactive effect of media strengths and Explant types on shoot length of sub cultured *Mansonia altissima*

Interactions

Media strengths x BAP levels

The results of interaction between medium strengths and BAP levels on number of leaves showed that higher average number of leaves (1.6) was produced from full strength MS medium without 1.0 mg/l BAP addition at 8 WAI (Table 3). This value was significantly higher than what was obtained from half strength media with or without BAP supplements in-between which there were similarities at 8 WAI). The result was also higher than 0.5 from full strength MS medium without BAP but comparable to 1.4 of the same medium with 2.0 mg/l BAP addition (Table 3).

Table 3. Interactive effect of media strengths and BAP levels on number of leaves of sub cultured *Mansonia altissima.*

	Factors	Number of leaves	
MS media strength	**BAP levels (mg/l)**	**4 WAI**	**8 WAI**
Half	0.0	0.49abc	1.0bc
	1.0	0.4bc	0.9bc
	2.0	0.5abc	0.9bc
Full	0.0	0.2c	0.5c
	1.0	0.6ab	1.6a
	2.0	0.8a	1.4ab

BAP levels x Explant types

The results of BAP levels by explant type interactions showed that shoot tips inoculated on media with 1.0 mg/l BAP addition gave highest number of leaves (2.5) at 8 WAI. This value was comparable to 2.3 from media added 2.0 mg/l BAP while both values were higher than others which were similar in values at same period (Table 4).

Table 4. Interactive effect of BAP levels and Explant types on number of leaves of sub cultured *Mansonia altissima*

Factors		Number of leaves	
BAP levels (mg/l)	**Explant types**	**4 WAI**	**8 WAI**
0.0	Shoot tip	0.7b	1.5b
	lower stem	0.0c	0.0c
1.0	Shoot tip	1.0ab	2.5a
	lower stem	0.0c	0.0c
2.0	Shoot tip	1.3a	2.3a
	lower stem	0.0c	0.0c

Media strengths x BAP levels x Explant types

The results of the interactive effect of the three factors was presented in Table 5. It showed that highest average number of leaves (3.2) was obtained from the shoot tips explant inoculated on full strength MS medium with the addition of 1.0 mg/l BAP at 8 WAI. The value was similar to 2.8 from shoot tips inoculated on full strength MS medium with 2.0 mg/l BAP addition and significantly higher than others (Plate 2). The number of leaves (2.0) from shoot tips inoculated on half strength MS media without BAP addition was related to that (1.8) obtained from shoot tip inoculated on half strength MS medium with 1.0 or 2.0 mg/l BAP addition at 8 WAI. Irrespective of the media strength and BAP levels, no number of leaves was produced by lower-stem explants at 8 WAI (Table 5).

Table 5. Interactive effect of Media strengths, BAP levels and Explant types on number of leaves of sub cultured *Mansonia altissima*

Factors			Number of leaves	
MS media strength	**BAP levels (mg/l)**	**Explant types**	**4 WAI**	**8 WAI**
Half	0.0	Shoot tip	1.0b	2.0b
		Basal stem	0.0d	0.0d
	1.0	Shoot tip	0.8bc	1.8bc
		Basal stem	0.0d	0.0d
	2.0	Shoot tip	1.0b	1.8bc
		Basal stem	0.0d	0.0d
Full	0.0	Shoot tip	0.4cd	1.0c
		Basal stem	0.0d	0.0d
	1.0	Shoot tip	1.2ab	3.2a
		Basal stem	0.0d	0.0d
	2.0	Shoot tip	1.6a	2.8a
		Basal stem	0.0d	0.0d

Root induction

The experiment on root induction was conducted using MS medium supplemented with 0.0, 1.0, 2.0 and 3.0 mg/L NAA. Result showed that none of the treatments induced any root on the plantlets at 12 WAI.

A

B

C

D

E

F

G

Plate 2: Growth of sub-cultured *Mansonia altissima* shoot tips and lower-stem at 8 WAI

A: Half strength MS/0.0 mg/l BAP/Shoot tip, **B**: Half strength MS/1.0 mg/l BAP Shoot tip, **C**: Half strength MS/2.0 mg/l BAP Shoot tip, **D**: Full strength MS/0.0 mg/l BAP/Shoot tip, **E**: Full strength MS/1.0 mg/l BAP Shoot tip, **F**: Full strength MS/2.0 mg/l BAP Shoot tip and **G**: Full strength MS/2.0 mg/l BAP lower-stem.

DISCUSSIONS

Seed germination

In-vitro propagation of *Mansonia altissima* was assessed. The similarity observed in the number of germinated seeds, radicle and shoot emergence from distilled water medium and 100 % Murashige and Skoog (MS) medium (Figure 1) is an indication that distilled water can be used for culture initiation of *M. altissima* instead of the nutrient MS medium. Seeds germination is subject to both internal and external factors. External factors affecting seed germination include water, Temperature, Aeration and Light (Rakesh, 2011). While the last three factors were assumed to be constant in this experiment, the result could then be attributed to the availability of more water in the distilled water medium compared with the nutrient media. The results also underscored the importance of endosperm in seed germination which might have supported the early growth of the seeds until exhausted. Availability of nutrients might have been the reason for higher growth observed from the MS media compared with distilled water medium at 3 WAI (Table 1). Higher number of adventitious roots in MS 25% basal salts couple with better root length might have resulted into highest shoot length obtained from the medium plantlets (Figure 1). Whereas, lack of nutrient and exhaustion of endosperm might have given rise to lower shoot and root growth from distilled water medium plantlets even though radicle and shoot emergence was better in the medium from the onset. Germination of seeds and growth of *Mansonia altissima* seedling was once recorded to respond well to 0.03g/l IAA and 0.005g/l IBA in the natural media (Maku *et al*., 2014) however, the result of this study showed that the species can be germinated in-vitro without addition of such growth regulators.

Shoot regeneration

The result showed that inoculated shoot tips of the *M. altissima* responded better than lower stem explants in shoot length and number of leaves at 8 WAI (Table 2). This depicts that shoot tips of the species can only be used for its in-vitro shoot regeneration and multiplication. The results could be attributed to the availability of actively dividing regions called meristem in the shoot tips. On the other hand, the non-responsiveness of the lower stem explants could be due to the concentration of auxin in the stem of the plantlets sub-cultured at that young stage. The Auxin might have inhibited the induction of axillary bud that would have given rise to new shoot growth (Susan, 2002). This result corresponded to that of

Emam, (2006) who observed that shoot tips of *Pyrus communis* rootstock successfully developed when cultured on MS medium compared with one-nodal cutting.

In relation to Media strengths, plantlet growth was better in MS 100 % basal salts medium compared with MS 50 % basal salts. This showed that the species required more nutrients for in-vitro shoot growth. Higher nutrient concentrations in the MS 100 % basal salts might have caused increased uptake through osmosis which culminated into higher mean shoot length and number of leaves (Table 2 and Figure 2) from the medium. This result corresponds to that of Elequisandra *et al*., (2017) who did similar study on *Dipteryx alata*. They reported that *D. alata* seedlings in the MS medium (100% original concentration) developed better than those in other concentrations at 120 days.

The use of BAP at 1.0 and 2.0 mg/L positively affected the growth of *M. altissima* plantlets compared with control at 8 WAI. The observed better growth of plantlets in MS medium supplemented with 1.0 mg/L BAP (Table 2) showed that it was the optimum BAP level required for in-vitro shoot regeneration and development of sub-cultured *M. altissima* plantlets. Addition of BAP at high concentration such as 2 mg/L in this study might have triggered inhibitory effect on shoot growth. This result corroborated the finding of Mohammad *et al*., (2014) who obtained 8.5 new micro shoots/explant of almond x peach hybrid from MS medium supplemented with 1 mg/L BAP.

Considering the interaction of the three factors, the observed highest average shoot length and number of leaves from shoot tips inoculated on MS 100 % basal salts medium supplemented with 1.0 mg/l BAP revealed that in-vitro regeneration of sub-cultured *M. altissima* cuttings could be achieved using these components.

CONCLUSION

Mansonia altissima is a threatened indigenous tree species in Nigeria. Successful protocol establishment for in-vitro propagation of the species will ensure its cryopreservation and mass production of it elite clones for plantation purposes. The present research work has shown that the seed of *M. altissima* can be germinated in-vitro using sterile distilled water and 25 % MS basal medium. Similarly, its shoot tip explant can be best regenerated when sub-cultured on 100 % basal salt MS medium supplemented with 0.1 BAP mg/L. These conditions are therefore recommended for culture initiation and shoot regeneration of the species in-vitro. Efforts to root the species plantlets did not yield any positive results. Hence, in-vitro root induction of the species is hereby suggested for further research.

REFERENCES

Beet W.C. (1989). The potential role of agro forestry in ACP countries. Technical Centre of Agriculture and Rural Cooperation (ACP-SEC IOME CONVENTION) Netherland.

Bonner, F.T. (1990). Storage of seeds: potential and limitations for germplasm conservation. *Forest Ecology and Management* 35:35-43.

Elequisandra da Costa Araruna, João Paulo Ribeiro-Oliveira, Vanderley José Pereira, Simone Abreu Asmar and Berildo de Melo. (2017). Salt concentrations in culture media for the development of *Dipteryx alata* in vitro. *Pesquisa Agropecuária Brasileira*. 52 (12). http://dx.doi.org/10.1590/s0100-204x2017001200020.

Emam, H.E. (2006). Physiological studies on in vitro propagation of *Pyrus communis* root stock. Ph.D. Thesis, Cairo University, Egypt.

Forestry Research Institute of Nigeria (FRIN) (2018). Annual Meteorological Report 2017-18. Nigeria. Unpublished report.

Gyimah, R. and T. Nakao (2003). Effect of light intensity and nutrient on growth and electron transport of tropical tree found in Ghana, Faculty of Agriculture, Miyazaki University, Japan. 40(1-2) pp 69-78.

IUCN (2008). International Union for Conservation of Nature and Natural Resources Red list of threatened species.

Ken Fern (2019). Tropical Plants Database, tropical.theferns.info. Online resources. Available at; <tropical.theferns.info/viewtropical.php?id=Mansonia+altissima> Date assessed, 27/06/2019.

Maku J. O., Gbadamosi A. E., Fadoju O. A. (2014). Germination and Seedling Growth of *Mansonia altissima* (A. Chev) in Response to Hormonal Treatment International *Journal of Agriculture and Forestry* 4(4): 269-274 DOI: 10.5923/j.ijaf.20140404.02.

Mohammad M. Arab, Abbas Yadollahi, Abdolali Shojaeiyan, Saber Shokri, Shoresh Maleki Ghojah (2014). Effects of nutrient media, different cytokinin types and their concentrations on in vitro multiplication of G x N15 (hybrid of almond x peach) vegetative rootstock. *Journal of Genetic Engineering and Biotechnology*. 12: 81–87.

Murashige T and Skoog E. (1962). A revised medium for rapid growth and bioassays with Tobacco tissue cultures. *Physiol. Plant* 15: 473-497.

Myers, N. (2000). Deforestation Rates in Tropical Forests and their Climatic implications. Friends of the Earth, London U.K., 116 pp. 4. WF Climate Change Campaign. 2000

Osunlaja, O.A., Olomola,D.B, Nwogwugwu, J.O., Afolabi, J.O. and Oloyede, E.O. Effects of Media Composition on Shoot Initiation of *Mansonia altissima* A. Chev. Using Nodal Culture Technique *Journal of Forestry Research and Management. Vol. 14 (1), 103-109; 2017, ISSN 0189-8418*.

Rakesh kumar Nama (2011). Seed Physiology. Available at slideshare.net. Date assessed, 15/7/2019.

Susan T. Rouse (2002). Shoots-Biology Encyclopedia-cells, plant body, function, System. Retrieved July 17, 2019 from www. biology reference.com.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Okeke et al., 2019

EFFECT OF DIFFERENT PROCESSING METHODS ON THE UTILIZATION OF *Jatropha curcas (*Linn) KERNEL MEALS ON WEANER RABBITS (*Oryctolagus cuniculus*)

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ABSTRACT

There is great competition between the usage of most grains as food or feed hence there is need to identify more livestock feed resources that are not directly consumed by human being. Jatropha curcas kernel is one of such options that can replace some protein sources in livestock diets. Twelve weaner rabbits (Oryctolagus cuniculus) housed individually in cages were used to appraise the effect of different processing methods (cooked once and cooked twice) on the utilization of Jatropha curcas kernel meals (JKM) based diets by weaner rabbits. The experimental animals were allocated to three dietary treatment groups marked T1 (control), T2 (cooked once) and T3 (cooked twice) in a completely randomized design. The preliminary determination of the chemical compositions of processed Jatropha curcas kernel meals revealed that the double cooked sample had higher crude protein (38.20%), and energy (1238Kcal/kg) values over the cooked once which had (32.29%) and (1126Kcal/kg), respectively. It was also shown that the anti-nutritional factors in the sample of the double cooked were lower in value over the cooked once that had higher values. There were significant (p<0.05) differences among the treatment means in terms of daily weight gain and average final weight. The apparent crude protein, crude fiber, ether, and ash digestibility were not significantly affected by the dietary inclusion of the test ingredient irrespective of the processing method did not impose any ill-effect on the experimental animals.

Keywords: *Jatropha curcas*, weaner rabbits, processing methods.

INTRODUCTION

The products of livestock such as beef, mutton, pork, egg as well as rabbits meats are highly essential for man`s protein intake. Rabbit meat is high in protein and low in fat, cholesterol, sodium and calories (Amagbade, 2006). Rabbit is reared purposely to achieve protein self-sufficiency for the home. As a result of this, its production has remained in the hands of children and micro-scale producers in most countries. The situation therefore calls for expansion and higher efficiency in production of rabbit and its meat.The level of animal meat consumption has direct influence on the general well-being and health of the populace; protein especially of animal origin has no substitute in the growth development, replacement and repair of the body tissue because protoplasm is mainly protein. Despite concerted efforts to increase food production in the most countries over 800million people still suffer from malnutrition (Amagbade, 2006). The 2011 National Agricultural Sample Survey indicated that Nigeria was endowed with an estimated 19.5 million cattle, 72.5 million goats, 41.3 million sheep, 7.1 million pigs and 28,000 camels, 145 million chickens, 11.6 million ducks, 1.2 million turkeys and 974, 499 donkeys (Audu 2019)

Jatropha curcas is known to be among the non-timber plants of the forest species of the genus *Jatropha curcas* and are known to be very toxic. It is commonly known as *physic nut*. It belongs to the family Euphobiacaea. It is known as Binita suga or chinida suga in Hausa, Odoala in Igbo and Lapalapa or Butuje in Yoruba. It is a small tree which can reach a height up to 60cm. The plants grows quickly, survives in poor string soil and it is resistant to drought. It is considered to have originated from Central America but presently grown in most of the tropics(Duke, 1986).Stewart(1989) reported that *Jatropha curcas* seed is toxic to rats, mice and ruminant but a well prepared meal after detoxification may contain about 32 – 35% of protein contains high quality of lysine, methionine and other essential amino acids.

The seeds of *Jatropha curcas* are good sources of oil of about 27 – 40% which when processed produce a high quality of bio-diesel, usable in standard diesel engines (Venkateshi, 1978). Different products of *Jatropha curcas* trees have been used in the treatment of toothache, carrtha, running nose, cough and so on. This study was carried out to determine the effect of different processing methods on the utilization of *Jatropha curcas* kernel meal (JKM) by weaner rabbits.

MATERIALS AND METHODS

The experiment was carried out at Agriculture Extension and Management Teaching and Research farm of the Federal College Forestry, Ibadan. The site is on latitude N7^{o} 23$^{'}$43$^{''}$ and longitude E 3^{o} 51’44, located in the rain forest vegetation of the South Western part of Nigeria. It receives a mean annual rainfall of 1300 to1500mm and average relative humidity of about 80-85%. Twelve weaner rabbits (6-8 weeks old) weighing 615-616g were used for the feeding trial. The rabbits were assigned to three treatments with four replicates each in a completely randomized design arrangement.

The *Jatropha curcas* kernel was prepared from *Jatropha curcas* fruit harvested from life *Jatropha curcas* trees used for boundary demarcation behind the Nigerian Police Barracks, Dugbe, Ibadan. The fruits were decortified and later shelled to remove the kernel. Then the kernels were shared into two equal parts. One part was boiled for forty minutes. The second part was boiled for first forty minutes before the water was poured away; then same kernels were washed and poured into clean iron pot and boiled for another forty minutes. The two sets of the kernels were then wrapped with *Thaumatococcus daniellii* (Katemfe) leaves treated with Methelated spirit. The wrapped kernels were allowed to ferment for 7 days so as to reduce the alkaloid as well as the moisture contents. They were sun-dried for four days to make them easily milled. The kernels were milled to size which was possible for it to mix adequately with other ingredients to form the experimental diet. The meal from the *Jatropha curcas* kernels boiled once were used to replace soybean meal in treatment 2 (T_2) at 25%.those that were boiled twice were used to replace soybean meal in treatment 3 (T_3) at 25% respectively, while treatment 1 (T_1) did not have either of the test ingredients. Hence it served as the control.

Table 1: Ingredient composition (%, as fed) of the experimental diets

Ingredients	Composition		
	T1	**T2**	**T3**
Maize	45.75	45.75	45.75
Soybeans	18.00	13.50	13.50
*JKM	0.00	4.50	4.50
Fish Meal	1.00	1.00	1.00
Blood Meal	0.50	0.50	0.50
Wheat Meal	29.25	29.25	29.25
Bone Meal	3.00	3.00	3.00
Oysters Shell	2.00	2.00	2.00
Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100	100	100
Calculated			
Crude Protein	17.54	17.01	17.20
ME (Kcal/kg)	2.74	2.63	2.71
Ether extract	4.73	5.23	7.32
Crude Fiber	5.25	6.20	6.04

Key: JKM= *Jatropha curcas Meal*

T_1= Diet containing no *Jatropha curcas* Meal
T_2 = Diet containing once cooked *Jatropha curcas* Meal *at 25% replacement of soybean meal*
T_3= Diet containing twice cooked *Jatropha curcas* Meal *at 25% replacement of soybean meal*

The hutches were cleaned and disinfected using Izalas disinfectant at 7 days before the rabbits were stocked. The feeder and drinker were washed and disinfected before the commencement of the experiment. The floor of the metal cage permits dropping of the feaces. These animals were de-wormed using ALBIDOL®. Antibiotics and vitamins were appropriately used as occasion demanded. The rabbit were acclimatized for one week before the introduction of the experimental diets. The three formulated diet were kept in polythene bags, away from rats. The rabbit were served with the experimental diets twice daily between 7:00am-7:30am and 6:30-7:30pm. Water was offered *ad libitum*.

Data collection for the experiment was centered on the followings:-
Daily feed intake was calculated as;
$DFI(g) = (FG - FL)$…………….. 1
Where,
DIF = Daily feed intake
FG = Feed gift
FL = Feed left-over

Average weight gain per treatment group was calculated at the end of every week as thus:-

$AWG(g) = (FBW - IBW)/7$…2
Where:
AWG = Average weight gain,
FBW =Final body live weight
IBW= Initial body weight

Feed Efficiency was determined using,
$FE = WG/FC$ …………….3

Where:
FE = Feed efficiency
WG = Weight gain (g)
FC = Feed consumed (g)

At the fourth week of the experiment rabbits were moved to separate cages already cleaned and disinfected for digestibility and metabolic trials. Three days adjustment was made prior to four days collection period. Rabbits were fed their respective diets while the feed intake was recorded. Faeces collected from the replicates for each day were weighed and oven dried at 80^{0}C to constant weight. Thereafter the proximate composition was determined according to the procedures of AOAC (2012). Nutrient digestibility was then computed as follows.

$ND(\%) = (NI - NV/NI)\ x\ 100\ \ldots.\ 4$
Where:
ND = Nutrient Digestibility (%),
NI =Nutrient intake
NV= Nutrient voided

Chemical analysis
Ground (1 mm) samples of the experimental diets were analyzed for dry matter (DM), ash, total N as Kjeldahl N and fat contents as well as Ash were determined using standard procedures (AOAC, 2012). Crude protein (CP) was calculated as Kjeldahl N x 6.25 (AOAC, 2012). Ether extract (EE) was determined by extracting the sample with petroleum ether using a Soxtec System HT (AOAC, 2012). Crude fibre (CF) was determined as the insoluble organic residue after digestion (AOAC, 2012).

Data Analysis
All data generated were subjected statistical analyses using SAS (SAS, 2000). The effect of JKM inclusion levels on performance and diet digestibility was examined by one-way analysis of variance (ANOVA) while the differences in mean were separated using the Duncan Multiple Range Test (1995) at 5% probability.

RESULTS
Table 2 below shows the chemical composition of processed *Jatropha curcas* kernels meals. It revealed that the double cooked sample had higher crude protein (38.20%) and energy (1236 Kcal/kg). Samples of JKM cooked once had higher nitrogen free extract (54.95%) over the double cooked twice (48.84%).

Table 2: Chemical Composition of processed *Jatropha curcas* Kernel Meal

Component	Cooked once	Cooked twice
Crude Protein	32.29	38.20
Crude Fiber	3.22	4.01
Ether Extract	7.40	6.92
Ash	2.13	3.04
Nitrogen Free Extract	54.95	48.84
Metabolizable Energy (Kcal/kg)	1126.00	1238.00
Anti-nutritional factors (ANF)		
Saponin	1.46	0.84
Trypsin	0.70	0.52
Agglutinin	0.47	0.31
Phobolester	0.26	0.16
Tannin	0.147	0.130

The growth performance characteristics of weaner rabbits fed the experimental diets are summarized in Table 3. There were significant ($p<0.05$) differences among the treatment means in terms of average final weight, average total weight gain and average daily weight gain. The improvement in the total weight and average daily weight gain of rabbits fed diet 3, followed by those of diets 2 indicated that the test ingredients affected both feed intake and body weight gain of the rabbits. This could be as a result of the higher crude protein content and energy contents of the test ingredients as contained in the diets. Rabbits fed diets 3 (25% JKM double boiled) had the highest weight gain (505.40g), followed by rabbits fed diet 2 (470.00g), while rabbits fed diets 1 (330.10g) had the least weight gain.

Table 3: Growth performance characteristics of weaner rabbits fed diets containing differently processed *Jatropha curcas*.

Parameter	T_1	T_2	T_3	SEM
Average Initial Live weight (g)	616.00	616.00	615.00	2.94
Average Final Live weight (g)	951.13^{c}	1090.00^{b}	1120.4^{a}	18.77
Average Daily weight gain (g)	230.10^{c}	470.00^{b}	505.4^{a}	57.27
Average Feed Intake	55.30	60.00	65.97	0.95
Average Feed Efficiency	0.20	0.24	0.26	0.04

Means on the same rows with different superscripts are significantly ($p<0.05$) different.
SEM = Standard Error of Mean

The crude protein, crude fiber, ether extract, and ash digestibility were not affected by the dietary inclusion of JKM as they were similar among all the treatments with animals fed diet containing once cooked *Jatropha curcas* meal *at 25%* replacement of soybean meal having the best Crude protein digestibility (85%) and Ether Extract digestibility (89%).

Table 4: Apparent nutrients digestibility of weaner; rabbits fed differently processed *Jatropha curcas* based diets

Parameter	T_1	T_2	T_3	SEM
Crude protein digestibility (%)	74.60	74.00	85.00	0.70
Crude fiber digestibility (%)	38.00	39.00	37.20	0.55
Ether Extract digestibility (%)	84.20	88.90	89.00	0.60
Soluble Carbohydrate (%)	74.00	78.00	78.00	0.48
Ash Digestibility (%)	52.30	56.40	56.00	0.42
NDF	52.01	54.31	45.10	0.33
ADF	44.50	46.10	45.10	0.24
ADL	39.50	39.10	39.22	0.22

Key: NDF – Neutral Detergent Fiber ; ADF - Acid detergent Fiber; ADL - Acid Detergent Lignin

DISCUSSION

The anti-nutritional factors in double cooked sample were lower in values when compared with the sample of the one cooked once. This may make it safer to be consumed by livestock. The weight gain been higher in double cooked JKM is in agreement with the findings of Jang *et al.,* (2018) who reported that growing pigs fed JKM as substitute for soybean meal gained more weight and Maidala *et al.,* (2016) who reported that rabbits fed cooked soyabean significantly gained more weight. The better performance of rabbits fed diets with cooked JKM could be attributed to the processing method (cooked once and cooked twice) of the test ingredients in the diets that may have possibly reduced Anti-Nutritional Factors to amounts that were not deleteriousbut promoted growth of the rabbits. According to Elemele *et al*..(2007), fermentation process improves digestibility of nutrients by breaking down nutrients into simpler forms, as well as removing inhibitory chemicals.

The rabbits in diet 1, 2 and 3 consumed an average of 55.30,60.70 and 65.97g respectively of the diets daily. These values were however not significant ($P<0.05$). This is similar to the findings of Matondi *et al*,.(2015) who also reported no significant difference in intake of rabbits fed soybeans. However, Gabriel *et al.,* (2006) reported that rate of feed intake in animals depends on the age, sex, physical condition, health and activity of the animal.

It is commonly accepted that an increased in crude protein content of a feed-stuff increases it crude protein digestibility because the proportional contribution of endogenous nitrogen to total faecal nitrogen had increased (Fraga, 1998). The crude protein, crude fiber, ether extract, and ash digestibility were not affected ($p<0.05$) by the dietary inclusion of JKM. This implies that JKM inclusion did not impose any significant effect ($p>0.05$) on nutrition digestibility irrespective of the processing method. This result is unlike the result of Maidala *et al.,* (2016) who reported higher protein and other nutrients in the diet containing processed cowpea (Fakolade and Adetomiwa, 2018) who also reported lower protein and higher crude fibre and ash levels respectively,in the diet of rabbits fed sun flower seed meal.

CONCLUSION

The result of this study showed that *Jatropha curcas* meals (JKMs) had effect on the growth performance of weaner rabbits, as there are significant ($p<0.05$) differences in daily weight gained and final live weight. No adverse effect in growth performance of weaner rabbits was observed when JKM was used to replace soya bean meal at 25%.

Recommendations

Based on the results of this research work it is important to recommend that:

i. Inclusion of *Jatropha curcas* at 25% (cooked twice) that gave better result in weaner rabbits could be used as replacement for soya bean meal in livestock diets.
ii. More research should be carried out on further processing and increased levels of inclusion of *Jatropha curcas* in livestock diet.

REFERENCES

Amagbade, A.O. (2006). The tropical Agriculture 16 series. Macmillan press Ltd. Pp14-16.

AOAC. (2012). Official Methods of Analysis of AOAC international. 19th edition. AOAC 53
International, Gaithersburg, Maryland, USA‖

Audu O. (2019).Nigeria releases census of goats, sheep, pigs, other livestocks in country sheep-pigs-livestocks-country.html. (Accessed on June 2nd, 2019).

Duke. J.A. (1986). Characteristics of the Temperature and Humidity Prevailing during Storage Renishiod Press Co, New York, Pp. 549

Elemele H. O., Rao D. R., and Chawan C. B. (2007). Evaluation of rabbit excreta as an ingredient in broiler diets. British Poultry Science 21: 345-349.

Fakolade, P.O. and Adetomiwa, A.A. (2018), "Performance and carcass characteristics of weaner rabbits fed wild sunflower (Tithoniadiversifolia) inclusion in their diet", *International Journal of Development and Sustainability*, 7 (8), 2216-2226.

Fraga, M. J.(1998). Department de production Animal.ETS inhennieros Agromones, Universidad polienica, 208040 Madrid.

Gabriel, I. (2006): Effect of whole wheat feeding on the development of coccidiosis infection in broiler chicken. *Poultry science.*1668-1676.

Maidala, A., Dahuwa, T.N. Bakoji, S. Bello, I.B. and Ajighjigh, D.T. (2016): Growth Performance and Carcass Characteristics of Rabbits Fed Differently Processed Soybean. *Journal of Biology and Genetic Research.* 2 (1):9-14.

Matondi G. H. M., Nyamushamba G. B., Imbayarwo-Chikosi V. E., Chimurenga Z.,

Masama E. and Marandure T. (2015).Growth Performance of Weaner Rabbits FedCowpea Based Rations as Protein Source *Journal of Animal Production Advances,* 5(10): 777-783

Stewart, G.A (1989): The uses and economic important of "physic nut`` (*Jatropha curcas*). Pp.189

Yang L., Ling C., Yuhui Z., Jianmei W., Yan L., Zhengfeng F., Lianqiang C., Shengyu X. and De W. (2018): Substitution of soybean meal with detoxified *Jatropha curcas*kernel meal: Effects on performance, nutrient utilization, and meat edibility of growing pigs. *Asian-Australas Journal of Animal Science 31(6)*888-898.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Okeke et al., 2019

EFFECT OF DIFFERENT PROCESSING METHODS ON THE UTILIZATION OF *Jatropha curcas (*Linn) KERNEL MEALS ON WEANER RABBITS (*Oryctolagus cuniculus*)

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ABSTRACT

There is great competition between the usage of most grains as food or feed hence there is need to identify more livestock feed resources that are not directly consumed by human being. Jatropha curcas kernel is one of such options that can replace some protein sources in livestock diets. Twelve weaner rabbits (Oryctolagus cuniculus) housed individually in cages were used to appraise the effect of different processing methods (cooked once and cooked twice) on the utilization of Jatropha curcas kernel meals (JKM) based diets by weaner rabbits. The experimental animals were allocated to three dietary treatment groups marked T1 (control), T2 (cooked once) and T3 (cooked twice) in a completely randomized design. The preliminary determination of the chemical compositions of processed Jatropha curcas kernel meals revealed that the double cooked sample had higher crude protein (38.20%), and energy (1238Kcal/kg) values over the cooked once which had (32.29%) and (1126Kcal/kg), respectively. It was also shown that the anti-nutritional factors in the sample of the double cooked were lower in value over the cooked once that had higher values. There were significant (p<0.05) differences among the treatment means in terms of daily weight gain and average final weight. The apparent crude protein, crude fiber, ether, and ash digestibility were not significantly affected by the dietary inclusion of the test ingredient irrespective of the processing method did not impose any ill-effect on the experimental animals.

Keywords: *Jatropha curcas*, weaner rabbits, processing methods.

INTRODUCTION

The products of livestock such as beef, mutton, pork, egg as well as rabbits meats are highly essential for man`s protein intake. Rabbit meat is high in protein and low in fat, cholesterol, sodium and calories (Amagbade, 2006). Rabbit is reared purposely to achieve protein self-sufficiency for the home. As a result of this, its production has remained in the hands of children and micro-scale producers in most countries. The situation therefore calls for expansion and higher efficiency in production of rabbit and its meat.The level of animal meat consumption has direct influence on the general well-being and health of the populace; protein especially of animal origin has no substitute in the growth development, replacement and repair of the body tissue because protoplasm is mainly protein. Despite concerted efforts to increase food production in the most countries over 800million people still suffer from malnutrition (Amagbade, 2006). The 2011 National Agricultural Sample Survey indicated that Nigeria was endowed with an estimated 19.5 million cattle, 72.5 million goats, 41.3 million sheep, 7.1 million pigs and 28,000 camels, 145 million chickens, 11.6 million ducks, 1.2 million turkeys and 974, 499 donkeys (Audu 2019)

Jatropha curcas is known to be among the non-timber plants of the forest species of the genus *Jatropha curcas* and are known to be very toxic. It is commonly known as *physic nut*. It belongs to the family Euphobiacaea. It is known as Binita suga or chinida suga in Hausa, Odoala in Igbo and Lapalapa or Butuje in Yoruba. It is a small tree which can reach a height up to 60cm. The plants grows quickly, survives in poor string soil and it is resistant to drought. It is considered to have originated from Central America but presently grown in most of the tropics(Duke, 1986).Stewart(1989) reported that *Jatropha curcas* seed is toxic to rats, mice and ruminant but a well prepared meal after detoxification may contain about 32 – 35% of protein contains high quality of lysine, methionine and other essential amino acids.

The seeds of *Jatropha curcas* are good sources of oil of about 27 – 40% which when processed produce a high quality of bio-diesel, usable in standard diesel engines (Venkateshi, 1978). Different products of *Jatropha curcas* trees have been used in the treatment of toothache, carrtha, running nose, cough and so on. This study was carried out to determine the effect of different processing methods on the utilization of *Jatropha curcas* kernel meal (JKM) by weaner rabbits.

MATERIALS AND METHODS

The experiment was carried out at Agriculture Extension and Management Teaching and Research farm of the Federal College Forestry, Ibadan. The site is on latitude N7^{o} 23$^{'}$43$^{''}$ and longitude E 3^{o} 51’44, located in the rain forest vegetation of the South Western part of Nigeria. It receives a mean annual rainfall of 1300 to1500mm and average relative humidity of about 80-85%. Twelve weaner rabbits (6-8 weeks old) weighing 615-616g were used for the feeding trial. The rabbits were assigned to three treatments with four replicates each in a completely randomized design arrangement.

The *Jatropha curcas* kernel was prepared from *Jatropha curcas* fruit harvested from life *Jatropha curcas* trees used for boundary demarcation behind the Nigerian Police Barracks, Dugbe, Ibadan. The fruits were decortified and later shelled to remove the kernel. Then the kernels were shared into two equal parts. One part was boiled for forty minutes. The second part was boiled for first forty minutes before the water was poured away; then same kernels were washed and poured into clean iron pot and boiled for another forty minutes. The two sets of the kernels were then wrapped with *Thaumatococcus daniellii* (Katemfe) leaves treated with Methelated spirit. The wrapped kernels were allowed to ferment for 7 days so as to reduce the alkaloid as well as the moisture contents. They were sun-dried for four days to make them easily milled. The kernels were milled to size which was possible for it to mix adequately with other ingredients to form the experimental diet. The meal from the *Jatropha curcas* kernels boiled once were used to replace soybean meal in treatment 2 (T_2) at 25%.those that were boiled twice were used to replace soybean meal in treatment 3 (T_3) at 25% respectively, while treatment 1 (T_1) did not have either of the test ingredients. Hence it served as the control.

Table 1: Ingredient composition (%, as fed) of the experimental diets

Ingredients	Composition		
	T1	**T2**	**T3**
Maize	45.75	45.75	45.75
Soybeans	18.00	13.50	13.50
*JKM	0.00	4.50	4.50
Fish Meal	1.00	1.00	1.00
Blood Meal	0.50	0.50	0.50
Wheat Meal	29.25	29.25	29.25
Bone Meal	3.00	3.00	3.00
Oysters Shell	2.00	2.00	2.00
Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100	100	100
Calculated			
Crude Protein	17.54	17.01	17.20
ME (Kcal/kg)	2.74	2.63	2.71
Ether extract	4.73	5.23	7.32
Crude Fiber	5.25	6.20	6.04

Key: JKM= *Jatropha curcas Meal*

T_1= Diet containing no *Jatropha curcas* Meal
T_2 = Diet containing once cooked *Jatropha curcas* Meal *at 25% replacement of soybean meal*
T_3= Diet containing twice cooked *Jatropha curcas* Meal *at 25% replacement of soybean meal*

The hutches were cleaned and disinfected using Izalas disinfectant at 7 days before the rabbits were stocked. The feeder and drinker were washed and disinfected before the commencement of the experiment. The floor of the metal cage permits dropping of the feaces. These animals were de-wormed using ALBIDOL®. Antibiotics and vitamins were appropriately used as occasion demanded. The rabbit were acclimatized for one week before the introduction of the experimental diets. The three formulated diet were kept in polythene bags, away from rats. The rabbit were served with the experimental diets twice daily between 7:00am-7:30am and 6:30-7:30pm. Water was offered *ad libitum*.

Data collection for the experiment was centered on the followings:-
Daily feed intake was calculated as;
$DFI(g) = (FG - FL)$…………….. 1
Where,
DIF = Daily feed intake
FG = Feed gift
FL = Feed left-over

Average weight gain per treatment group was calculated at the end of every week as thus:-

$AWG(g) = (FBW - IBW)/7$…2
Where:
AWG = Average weight gain,
FBW =Final body live weight
IBW= Initial body weight

Feed Efficiency was determined using,
$FE = WG/FC$ …………….3

Where:
FE = Feed efficiency
WG = Weight gain (g)
FC = Feed consumed (g)

At the fourth week of the experiment rabbits were moved to separate cages already cleaned and disinfected for digestibility and metabolic trials. Three days adjustment was made prior to four days collection period. Rabbits were fed their respective diets while the feed intake was recorded. Faeces collected from the replicates for each day were weighed and oven dried at 80^{0}C to constant weight. Thereafter the proximate composition was determined according to the procedures of AOAC (2012). Nutrient digestibility was then computed as follows.

$ND(\%) = (NI - NV/NI)\, x\, 100 \ldots .4$
Where:
ND = Nutrient Digestibility (%),
NI =Nutrient intake
NV= Nutrient voided

Chemical analysis
Ground (1 mm) samples of the experimental diets were analyzed for dry matter (DM), ash, total N as Kjeldahl N and fat contents as well as Ash were determined using standard procedures (AOAC, 2012). Crude protein (CP) was calculated as Kjeldahl N x 6.25 (AOAC, 2012). Ether extract (EE) was determined by extracting the sample with petroleum ether using a Soxtec System HT (AOAC, 2012). Crude fibre (CF) was determined as the insoluble organic residue after digestion (AOAC, 2012).

Data Analysis
All data generated were subjected statistical analyses using SAS (SAS, 2000). The effect of JKM inclusion levels on performance and diet digestibility was examined by one-way analysis of variance (ANOVA) while the differences in mean were separated using the Duncan Multiple Range Test (1995) at 5% probability.

RESULTS
Table 2 below shows the chemical composition of processed *Jatropha curcas* kernels meals. It revealed that the double cooked sample had higher crude protein (38.20%) and energy (1236 Kcal/kg). Samples of JKM cooked once had higher nitrogen free extract (54.95%) over the double cooked twice (48.84%).

Table 2: Chemical Composition of processed *Jatropha curcas* Kernel Meal

Component	Cooked once	Cooked twice
Crude Protein	32.29	38.20
Crude Fiber	3.22	4.01
Ether Extract	7.40	6.92
Ash	2.13	3.04
Nitrogen Free Extract	54.95	48.84
Metabolizable Energy (Kcal/kg)	1126.00	1238.00
Anti-nutritional factors (ANF)		
Saponin	1.46	0.84
Trypsin	0.70	0.52
Agglutinin	0.47	0.31
Phobolester	0.26	0.16
Tannin	0.147	0.130

The growth performance characteristics of weaner rabbits fed the experimental diets are summarized in Table 3. There were significant ($p<0.05$) differences among the treatment means in terms of average final weight, average total weight gain and average daily weight gain. The improvement in the total weight and average daily weight gain of rabbits fed diet 3, followed by those of diets 2 indicated that the test ingredients affected both feed intake and body weight gain of the rabbits. This could be as a result of the higher crude protein content and energy contents of the test ingredients as contained in the diets. Rabbits fed diets 3 (25% JKM double boiled) had the highest weight gain (505.40g), followed by rabbits fed diet 2 (470.00g), while rabbits fed diets 1 (330.10g) had the least weight gain.

Table 3: Growth performance characteristics of weaner rabbits fed diets containing differently processed *Jatropha curcas*.

Parameter	T_1	T_2	T_3	SEM
Average Initial Live weight (g)	616.00	616.00	615.00	2.94
Average Final Live weight (g)	951.13^c	1090.00^b	1120.4^a	18.77
Average Daily weight gain (g)	230.10^c	470.00^b	505.4^a	57.27
Average Feed Intake	55.30	60.00	65.97	0.95
Average Feed Efficiency	0.20	0.24	0.26	0.04

Means on the same rows with different superscripts are significantly ($p<0.05$) different.
SEM = Standard Error of Mean

The crude protein, crude fiber, ether extract, and ash digestibility were not affected by the dietary inclusion of JKM as they were similar among all the treatments with animals fed diet containing once cooked *Jatropha curcas* meal *at 25%* replacement of soybean meal having the best Crude protein digestibility (85%) and Ether Extract digestibility (89%).

Table 4: Apparent nutrients digestibility of weaner; rabbits fed differently processed *Jatropha curcas* based diets

Parameter	T_1	T_2	T_3	SEM
Crude protein digestibility (%)	74.60	74.00	85.00	0.70
Crude fiber digestibility (%)	38.00	39.00	37.20	0.55
Ether Extract digestibility (%)	84.20	88.90	89.00	0.60
Soluble Carbohydrate (%)	74.00	78.00	78.00	0.48
Ash Digestibility (%)	52.30	56.40	56.00	0.42
NDF	52.01	54.31	45.10	0.33
ADF	44.50	46.10	45.10	0.24
ADL	39.50	39.10	39.22	0.22

Key: NDF – Neutral Detergent Fiber ; ADF - Acid detergent Fiber; ADL - Acid Detergent Lignin

DISCUSSION

The anti-nutritional factors in double cooked sample were lower in values when compared with the sample of the one cooked once. This may make it safer to be consumed by livestock. The weight gain been higher in double cooked JKM is in agreement with the findings of Jang *et al.*, (2018) who reported that growing pigs fed JKM as substitute for soybean meal gained more weight and Maidala *et al.*, (2016) who reported that rabbits fed cooked soyabean significantly gained more weight. The better performance of rabbits fed diets with cooked JKM could be attributed to the processing method (cooked once and cooked twice) of the test ingredients in the diets that may have possibly reduced Anti-Nutritional Factors to amounts that were not deleteriousbut promoted growth of the rabbits. According to Elemele *et al.*.(2007), fermentation process improves digestibility of nutrients by breaking down nutrients into simpler forms, as well as removing inhibitory chemicals.

The rabbits in diet 1, 2 and 3 consumed an average of 55.30,60.70 and 65.97g respectively of the diets daily. These values were however not significant ($P<0.05$). This is similar to the findings of Matondi *et al*,.(2015) who also reported no significant difference in intake of rabbits fed soybeans. However, Gabriel *et al.*, (2006) reported that rate of feed intake in animals depends on the age, sex, physical condition, health and activity of the animal.

It is commonly accepted that an increased in crude protein content of a feed-stuff increases it crude protein digestibility because the proportional contribution of endogenous nitrogen to total faecal nitrogen had increased (Fraga, 1998). The crude protein, crude fiber, ether extract, and ash digestibility were not affected ($p<0.05$) by the dietary inclusion of JKM. This implies that JKM inclusion did not impose any significant effect ($p>0.05$) on nutrition digestibility irrespective of the processing method. This result is unlike the result of Maidala *et al.*, (2016) who reported higher protein and other nutrients in the diet containing processed cowpea (Fakolade and Adetomiwa, 2018) who also reported lower protein and higher crude fibre and ash levels respectively,in the diet of rabbits fed sun flower seed meal.

CONCLUSION

The result of this study showed that *Jatropha curcas* meals (JKMs) had effect on the growth performance of weaner rabbits, as there are significant ($p<0.05$) differences in daily weight gained and final live weight. No adverse effect in growth performance of weaner rabbits was observed when JKM was used to replace soya bean meal at 25%.

Recommendations

Based on the results of this research work it is important to recommend that:

i. Inclusion of *Jatropha curcas* at 25% (cooked twice) that gave better result in weaner rabbits could be used as replacement for soya bean meal in livestock diets.
ii. More research should be carried out on further processing and increased levels of inclusion of *Jatropha curcas* in livestock diet.

REFERENCES

Amagbade, A.O. (2006). The tropical Agriculture 16 series. Macmillan press Ltd. Pp14-16.

AOAC. (2012). Official Methods of Analysis of AOAC international. 19th edition. AOAC 53
International, Gaithersburg, Maryland, USA‖

Audu O. (2019).Nigeria releases census of goats, sheep, pigs, other livestocks in country sheep-pigs-livestocks-country.html. (Accessed on June 2nd, 2019).

Duke. J.A. (1986). Characteristics of the Temperature and Humidity Prevailing during Storage Renishiod Press Co, New York, Pp. 549

Elemele H. O., Rao D. R., and Chawan C. B. (2007). Evaluation of rabbit excreta as an ingredient in broiler diets. British Poultry Science 21: 345-349.

Fakolade, P.O. and Adetomiwa, A.A. (2018), "Performance and carcass characteristics of weaner rabbits fed wild sunflower (Tithoniadiversifolia) inclusion in their diet", *International Journal of Development and Sustainability*, 7 (8), 2216-2226.

Fraga, M. J.(1998). Department de production Animal.ETS inhennieros Agromones, Universidad polienica, 208040 Madrid.

Gabriel, I. (2006): Effect of whole wheat feeding on the development of coccidiosis infection in broiler chicken. *Poultry science.*1668-1676.

Maidala, A., Dahuwa, T.N. Bakoji, S. Bello, I.B. and Ajighjigh, D.T. (2016): Growth Performance and Carcass Characteristics of Rabbits Fed Differently Processed Soybean. *Journal of Biology and Genetic Research*. 2 (1):9-14.

Matondi G. H. M., Nyamushamba G. B., Imbayarwo-Chikosi V. E., Chimurenga Z.,

Masama E. and Marandure T. (2015).Growth Performance of Weaner Rabbits FedCowpea Based Rations as Protein Source *Journal of Animal Production Advances*, 5(10): 777-783

Stewart, G.A (1989): The uses and economic important of "physic nut`` (*Jatropha curcas*). Pp.189

Yang L., Ling C., Yuhui Z., Jianmei W., Yan L., Zhengfeng F., Lianqiang C., Shengyu X. and De W. (2018): Substitution of soybean meal with detoxified *Jatropha curcas*kernel meal: Effects on performance, nutrient utilization, and meat edibility of growing pigs. *Asian-Australas Journal of Animal Science 31(6)*888-898.

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Yisau, and Aduradola 2019

GROWTH RESPONSE OF *Sysepalum dulcificum* SEEDLINGS TO WATERING REGIMES AND NITROGEN-BASED FERTILIZERS

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ABSTRACT

The experiment was carried to determine the effect of selected nitrogen based fertilizer and watering regimes on the growth variables in Synsepalum dulcificum seedlings. The study was carried out at the Forest Nursery of the Federal University of Agriculture Abeokuta, Ogun State, Nigeria. Seedlings were subjected to treatments such as Urea, NaNO3 and cow dung as fertilizer source and a control while, watering daily (7/7), every other day (3/7) and weekly (1/7) were the watering frequencies employed and these were laid out in a 3x4 factorial in CRD with 5 replicates in each treatment. Collected data was subjected to Analysis of Variance (ANOVA) and significant means were separated using LSD. Obtained results showed that height (12.45 cm), collar diameter (1.42 mm), fresh weight (0.70 g) and total dry weight (0.22 g) were significantly (p<0.05) higher in seedlings raised with cow dung while daily watering enhanced (p<0.05) collar diameter (1.43 mm) and fresh weight (0.63g). Application of cow dung and daily watering showed the best method to enhance the growth rate of Synsepalum dulcificum.

Keywords: Growth rate, watering, fertilizer, *Synsepalum dulcificum*

INTRODUTION

Fertilization is one of the silvicultural techniques and most critical components of producing high-quality seedlings in the nursery before planting out in the field. Without a good application of the required nutrient by seedlings, growth will be slow paced and seedling vigour will be reduced but with the appropriate fertilization, growth rates can be promoted up to three to five times greater than normal (Jacob and Landis, 2009). Therefore, to achieve desired growth rates, nursery plants must rely on root uptake of nutrients from the growing medium. Photosynthesis as a physiological process, rapid growth and development of plants are dependent on the supply of adequate quantities of mineral nutrients in a balanced proportion (Jacob and Landis, 2009).

Water deficits affect almost every aspect of tree growth and development it therefore becomes the most essential component for plant organism (Klymchuk *et al.*, 2008; Pallardy, 2008). Water stress in plants occurs when there is a misappropriation (in quantity and quality) of water supply to the plant thereby causing an imbalance. Hence, for continuous performance of vital processes such as photosynthesis and nutrient uptake, water should be made continuously available at the appropriate time, quality and quantity Araya (2007). Physiological and metabolic activities will be retarded when there is deficit in sufficient water to the plant. Water deficit causes unwanted moisture stress in plants such as reducing leaf expansion, leaf water potential of plant resulting in cell turgor loss and stomata conductance. This leads to loss of transpiration and decrease in photosynthetic rate thereby reducing growth and in severe cases, it causes wilting of plant (McDonald, 1984; Jensen *et al.*, 1998; Araya, 2007). Also, plant moisture stress on seedling growth are mostly evident on roots and shoots elongation thereby increasing their ratio to be 3.5 times higher, dry weight and volume growth however, persistent severe moisture stress can either damage or kill the seedling, moderate moisture stress can be beneficial in the aspect of inducing seed dormancy (McDonald, 1984; Huang *et al*., 1985). In addition to the physiological stress caused by water deficit, Shaxson and Barber (2003) discussed the interaction that often occur between soil water and nutrients, which shows that soil water can influence the availability of nutrients and the availability of nutrients can influence the uptake of soil water and plant's resistance to drought.

Although Nitrogen is more abundant than other nutrients in forest ecosystem, yet the most limiting nutrients in growth of forest trees (William and Norman, 2008). Hence, there is a need to determine the type of nitrogenous fertilizer and rate of irrigation that will enhance the growth rate of this forest seedling *Synsepalum dulcificum*.

MATERIALS AND METHODS

Study Area

The study was carried out at the forest nursery unit of the Federal University of Agriculture, Abeokuta situated North-East of Abeokuta, in Odeda Local Government of Ogun State, latitude $7^0 10^1$N and $7^0 58^1$N, and longitude $3^0 20^1$E and $4^0 37^1$N. This site falls within the tropical lowland with two distinct seasons: the longest- wet season last for eight months and the shortest-dry season lasted four months. It is characterized with mean annual rainfall of 1250- 1500mm, and mean monthly temperature ranges between 25.7^0C in July and 30.2^0C in February (Ogun-Osun River Basin Development Authority).

Seeds collection and soil media

Seeds of *Synsepalum dulcificum* were collected from the mother trees at Akinyele Local Government Area of Oyo State, and were raised in germination boxes. Top soil used as planting medium was thoroughly mixed and passed through 2 mm sieve to get a uniform soil mixture for the seedlings. It was analyzed for its nutrient content at the department of Soil Science and Land Management Federal University of Agriculture, Abeokuta (Table 1).

Table 1: Soil Analysis

Soil macronutrients	Values
N	0.251 %
P	24.67 mg/kg
K	35.49 ppm
Ca	213.00 ppm
Mg	55.50 ppm
Na	2.49 ppm
Organic carbon	0.479 %
Organic matter	0.825 %
Exchangeable acidity	2.14 cmol/kg

Source: Laboratory Results 2015

Sixty (60) seedlings were transplanted at the rate of one seedling per pot to soil filled ploy pots of size 12cm by 24cm and were fertilized with three (3) sources of nitrogen based fertilizers namely; Urea (5g), Sodium nitrate $NaNO_3$ (10g), Cow dung (15g) and non-fertilized (control) and watered to field capacity i.e. the daily watering (7/7), 2days interval (3/7) and 7days interval (1/7). This was laid out in a 3x4 Factorial in Complete Randomized Design (CRD) as source of nitrogen based fertilizer made up the first factor while frequency of watering made up the second factor of the experiment. There were 15 seedlings per treatment with five replicates in each treatment.

Data collection

Morphological and physiological variables were taken during and after the experiment.
Seedling height- (SH), Leaf area - (LA), Collar diameter- (CD), Root length- (RL) Shoot/root ratio- (S/R), Shoot weight- (SW), Root weight- (RW), Total dry weight- (TDW), Total fresh weight- (TFW), Net assimilation rate- (NAR), Relative growth rate- (RGR), Absolute growth rate- (AGR),

Chlorophyll content, Relative turgidity and Relative water content.

Morphological variables were measured on seedlings forth nightly for 12 weeks while, physiological variables were measured and derived after 12 weeks as a process of destructive analysis. Seedling height was measured from the soil level to the terminal bud of the plant, collar diameter was measured at 0.5cm above the soil level with Veneer Caliper, and leaves were counted and recorded.

Leaf area was measured both at the width and length of leaf and was calculated using Ugese *et al.* (2008c)

$$\text{LA} = (4.41 + 1.14)\ \text{L} * \text{B}\ldots\ldots 1$$

Measurement of Root to shoot ratio

Plants were removed from soil after 12 weeks and washed off any loose soil. Removed plant was blotted to remove any free surface moisture and roots were separated from the shoots by cutting at soil line. Root and shoot for each plant was separately oven dried at 70^0C for 24 hours, weighed and recorded. The root to shoot ratio was calculated

$$\text{Ratio}= \frac{dry\ weight\ of\ root}{dry\ weight\ of\ shoot} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Relative water content (RWC) was determined by obtaining the fresh weight of the plants, after which the plants were immersed in water for 24 hours, the plants were removed, surface water was blotted-off and turgid weight was recorded. The same plants were oven dried at 70^0C to a constant weight for 48 hours until constant weight was obtained and recorded. It was calculated from the following equation (Turner, 1981):

$$\text{Relative water content} = (F_{wt} - D_{wt}/T_{wt} - D_{wt})x\ 100 \ldots 3$$

$$\text{Relative Growth rate} = \frac{\log_e W_2 - \log_e W_1}{T_1 - T_2} \ldots .4$$

$$\text{Absolute growth rate} = \frac{W_2 - W_1}{T_2 - T_1} \ldots\ldots\ldots\ldots .5$$

$$\text{Net assimilation rate} = \frac{(W_2 - W_1)(\log_e A_2 - \log_e A_1)}{(A_1 - A_2)(T_2 - T_1)} \ldots\ldots\ldots\ldots 6$$

$$\text{Leaf Area Ratio} = \frac{(LA_1 - LA_2)}{(W_1 - W_2)} \ldots\ldots\ldots\ldots .7$$

Where T_2 = Final time of harvesting, T_1 = Initial time of harvesting, T_2-T_1 = Time interval between initial time and final time, A_2 = Leaf area at T_2, A_1 = Leaf area at T_1, W_2 = Total dry weight of plant at T_2, W_1 = Total dry weight of plant at T_1.

Procedure for chlorophyll Analysis

The fresh tissue were collected from the field and were ground in a mortar in the presence of excess acetone until all the colour was released from the tissue. The extract and washings were then made up to a known volume. Measurement of chlorophyll was made by direct determination of the absorbance at different wavelengths using a standard spectrophotometer (read at 400-700nm) and 80% acetone extract was measured at 663 and 645 nm in 1cm cells. The concentration was calculated using the following formulae Arnon (1949).

Total chlorophyll (mg/l) = 20.2 A_{645} + 8.02 A_{663}

Data Analysis

Data collected were subjected to statistical analysis of variances on the general linear model of SAS Software (SAS institute, inc.2013). Fisher's Least Significant Difference (LSD) was used to further separate the means that were significantly different.

RESULTS

Effect of Source of Nitrogenous fertilizer and frequency of watering on morphological variables in *Synsepalum dulcificum* seedlings

Seedlings raised with cow dung had the tallest plant (12.45 cm) with largest collar diameter (1.42 mm) and were significantly different (*$p<0.05$*) from seedlings raised with urea with the least effect (11.07 cm and 1.11 mm respectively) (Table 2). Slight similarity was in effect as seedlings watered daily had the largest collar diameter (1.43 mm) while the least mean (1.16 mm) was observed in seedlings watered weekly (Table 3). The interaction of nitrogenous fertilizer and watering frequencies had no significant effect (*$p>0.05$*) on all morphological variables (Table 4).

Effect of Source of Nitrogenous fertilizers and frequency of watering on physiological variables in *Synsepalum dulcificum* seedlings

Similarly, treatment effect was significant ($p<0.05$) on variable measured as shown on Tables 5 and 6. Seedlings fertilized with cow dung produced the highest fresh weight (0.70 g), turgid weights (0.79 g), shoot dry weight (0.13 g), root dry weight (0.10 g), total dry weight (0.22 g), relative water content (85.79 %), absolute growth rate (0.002 gwk^{-1}) and relative growth rate (0.017 $gg^{-1}wk^{-1}$) while the least effect was recorded in seedlings fertilized with urea.

Result showed that daily watering had the highest effect on seedlings fresh weight (0.63 g) and dry stem weight (0.05 g) which was not significantly different ($p>0.05$)from seedlings watered every other day (0.59 g, 0.04 g). However, daily watering was significantly different ($p<0.05$) from weekly watering which least (0.44 g, 0.03 g) enhanced these variables.

The interaction of the source of nitrogenous fertilizer and frequency of watering had no significant effect on the physiological variables measured (Table 7).

Table 2: Effect of Sources of Nitrogenous fertilizer on Morphological variables in *Synsepalum dulcificum* seedlings

Source of Nitrogen	Number of leaves	Plant Height (cm)	Collar Diameter (mm)	Leaf area (cm^2/plt)
Urea	5.58 ^{a}	11.07 ^{b}	1.11 ^{b}	29.96 ^{a}
$NaNO_3$	5.83 ^{a}	11.73 ^{ab}	1.23 ^{ab}	27.03 ^{a}
Cow dung	6.00 ^{a}	12.45 ^{a}	1.42 ^{a}	32.43 ^{a}
Control	5.67 ^{a}	12.33 ^{a}	1.37 ^{a}	31.80 ^{a}

Means within a column with the same superscripts are not significantly different ($p>0.05$), LSD $p=0.05$

Table 3: Effect of frequency of watering on Morphological variables in *Synsepalum dulcificum* seedlings

Frequency of watering	Number of leaves	Plant Height (cm)	Collar Diameter (mm)	Leaf area (cm^2/plt)
Every other day	5.69 ^{a}	12.01 ^{a}	1.25 ^{ab}	30.81 ^{a}
Once a week	5.38 ^{a}	11.72 ^{a}	1.16 ^{b}	27.89 ^{a}
Daily	6.25 ^{a}	11.95 ^{a}	1.43 ^{a}	32.21 ^{a}

Means within a column with the same superscripts are not significantly different ($p>0.05$), LSD $p=0.05$

Table 4: Effect of Interaction of source of nitrogenous fertilizer and frequency of watering on Morphological variables in *Synsepalum dulcificum* seedlings

Nitrogenous fertilizer	Frequency of watering	Number of leaves	Plant Height (cm)	Collar Diameter (mm)	Leaf area (cm^2/plt)
Urea	Every other day	5.50^{a}	11.90^{b}	1.01^{c}	26.88^{d}
	Once a week	5.75^{a}	10.88^{b}	1.07^{c}	27.49^{d}
	Daily	5.50^{a}	10.43^{b}	1.25^{c}	35.51^{d}
$NaNO_2$	Every other day	5.50^{a}	12.27^{b}	1.26^{c}	28.04^{d}
	Once a week	6.00^{a}	11.60^{b}	0.99^{c}	23.30^{d}
	Daily	6.00^{a}	11.30^{b}	1.44^{c}	29.75^{d}
Cow dung	Every other day	6.00^{a}	11.85^{b}	1.42^{c}	32.82^{d}
	Once a week	5.25^{a}	12.40^{b}	1.31^{c}	31.85^{d}
	Daily	6.75^{a}	13.10^{b}	1.51^{c}	32.64^{d}
Control	Every other day	5.75^{a}	12.02^{b}	1.33^{c}	35.52^{d}
	Once a week	4.50^{a}	12.00^{b}	1.27^{c}	28.93^{d}
	Daily	6.75^{a}	12.98^{b}	1.50^{c}	30.96^{d}

Means within a column with the same superscripts are not significantly different ($p>0.05$), LSD $p=0.05$

Table 5: Effect of Sources of Nitrogenous fertilizer on Physiological variables in *Synsepalum dulcificum* seedlings

Fertilizer	**FW**	**TW**	**SHDW**	**RDW g/plant**	**LDW**	**SDW**	**TDW**	**R/S Ratio**	**RWC (%)**	**AGR (gwk^{-1})**	**RGR ($gg^{-1}wk^{-1}$)**	**NAR ($gcm^{-2}wk^{-1}$)**
Urea	0.32^{b}	0.48^{b}	0.08^{b}	0.05^{c}	0.05^{a}	0.03^{a}	0.13^{b}	0.64^{b}	51.93^{b}	0.000^{b}	0.007^{b}	0.000^{a}
$NaNO_2$	0.59^{a}	0.63^{ab}	0.12^{ab}	0.07^{b}	0.07^{a}	0.045^{a}	0.18^{a}	0.74^{b}	82.83^{a}	0.001^{a}	0.012^{ab}	0.025^{a}
Cow-dung	0.70^{a}	0.79^{a}	0.13^{a}	0.10^{a}	0.08^{a}	0.05^{a}	0.22^{a}	0.75^{b}	85.79^{a}	0.002^{a}	0.017^{a}	0.002^{a}
Control	0.61^{a}	0.73^{a}	0.12^{a}	0.09^{ab}	0.07^{a}	0.047^{a}	0.20^{a}	0.76^{b}	77.32^{a}	0.002^{a}	0.015^{a}	0.024^{a}

Means within a column with the same superscripts are not significantly different (*p>0.05*), LSD *p=0.05;* FW= fresh weight, TW= turgid weight, SHDW= shoot dry weight, RDW= root dry weight, LDW= leaf dry weight, SDW= stem dry weight, TDW= total dry weight, R/S Ratio= root/shoot ratio, RWC= relative water content, AGR= absolute growth rate, RGR= relative growth rate, NAR= net assimilation rate.

Table 6: Effect of Frequency of watering on Physiological variables in *Synsepalum dulcificum* seedlings

Frequency of watering	FW	TW	SHDW	RDW g/plant	LDW	SDW	TDW	R/S Ratio	RWC (%)	AGR (gwk^{-1})	RGR($gg^{-1}wk^{-1}$)	NAR ($gcm^{-2}wk^{-1}$)
Daily	0.63^{a}	0.73^{a}	0.12^{a}	0.08^{b}	0.07^{c}	0.05^{a}	0.21^{d}	0.67^{b}	78.39^{e}	0.0021^{f}	0.015^{g}	0.0007^{f}
Every other day	0.59^{a}	0.68^{a}	0.11^{a}	0.07^{b}	0.07^{c}	0.04^{ab}	0.19^{d}	0.73^{b}	78.47^{e}	0.0017^{f}	0.013^{g}	0.0376^{f}
Once a week	0.44^{b}	0.56^{a}	0.09^{a}	0.06^{b}	0.06^{c}	0.03^{b}	0.17^{d}	0.77^{b}	66.55^{e}	0.0014^{f}	0.011^{g}	0.0008^{f}

Means within a column with the same superscripts are not significantly different (*p>0.05*), LSD *p=0.05;* FW= fresh weight, TW= turgid weight, SHDW= shoot dry weight, RDW= root dry weight, LDW= leaf dry weight, SDW= stem dry weight, TDW= total dry weight, R/S Ratio= root/sh ot ratio, RWC= relative water content, AGR= absolute growth rate, RGR= relative growth rate, NAR= net assimilation rate.

Table 7: Effect of Interaction of source of nitrogen and frequency of watering on physiological variables in *Synsepalum dulcificum* seedlings

Fertilizer	Frequency of watering	FW	TW	SHDW	RDW g/plant	LDW	SDW	TDW	R/S Ratio	RWC (%)	AGR (gwk^{-1})	RGR ($gg^{-1}wk^{-1}$)	NAR ($gcm^{-2}wk^{-1}$)
Urea	Every other day	0.22^{a}	0.40^{b}	0.05^{c}	0.06^{d}	0.02^{e}	0.04^{f}	0.11^{g}	0.94^{h}	39.21^{i}	0.000^{a}	0.01^{b}	0.00^{d}
	Once a week	0.39^{a}	0.50^{b}	0.05^{c}	0.09^{d}	0.03^{e}	0.06^{f}	0.14^{g}	0.53^{h}	68.85^{i}	0.001^{a}	0.01^{b}	0.00^{d}
	Daily	0.35^{a}	0.53^{b}	0.04^{c}	0.10^{d}	0.04^{e}	0.06^{f}	0.14^{g}	0.43^{h}	47.74^{i}	0.001^{a}	0.01^{b}	0.00^{d}
$NaNO_2$	Every other day	0.72^{a}	0.68^{b}	0.08^{c}	0.11^{d}	0.04^{e}	0.07^{f}	0.19^{g}	0.78^{h}	111.33^{i}	0.002^{a}	0.02^{b}	0.07^{d}
	Once a week	0.42^{a}	0.50^{b}	0.05^{c}	0.09^{d}	0.04^{e}	0.05^{f}	0.14^{g}	0.93^{h}	61.20^{i}	0.001^{a}	0.01^{b}	0.00^{d}
	Every day	0.62^{a}	0.73^{b}	0.08^{c}	0.16^{d}	0.06^{e}	0.09^{f}	0.22^{g}	0.53^{h}	84.83^{i}	0.002^{a}	0.02^{b}	0.00^{d}
CD	Every other day	0.77^{a}	0.90^{b}	0.08^{c}	0.15^{d}	0.06^{e}	0.09^{f}	0.22^{g}	0.54^{h}	80.31^{i}	0.002^{a}	0.02^{b}	0.01^{d}
	Once a week	0.52^{a}	0.63^{b}	0.09^{c}	0.11^{d}	0.04^{e}	0.07^{f}	0.20^{g}	0.88^{h}	72.58^{i}	0.002^{a}	0.02^{b}	0.00^{d}
	Daily	0.82^{a}	0.85^{b}	0.12^{c}	0.13^{d}	0.06^{e}	0.08^{f}	0.25^{g}	0.87^{h}	95.58^{i}	0.003^{a}	0.02^{b}	0.00^{d}
Control	Every other day	0.67^{a}	0.75^{b}	0.09^{c}	0.14^{d}	0.06^{e}	0.09^{f}	0.23^{g}	0.64^{h}	83.01^{i}	0.002^{a}	0.02^{b}	0.07^{d}
	Once a week	0.45^{a}	0.63^{b}	0.08^{c}	0.11^{d}	0.04^{e}	0.07^{f}	0.19^{g}	0.75^{h}	63.55^{i}	0.002^{a}	0.01^{b}	0.00^{d}
	Daily	0.72^{a}	0.80^{b}	0.10^{c}	0.11^{d}	0.05^{e}	0.07^{f}	0.21^{g}	0.86^{h}	85.41^{i}	0.002^{a}	0.02^{b}	0.00^{d}

DISCUSSION

The sources of nitrogenous fertilizer affected growth of *Synsepalum dulcificum* seedlings as these affected some of the morphological and physiological variables. It was observed that morphological variables such as plant height and collar diameter were enhanced and can be attributed to the application of cow dung as source of fertilizer (Okunomo, 2010; Uddin *et al.*, 2012). Increase in collar diameter is important because it determines the rate of root growth and hence, its survival and growth on the field. Also, weed competition may be suppressed with increasing height. According to Jacob and Landis (2009) increase in physiological variables such as fresh weight, turgid weight, dry shoot weight, dry root weight, total dry weight, relative water content, absolute growth rate and relative growth rate in the seedlings were also achievable due to the application of cow dung. The reduced growth rate recorded for urea treated seedlings might be as a result of nitrification which occurred during uptake of nitrogen according to Mariswamy *et al.* (2011).

In addition, daily watering of the seedlings increased the collar diameter, fresh weight and dry stem weight irrespective of the source of fertilizer applied and cannot be introduced in a drought prone area (Okunomo, 2010). Dry weight is a better measure of growth and it indicates that this specie will have better growth rate with increase in levels of water in the soil. Also, frequent watering is necessary as lack of soil water will also diminish nutrient availability by reducing microbial activity, which is responsible for the liberation of nitrogen, phosphorus and sulphur from soil organic matter which limits growth of physiological and morphological variables in plants (Shaxson and Barber, 2003; Hartmann *et al.*, 2005; Vandoorne *et al.*, 2012 and Hirons and Percival 2011).

The negligible effect of the interaction of fertilizer and water showed that soil water can influence the availability of nutrients and the availability of nutrients can influence the uptake of soil water and plant's resistance to drought (Shaxson and Barber, 2003)

CONCLUSION

The application of cow dung as source of nitrogen fertilizer and daily watering improved the development and growth rates of *Synsepalum dulcificum* seedlings. The non-significance difference in the interaction of source of nitrogen fertilizer and frequency of watering could however be that nitrogen fertilization and watering regime would stimulate the growth of *Synsepalum dulcificum* seedlings independently.

REFERENCES

Araya, Y.N. 2007. Ecology of Water Relations in Plants In: ed. Encyclopaedia of life sciences\ (26 vol. set). Wiley 1-17pp.

Arnon, D. I. 1949. Copper enzymes in isolated chloroplasts, polyphenoxidase in *Beta vulgaris*. *Plant physiology* 24(1): 1-15.

Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 2002. Plant Propagation Principles and Practices. 7th Edtion. Prentice Hall, New Jersey, pp.367-574

Hiron, A. D. and Percival, G. C. 2011. Fundamentals of tree establishment: a review. Found at http://www.forestry.gov.uk/pdf/Trees-people-and-the-buit environment_Hirons.pdf/$FILE/Trees-people-and-the-buit-environment_Hirons.pdf. Accessed on July 9, 2014.

Huang, R.S., Smith, W.K. and Yost, R.S. 1985. Influence of vesicula rarbiscular mycorrhiza on growth, water relations and lead orientation in *Leucaena leucocephala* (Lan) wit. *New Phytologist*, 99(2): 229-243.

Jacobs, D. F. and Landis, T. D. 2009. (2009): Fertilization. In: Dumroese, R. K.; Luna, T. and Landis, T. D., editors. Nursery manual for native plants: A guide for tribal nurseries Volume 1: Nursery management. Agriculture Handbook 730. Washington, D.C.: U.S. Department of Agriculture, Forest Service. p. 201-215.

Jensen, C.R., Mogensen, V.O., Poulsen, H.H., Henson, I.E., Aagot, S., Hansen, E., Ali, M. and Wollenweber, B. 1998. Soil water matric potential rather than water content determines drought responses in field-grown lupin (*Lupinus angustifolius*). *Australian Journal of Plant Physiology*, 25(3):353–363

Klymchuk, D., Vorobyova, T., Sivash, O. and Jadko, S. 2008. Effects of Plant Water Deficit on the Water Relations of *Alisma plantago-aquatica* L. Under Natural Environment *Gen. Appl. Plant Physiology*, 34(3-4): 227-238.

Mariswamy, K. M., Manjunath, G. O., Patil, S. K., Puttaswamy, H., Vasudeva, R. and Krishna, A. 2011. Influence of Nutrients on Seedling Growth and Biomass Production of *Terminalia bellirica* (Roxb) seedlings; An Important Medicinal Tree species. *International Journal of Science and Nature* 2(3):662-664.

McDonald, S. E. 1984. Irrigation in Forest-Tree Nurseries: Monitoring and Effects on seedling Growth. In Duryea Mary L. and Thomas D. Landis (eds.). Forestry Nursery Manual: Production of Bare root Seedlings Forestry Sciences 11:107-121.

Okunomo, K. 2010. Effect of Watering regimes and levels of Urea fertilizer application on establishment of Teak seedlings in an acidic soil. *The Nigerian Journal of Research and Production* 16(2): 1-12.

Pallardy, S. G. 2008. Mineral Nutrition. In: Physiology of Woody Plants, 3rd ed. California 92101-4495, USA Academic Press. Pp 255-256

Shaxson, F. and Barber, R. 2003. Optimizing Soil Moisture for Plant Production: The Significance of Soil Porosity. Food and Agriculture Organization of the United Nations, Rome 22-23pp.

Turner, N. 1981. Techniques and experimental approaches for the measurement of plant water status. *Plant Soil*, 58(1): 339 - 366.

Uddin, M.B., Mukul, S.A. and Hossain, M.K. 2012. Effects of Organic Manure onSeedling Growth and Nodulation Capabilities of Five Popular Leguminous Agroforestry Tree Components of Bangladesh. *Journal of Forest Science* 28(4):212-219

Ugese, F. D., Baiyeri, K. P. and Mbah, B. N. 2008c. Leaf area determination of shea butter tree (*Vitellaria Paradoxa* C. F. Gaertn.). *International Agrophysics* 22: 167-170.

Vandoorne, B., Mathieu, A. S., Van den Ende, W., Vergauwen, R., Perilleux, C., Javaux, M., and Lutt, S. (2012). Water stress drastically reduces root growth and inulin yield in Cichoriumintybus (var. sativum) independently of photosynthesis. *Journal ofExperimental Botany*, *63*(12), 4359-4373.

William, G.H. and Norman, P.A.H. 2008. Introduction to plant Physiology 4th edition. John Wiley and Son Inc. Hoboken, United States of America 65-74pp

Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
jfewr ©2019 - jfewr Publications
E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Riki et al., 2019

ANATOMICAL AND CHEMICAL PROPERTIES OF WOOD AND THEIR PRACTICAL IMPLICATIONS IN PULP AND PAPER PRODUCTION: A REVIEW

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ABSTRACT

Wood is a highly variable and complex material that has different chemical, physical and anatomical properties that influence its commercial value. This review therefore, explains the wide variability between anatomical and chemical properties of wood and their practical implication in pulp and paper production. In papermaking, fibres are the cell elements that impart strength to the paper sheet. The function of the vessel element is to conduct water and dissolved minerals from the roots to the higher parts of the plant. Generally, lingnocellulose materials from wood and non-wood plant consist of lignin, hemicelluloses, extractive and some inorganic matter. Information on the chemical composition is important in deciding the techno-commercial suitability, pulping method and paper strength of a particular wood material.

Keywoods: Wood, Anatomcal, Chemical, Pulp, Paper

INTRODUCTION

A comprehensive knowledge of the characteristics of any material is essential for its best utilization. This is especially true for wood because of its cellular nature and its complex cell wall structure. One of the greatest architects of our time, Frank Lloyd Wright, put it best in 1928: "We may use wood with intelligence only if we understand wood" (Jozsa and Middleton, 1994). Resource Managers and Foresters, who wish to maximize forest values, need to understand not only the principles of tree growth, but also some of the macroscopic and microscopic features that determine wood (Jozsa and Middleton, 1994).

Wood is a hard, fibrous tissue found in many trees. It has been used for hundreds of thousands of years for fuel, construction and industrial raw materials. It is an organic and natural composite of cellulose fibres embedded in a matrix of lignin which resists compression. Wood is sometimes defined as the only secondary xylem in the stems of trees (Hickey and King, 2001). It is the single most important raw material in pulp and paper production and therefore has to play a major role in industrial and economic growth of a nation.

Among many indices that made wood a valuable raw material valued for pulp and paper production, the anatomical and chemical composition of wood stand out. Though many works have been carried out on the potentials of many wood species for pulp and paper production, no detailed review of the anatomical and chemical properties have been documented to serve as the benchmark for researchers and pulp and paper producers for selecting any wood material for paper production. This paper therefore, attempts to review the major anatomical and chemical properties of wood and their practical implications in pulp and paper making. This is expected to serve as a guide to the pulp paper Producers, Researchers and young Scientist who are in dare need for screening lignocellulosic materials for pulp and paper production.

Anatomical Characteristics of Wood and their Practical Implication in Pulp and Paper Production

Wood anatomy has to do with the arrangement of the cellular structure of the wood and this has a great implication on their end-use. For example, several researchers have revealed that the characteristics of wood pulp and the products made from them are determined by the properties of wood used as raw material and their anatomic, morphological and chemical properties as well. Some of the anatomical properties of importance in the selection of a lignocellulosic material are presented in Table 1, 2 and 3 with their discussions thereafter.

Table 1: Fibre Dimensions of Hard Wood Species suitable for Pulp and Paper making

Fibre Sources	Fibre Length (mm)	Diameter (µm)	Lumen Diameter (µm)	Cell wall Thickness (µm)	Sources
Delonix regia	1.34±0.14	39.42±3.51	26.83±2.75	6.49±0.87	Riki, 2018
Ficus exasperate	1.07±0.28	24.52±15.19	14.05±0.22	5.47±7.23	Anguruwa, 2018
Ricinodedron heudelotti	1.40±0.17	41.40±11.7	32.3±11.0	4.60±1.15	Ogunleye *et al*., 2016
Gerdenia ternifolia	1.18 –1.50	22.80–31.00	5.21 – 7.45	12.80 –16.30	Noah *et al*., (2015
Ficus mucoso	1.5–1.7	27.4 – 30.1	1.4 – 5.5	19.0– 39.4	Adejoba and Onilude, 2012)
Aningeria robusta	1.66 –1.93	26.42-32.57	5.48-7.50	14.51-18.33	Ajala and Noah, (2019)
Fiji Pinuscaribaea	2.4	0.045-0.047	0.04-0.06	0.036-0.037	FAO (1975)

Table 2: Average Fiber Dimensions of Soft Wood Species suitable for Pulp and Paper making

Fibre Sources	Fibre Length (mm)	Diameter (µm)	Lumen Diameter (µm)	Cell wall Thickness (µm)	Source
Coniferous trees (Softwood e.g *Pinus Caribeae, Picea brewerian,Cedrus alantica, Abies magnifica, Juniperus communic, Metasequoia glyptostroboides etc*)	3.7	32.43	15.30	13.17	As., 2002

Table 3: Fibre Dimensions of some Non-wood plant materials suitable for Pulp and Paper making

Fibre Sources	Fibre Length (mm)	Diameter (µm)	Lumen Diameter (µm)	Cell wall Thickness (µm)	Sources
Oryza sativa (Rice straw)	0.89	14.80	6.40	4.20	Ahmet *et al*., 2004
*Hibiscus cannabinus (*Kenaf - bark)	2.32	21.9	11.9	4.2	Ververis *et al*., 2004
Hibiscus cannabinus (Kenaf- core)	0.74	22.2	13.2	4.3	Ververis *et al*., 2004
Hibiscus cannabinus (Kenaf -whole)	1.29	22.1	12.7	4.3	Ververis *et al*., 2004
Panicum virgatum (Switch grass)	1.15	13.1	5.8	4.6	Ververis *et al*., 2004
Triticum aestivum (Wheat straw)	0.74	13.2	4.0	4.6	Deniz *et al*., 2004
Secale cereale (Rye straw)	1.15	14.7	4.2	1.1	Eroglu, 1998
Gossypium Spp (Cotton stalks)	0.83	19.6	12.8	3.4	Ververis *et al*., 2004
Thaumatococcus daniellii (Miraculus Berry)	2.68	15.61	10.11	2.75	Oluwadare and Sotannde, 2006

Vessel elements and Parenchyma cells

In papermaking, fibres are the cell elements that impart strength to the paper sheet. The function of the vessel element is to conduct water and dissolved minerals from the roots to the higher parts of the plant. As result, the primary cell wall is partly strengthened, or almost entirely covered with a lignified secondary wall. Large vessel elements cause a vessel-picking problem in papermaking when hardwoods are used (Panula-Ontto *et al*., 2007). On the contrary, the function of parenchyma cell in plant is to store water, nutrient and assimilated products. In papermaking, parenchyma cells with spherical and small cells are considered to decrease the raw material quality (Karjalainen *et al*., 2012). Parenchyma has low density and decreases the bulk density of the chip charge to the pulp digester. It also consumes chemicals without participating in paper strength and it makes pulp water drainage more difficult. The proportion of parenchyma cell in fibres used for papermaking is between the range of 20 – 50% (Veveris *et al*., 2004). The image of the vessel element and parenchyma cell is presented in figure 1.

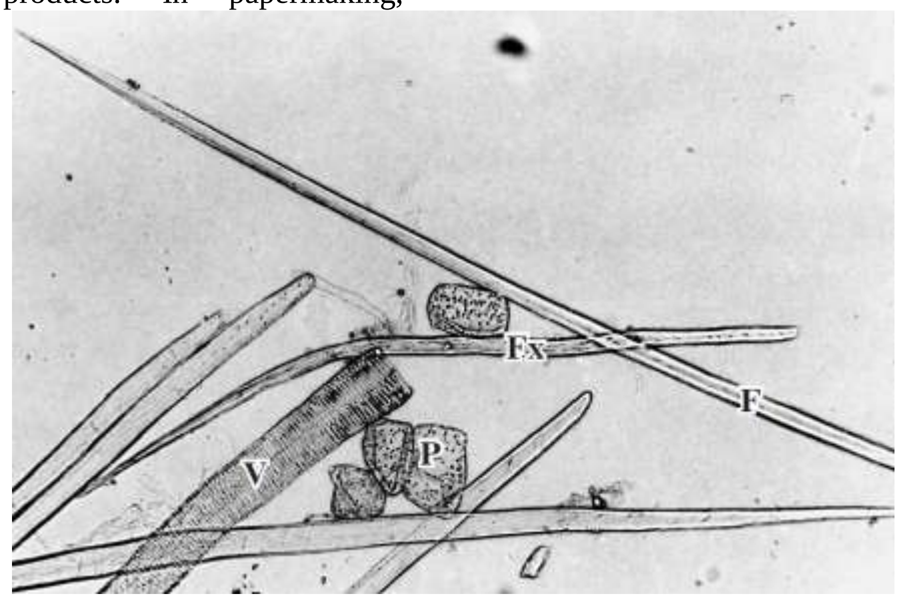

Figure 1: Image of fibre, vessel element and parenchyma cell in a *Cynara cardunculus* plant.
Sources: (Quilhó *et al.*, 2004).

Fibre Length

Fibre length has been described by Dinwoodie (1965) as one of the major factor controlling the strength properties of paper. Others include fibre density and fibre strength. According to him, fibre length is associated with the number of bonding site available on an individual fibre. Montigny and Zoborowski (1982) showed that there is a simple straight line relationship between the fibre length index of pulp and the tearing strength of the paper. This was confirmed by Seth and Page (1988) while working on the dependence of tearing resistance on fibre length, they showed that tearing resistance and to a lesser extend folding endurance are basically dependent upon the fibre length. Fuwape *et al.*, (2010) reported that long fibres have a strong positive correlation with tearing strength only without any clear relationship with other paper properties.

Fibre Diameter

Fibre diameter is the thickness of individual fibres, its measurement is used to determine the end-use of the fibres. Fibre diameters are determined by the dimensions of the cambial fusiform cells from which they are derived and by the process that occurs during cell differentiation (Ridoutt and Sands, 1993; Ridoutt and Sands, 1994; Izekor and Fuwape, 2011). In paper production, the importance of fibre diameter is usually based on its relationship with fibre length. This is otherwise called slenderness ratio or felting rate.

Lumen Width
Lumen is the inside space of a tabular structure. Lumen width is the distance between the diameters of the fibre. Lumen width has an effect on the pulping process. Larger lumen width gives better pulp beating because of the penetration of liquid into empty spaces of the fibres (Emerhi, 2012).

Cell-wall thickness
Cell-wall thickness is one of the significant fibre dimensions that determine the choice of a fibrous raw material for pulp and paper production. The thickness of cell-wall increases with the age of the tree. Atchinson and McGovern (1993), showed that most non-wood fibres are thin-walled which invariably lower the coarseness of their pulp. Research shows that the thin-walled fibres are very important in the manufacture of many grades of papers. Variations in fibre wall thickness from tree to tree and within individual trees are similar to the patterns of variation in density as a result of the close relationship between these two wood properties (Bhat *el al.*, 1990).

Derived fibre morphologies
Some common derived fibre morphologies used in assessing the fibre of lignocellulosic materials for pulp and paper productions are discussed below:

Slenderness Ratio
Slenderness ratio, which is also termed felting power, is inversely proportional to the fibre diameter. It described the value obtained from the ratio of fibre length to fibre diameter. Generally, it is stated that if the slenderness ratio of fibrous material is less than 70, it is stated that it is not valuable for quality pulp and paper production (Veveris *et al*., 2004). This is because a low slenderness ratio means reduced tearing resistance, which is partly due the short thick fibres do not produced good surface contact and fibre-to-fibre bonding (Ogbonnaya *et al*., 1997). This expression for slenderness ratio is stated in equation 1.

$$\text{Slenderness ratio} = \frac{fibre\ length}{fibre\ diameter} \ldots.\text{eqn } 1$$

Flexibility ratio
This measures the ratio of lumen to fibre diameter. It is one of the important factors which determine the suitability of pulp for paper making. It expressed the actual proportion of lumen out of a total circumference of a fibre in percentage. Flexibility according to Stamn (1964), and Amidon (1981), is the key to the development of burst and tensile strength as well as the development of the paper properties that affects printing. The expression for flexibility ratio is stated in equation 2.

$$\text{Fexibility ratio} = \frac{lumen\ width}{fibre\ diameter} \text{ x } \frac{100}{1} \ldots\ldots\ldots\ldots.\text{eqn } 2$$

Based on flexibility ratio, Bektals *et al*. (1999), classified into the following four groups.

High elastic fibres: This represents woods with flexibility ratio greater than 75%. Density of such wood is low, usually less than 0.45g/cm^3 thin-walled and large lumen. Fibres of such wood can collapse easily and flatten to produce good surface area contact, thus, there is a good fibre-fibre bonding.
Elastic fibres: This constitutes woods with fibre flexibility between 50-75%. Density is medium with cell-wall and lumen of equal dimension. The fibre collapsed partially to give relative contact and fibre bonding.
Rigid fibres: This constitutes woods with fibre flexibility between 30-50%. The cell-walls are thicker with medium to high density fibres seldom flatten and have poor surface contact and fibre-to-fibre bonding.
High rigid fibres: Wood with fibre flexibility less than 30%. This is generally applicable to over matured tress. Fibres are very thick-walled with narrow lumina, very poor surface contact and fibre-to-fibre bonding.

Runkel ratio
This measures the amount of wood in respect to the cavity or lumen of the fibre. It is twice the thickness of the cell-wall divided by the width of the lumen as shown in equation 3.

$$\text{Runkel ratio} = \frac{2\ x\ cell\ wall\ thickness}{lumen\ width} \ldots\ldots..\text{eqn } 3$$

Ademiluyi and Okeke (1977), classified fibre value according to the runkel ratio and concluded that as Runkel ratio increases, the paper quality produced decreases with Runkel ratio less than one being the best while those greater than one are of poorer quality. Fibres with Higher Runkel ratio are stiffer, less flexible and form bulkier paper of low bonded areas than fibres with lower Runkel ratio (Veveris *et al*., 2004).

Chemical Components in Wood and Their Practical Implication in Pulp and Paper Production

Chemical composition of candidate plant gives an idea of how feasible the plant is as a raw material for papermaking. The fibrous constituent is the most important part of the plant. Since plant fibres consist of cell walls, the composition and amount of fibres is reflected in the properties of cell walls (McDougall *et al*., 1993). Generally, lingnocellulose materials from wood and non-wood plant consist of cellulose, lignin, hemicelluloses, extractive and some inorganic matter. Information on the chemical composition is important in deciding the techno-commercial suitability, pulping method and paper strength of a particular wood material (Abdul-Khalil *et al*, 2010). Some of the chemical components that are of significance in the selection of a raw material for pulp and papermaking are discussed below:

Lignin

Lignin contents in different woods range between 25-35% in softwoods and 18-25% in hardwoods (Biermann, 1996) while, non-wood fibres contain between 5-23% lignin (Goring, 1971) as presented in Table 4. Lignin is considered as an integral part of the wood and is highly valued in service. It is only in pulping and bleaching that lignin is more or less released in degraded and altered form (Kock, 2006). Because of its importance in pulp and papermaking, several advances have been made towards its removal during pulping processes. Some of these include the use of 75% sulphuric acid (Klasson lignin method), the use of solvents like sodium hydroxide or in conjunction with sodium sulphide (sodium lignin method) and the use of organosolvents (Milled wood lignin method). The ease of delignification of the material during the chemical pulping process can be estimated from lignin content (Mossello *et al.*, 2010). However, it requires high chemical consumption and or reaction time during pulping process in some plants (Abdul-Khalil *et al*., 2010).

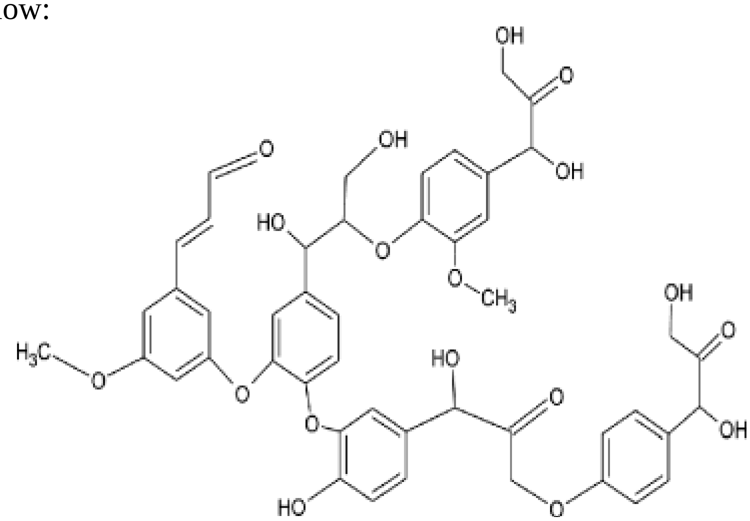

Figure 2: Chemical structure of lignin (Kock, 2006).

Cellulose

This is the chief component of plant fibres used in pulping and the most abundant natural polymer in the world. It is made of 40-45 % of wood dry weight. It is the main component of the fibre wall and the skeletal polysaccharide of cell walls (Marius du Plessis, 2012). Actually, the building block of cellulose is cellobiose since the repeating unites two sugar units. The number of glucose units in cellulose molecule is referred to as the degree of polymerization (DP) that is above 10,000 in native wood but less than 1,000 for highly bleached kraft pulp. Hydrogen bonding between cellulose molecules results in the high strength of cellulose fibre which will lead to increase of fibre strength (Biermann, 1996; Rowell *et al.,* 2000).

Cellulose being the major constituent of papermaking is expected to be in high quality and its quality depends on the raw material and pulping methods. In terms of physical attributes, one of the most important ways in which the individualized fibers in pulp are different in comparison to the wood from which they originated is the great increase in surface area per unit of dry mass, i.e. specific surface area. Studies have shown that the specific surface area of never-dried pulp fibers can be more than 100 square meters per gram (Stone and Scallan 1966). Mechanical pulping processes tend to separate the fiber material into a wide range of sizes, due to partial breakage of many of the individual tracheids and libriform fibers. By contrast, chemical pulping operations tend to leave the fibers relatively intact. Chemical pulping also tends to increase the flexibility and conformability of never-dried fibers (Tam Doo and Kerekes 1982; Paavilainen 1993). One of the most dramatic consequences of such changes is that kraft fibers more readily flatten into a ribbon-like form under compression and shear forces in the wet state. Flexible, ribbonlike fibers tend to form stronger inter-fiber bonding, compared to relatively stiff fibers, in which the open lumen structure may persist during papermaking (Hubbe *et al.,* 2007). Alpha (α) cellulose is the purest form of cellulose. It is insoluble and can be filtered from the solution and washed prior to use in the production of paper or cellulosic polymers. A high percent of alpha cellulose in paper will provides a stable, permanent material.

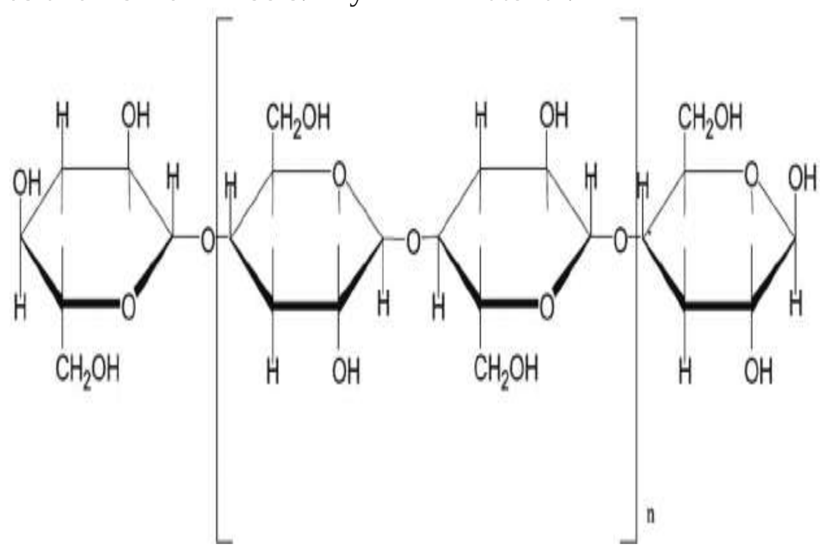

Figure 3: Structural arrangements of cellulose in wood.
Source: (Bowyer and Smith 1998).

Hemicellulose
Hemicelluloses constitutes about 15 - 30 % of dry wood but have shorter chain of polysaccharides (DP of only 50 - 300) compared to cellulose (Biermann, 1996). The main function of hemicelluloses is to increase fibre-to-fibre bonding but at a higher amount, tends to lower the strength properties of paper. Starch is often added to pulp to accelerate the strength of paper with about similar mechanisms of effect as the hemicelluloses (Biermann, 1996).

Hemicellulose is an important component in plant fibre and it contributes to paper properties. During pulping and fibre recycling, it could be removed by either its degradation or release. Although it is less important than the cellulose content in pulp, hemicellulose in pulp brings an important contribution to pulp quality and its prospective loss raises some concerns (Lima *et al.*, 2003; Wan *et al.*, 2010). Firstly, hemicellulose can enhance pulp beatability, because its abundant end groups are more accessible to water molecules compared to cellulose (1). Secondly, hemicellulose in chemical pulp, serving as an inter-fibre binding agent, improves the strength properties of paper products, including tensile, tear, and burst (Lima *et al.*, 2003). In addition, hemicellulose can slow down the deterioration of fibres during manufacturing and the subsequent commercial circulation of paper (Wan *et al.,* 2010). Thus, the hemicellulose loss from pulp has negative effects on the pulp and paper properties (Hu *et al.,* 2013). The average value of hemicellulose that constitute good quality paper is a function of the raw material, quantity and method of pulping.

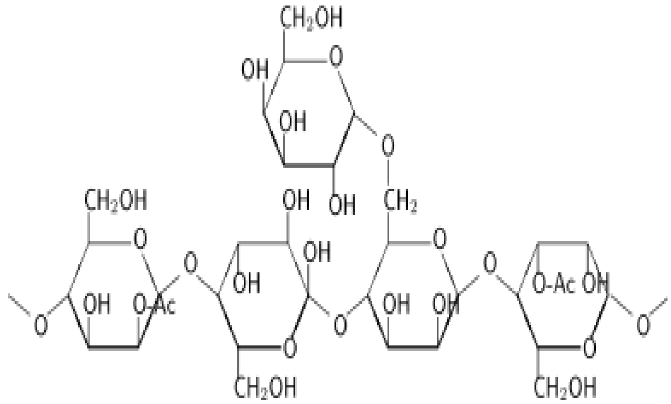

Figure 4: Structural arrangements of Hemicellulose wood. Source: (Bowyer and Smith 1998).

Effects of Hemicellulose Loss on the Strength Properties

The reductions of strength properties with hemicellulose loss are shown in Figure 5. When the hemicellulose loss was 4%, the burst, tear, and tensile indices decreased by 3.5%, 6.7%, and 9.1%, respectively. However, the burst, tear, and tensile indices dropped by 66.7%, 58.0%, and 60.0% respectively, when the hemicellulose loss reached 73%. Similar losses were also observed by Wan *et al.,* (2010). There are three possible explanations for the decrease in the strength properties of pulp with hemicellulose loss. One is that the hemicellulose loss decreases the number of free hydroxyl groups on the fibre surface and then reduces the hydrogen bond strength between fibres (1). Another possible explanation is that the hemicellulose loss decreases the fibril surface area accessible to water molecules and fibre surface charge, which changes fibre swelling and flexibility (Lyytikainen *et al.,* 2011).

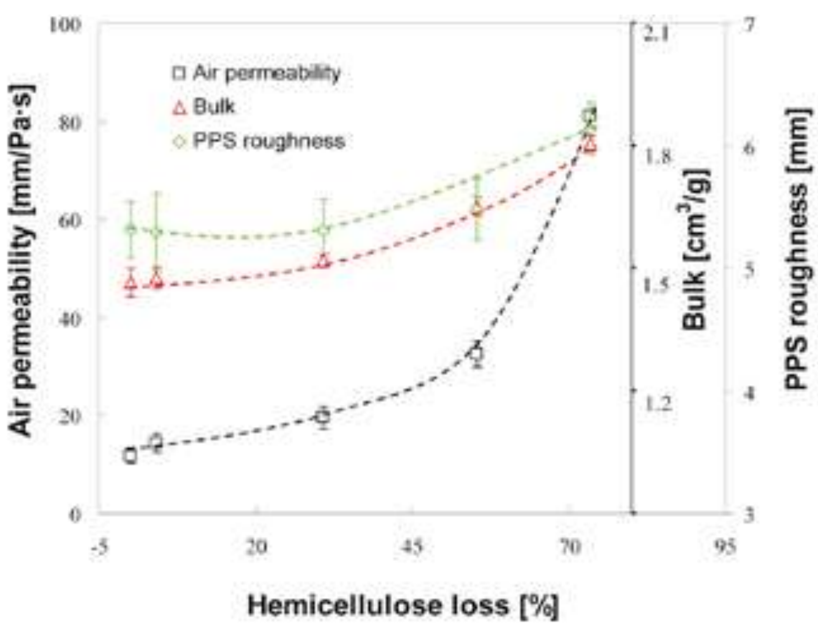

Figure 5: Effects of hemicellulose loss on the strength properties of paper (Hu *et al.,* 2013)

Extractives

Extractives is the extraneous plant component that is generally present in small to moderate amounts and can be isolated by organic solvent or water (Mossello *et al.*, 2010). It contains less than 10 % of the dry weight of wood (Marius du Plessis, 2012). These are generally the heterogenous groups of compounds of lipophilic and hydrophilic including terpenes, fatty acids ester, tannins, volatile oils, polyhydric alcohols and aromatic compounds.

High extractive content lowers pulp yield, impacts on the brightness of unbleached pulp and increases chemical demand of pulping and bleaching chemicals (Little *et al*. 2003). Generally, the presence of extractives in woody materials increases the consumption of pulp reagent and reduces yields. For this reason, material with little or no extractive content is desirable (Rodra-gueza *et al*., 2008).

Inorganic content

The inorganic constituent of lignocellulosic material is usually referred to as ash content which is considered the residue remaining after combustion of organic matter at a temperature of 525±25 ºC (Rowell *et al.*, 1997). The ash content consist mainly the metal salts such as silicates, carbonates, oxalates and phosphate of potassium, magnesium, calcium, iron and manganese as well as silicon. Normally, they are deposited in the cell walls, libriform fibres and luminar of parenchyma cells and in the resin canals and ray cells (Sjostrom**,** 1993). High ash content is undesirable during refining and recovery of the cooking liquor (Rodra-gueza *et al*., 2008). For example high silica content can complicate the recovery of chemical during pulping. Nitrogen in the spent liquor can lead to generation of NOx in the chemical recovery furnace while potassium in the fibre can combine with chlorine KCl leading to corrosive effect on metal parts in the furnace and boiler (Salmenoia and Makela, 2000).

Table 4: Percentage Chemical Composition of Non-wood fibres

Plant Species	Lignin	Cellulose	α-Cellulose	Hemi-Cellulose	Ash	Silical	Sources
Palm fruits fibres	18.50	37.01	-	68.52	0.64	-	Sridach *et al*., 2010
Pineapple leaf	10.5	-	73.4	80.5	2.0	-	Abdul-Khalil *et al.*, 2006
Banana stem	18.6	-	63.9	65.2	-	-	Abdul-Khalil *et al.*, 2006
Rice straw (whole)	17.2	48.2	35.6	70.9	16.6	14.9	Ahmet *et al*., 2004
Oil palm frond	20.5	-	49.8	83.5	2.4	-	Abdul-Khalil *et al*, 2006
Kenaf	19.20	-	46.75	71.80	1.40	0.28	Dutt *et al*., 2009
Hemp	18.50	-	46.75	71.80	1.56	0.35	Dutt *et al*., 2009
Wheat straw	15.3	-	38.2	74.5	4.7	-	Deniz *et al*., 2004

CONCLUSION

The anatomical and chemical properties of wood and the products made from them are determined by the properties of wood used as raw material, these are the ultimate factors that determine the overall properties of wood as valuable raw material for pulp and paper production and distinguish it from other non-biological materials. The quality of paper depend solely on the raw material and pulping method used, therefore these properties will serve as a guide to the pulp and paper producers.

REFERENCES

Abdul-Khalil, H.P.S., A.F. Ireana-Yusra, A.H-Bhat and M. Jawaid 2010. Cell wall ultra-structure, anatomy, lignin distribution and chemical composition of Malaysian cultivated Kenaf fiber. In. Crops Pods. (31): Pp 113-121.

Abdul-Khalil, H.P.S., Siti Alwani M. and Mohd Omor A. K. 2006. Chemical Composition, Anatomy, Lignin distribution, and Cell wall structure of Malaysian Plant waste fibers "Cell wall of tropical fibers," *BioResources*, 1 (2) Pp 220-232.

Adejoba, O. R. and Onilude, M. A 2012. Evaluation of Fibre Charateristics of Ficus mucoso: a lesser used species. Proceedings of the 3rd

Biennial National Conference of the Forests and Forest Products Society. Pp162-167.

Ajala, O. O. and Noah, A. S. 2019. Evaluation of Fibre Characteristics of *Aningeria robusta* (A. Chev.) Wood for its Pulping Potentials. *Journal of Forestry Research and Management* 16(1). 90-97.

Ademiluyi, E. O. and Okeke, R. S. 1977. Fibre characteristics of 14 savannah timber specie in relation to pulp making. Paper presented at 6th conference of FAN.

Ahmet, T., Ilhan, D. and Hudaverdi, E. 2004. Rice Straw Pulping with Oxide Added Soda- Oxide-Anthraquinone. *Pakistan Journal of Bilogical Sciences*, 7(8) 1350-1354.

Amidon, T. S. 1981. Effect of the wood properties of hardwood on kraft paper properties Tappi 64(3): 123-126.

Anguruwa, G. T. 2018. Anatomical, Physico-Chemical and Bio-Energy Properties of *Ficus exasperate* Vahl. in Ibadan, Nigeria. PhD Thesis (Unpublished).

As, N., Koc, H., Dogu, D., Atik, C., Aksu, B and Erdinler, S. 2002. The Chemical Mechanical,Physical and Anatomical Properties of Economically Important Wood in Turkey, Istanbul *Technical University Istanbul, Journal of Forestry* : 70-88 pp.

Atchinson, J. E. and McGovern, J. N. (1993). History of paper and the importance of non-wood plant fibre. In F. Hamilton and B. Leopard eds. Pulp and manufacture, 3 Tappi press Atlanta, G.A. 3p.

Bektas, I., Tutus, A. and Eroglu H. 1999. A Study of The Suitability of Calabrian Pine (*Pinus brutia* Ten.) For Pulp and Paper Manufacture. Turkish Journal Agriculture and Forestry 23(3): 589-597.

Bhat, K. and Dhamdodaran, T. 1990. Wood density and fibre length of *Eucalyptus grandis* grown in Kerala, India. *Wood and Fibre Science* 22(1): 54-61.

Biermann, C. J. (1996). Handbook of Pulping and paper making. 2nd., Ed, Acacdemic press, San Dieego, Califonia.

Bowyer, J. L. and Smith, R. L. (1998). The Nature of Wood and Wood Products. CD-ROM, University of Minnesota, Forest Products Management Development Institute, St. Paul, Minnesota, USA. 12.

Deniz, I., Kirci, H. and Ates, S. 2004. Optimization of Wheat Straw (*Tiriticum durum*) Kraft Pulping. *Indian Journal of Crop* Prodution 19(3): 237-243.

Dinwoodie, J. M. 1965. The relationships between fibre morphology and paper properties, A review of literature, Tappi. 48 (8): 440-447.

Dutt, D., Upadhyay, J.S., Singh, B and Tyagi, C. H. 2009. Studies on *Hibiscus cannabinus* and *Hibiscus sabdariffa* as an alternative pulp blend for softwood: An optimization of kraft delignification process. *Industrial Crops and Products* 29 (2009):16–26.

Emerhi, E. A. 2012. Variations in anatomical properties of *Rhizophora racemosa* (Leechm) and *Rhizophora harrisonii* (G. Mey) in a Nigerian mangrove forest ecosystem. *International Journal of Forest, Soil and Erosion*, 2(2): 89-96.

Eroglu, H. 1998. Fiberboard industry, Karadeniz Technical University. Publication No: 304, Trabzon, Pp. 30.

FAO 1975. Pulping and paper Making Properties of Fast –growing Plantation Wood Species. Rome. 466pp

Fuwape J. A., Fabiyi J. S. and Adebayo, B. A. 2010. Introduction to pulp and paper technology in Nigeria. Published by Stebak Books and Publishers.

Goring, D. A. I. 1971. Polymer properties of lignin Derivatives. In Lignins: Occurance, formation, structure and Reactions, Sarkanen, K.V. and C.H Luwig (Eds), Wiley Interscience, New York, pp: 916.

Hickey, M. and King, C. 2001. The Cambridge Illustrated Glossary of Botanical Terms "Cambridge University press" (16), Pp 2000-220.

Hu, G., Shiyu, F. and Liu, H. 2013. Hemicellulose in pulp affects paper properties and printability. 66 (2) 139-141.

Hubbe, M. A., Venditti, R. A. and Rojas, O. J. 2007. "What Happens to Cellulosic Fibers during Papermaking and Recycling?" A Review . *BioResources* 2(4), 739-788

Izekor, D. N. and Fuwape, J. A. 2011. Variation in the anatomical characteristics of plantation grown *Tectona grandis* wood in Edo State, Nigeria. Archives of Applied Science Research 3 (1): 83-90.

Jozsa, L. A., and Middleton G. R. 1994. A Discussion of wood quality attributes and their practical implications.

Karjalainen, M., Ammala, A., Rousu, P., and Niinimaki, J. 2012. Method for Automatic Analysis of Wheat Straw Pulp cell types. "Wheat Straw cell sizes" *Bioresources*, 7 (1), 827-840.

Kock, G. 2006. Raw material for pulp. In: Handbook of Pulp, Sixta, H. (Ed.). Vol.1. Wiley-VCH Verlag GmbH and Co., Weinheim, pp: 21-68.

Lima, D.U., Oliveira, B.C. and Buckeridge, M.S. 2003. Seed storage hemicelluloses as wet-end additives in papermaking, *Carbohydrate Polymers*, 52(2003):367-373

Little, K. M., van-Staden, J. and Clarke, G. P. Y. 2003. The relationship between vegetation management and the wood and pulping properties of a *Eucalyptus* hybrid clone. *Annals of Forest Science* 60: 673-680.

Lyytikainen, K., Saukkonen, E., Kajanto, I. and Kayhko, J. (2011). The effect of hemicellulose extraction on fibre charge properties and retention behavior of kraft pulp fibres, *Bioresources*, 6(1): 219-231.

Marius du Plessis 2012. A fibre optimisation index developed from a material investigation of Eucalyptus grandis for kraft pulping process. Pp 174.

McDougall, G. J., Morrison, I. M., Stewart, D., Weyers, J. D. B. and Hilman, J. R. 1993. Plant fibres bptany, chemistry and processing. *Journal of the science of Food and Agriculture* 62:1-20.

Montigny, M and Zoboroski, D. L. 1982. Fibre length and fibre strength in relation to tearing resistance of hard wood pulps Tappi 53 (11): 2153-2154.

Mossello, M., Harun, T., Resalati, H., Ibrahim, R., Md-Tahir, P., Shamsi, S. R. F. and Mohamed A. Z. 2000. Soda-Anthraquinone Pulp from Malaysian Cultivated Kenaf for Linear board Production "Kenaf Na-AQ for board," *Biouresources*, 5(3), Pp 1542-1553.

Noah, A. S., Ogunleye, M. B., Abiola, J. K. and Nnate, F. N. 2015. Fibre Characteristics of Gerdenia ternifolia (Linn C.) Schumach for its Pulping Potential. *American Scientific Journal for Engineering, Technology and Sciences.* Pp322-332.

Oluwadare, A. O. and Sotannde, O. A. 2006. Variation of the fibre Dimentions in the stalks of Miraculous Berry (*Thaumatococcus daniellii* Stalk). *Production Agriculture Technology (PAT)*, 2(1): 85-90.

Ogbonnaya, C. I., Roy-Macauley, H., Nwalozie, M. C. and Annerose, D. J. M. 1997. The physical and histochemical properties of Kenaf (*Hibiscus cannabinus L.*) grown under water deficit on a sandy soil. *Industrial crops and products*, 7: 9-18.

Ogunleye, B. M., Fuwape, J. A., Oluyege, A. O., Ajayi, B. and Fabiyi, J. S. 2016. Evaluation Of Fiber Characteristics Of *Ricinodedron Heudelotii* (Baill, Pierre Ex Pax) For Pulp And Paper Making. International *Journal of Science and Technology*, 6(1I): 634-637.

Paavilainen, L. 1993. "Conformability – flexibility and collapsibility – of sulfate pulp fibers," *Paperi Puu* 75(9-10), 896-702.

Panula-Ontta, S., Fuhrmann, A., Kariniemi, M., and Sarkilahti, A. 2007. "Evaluation of Vessel picking tendency in Printing," ICEP Int. Colloquium on Eucalyptus Pulp, March 4-7, Belo Horizonte, Brazil.

Quilho, T., Gominho, J. and Pereira, H. 2004. Anatomical characterisation and variability of the Thistle *cynara cardunculus* in view of pulping potential. *IAWA Journal*, 25 (2): 217–230.

Riki, J. T. B. (2018): Wood Quality Studies of some Hardwood Species in University of Ibadan, Ibadan, Nigeria. M.Sc Dissertation (Unpublished).

Rodra-Gueze, A., Morala, A., Serranoa, L. Labidio, J. and Jimanez, L. 2008. Rice straw pulp obtained by using various methods. *Bioresources Technology*., 99: 2881-2886.

Rowell, R. M., R. A Young and Rowell, J. K. 1997. Paper and composites from Agro-based Resources. Lewis, New York.

Rowell, J. K., Han, J. S. and Rowell, J. S. 2000. Characterization and factors affecting fiber properties Nat. Polymers Agrofibers composites.

Ridoutt and Sands, 1993. Within-tree variation in cambial anatomy and xylem cell differentiation in *Eucalyptus globulus*. Trees 8: 18-22.

Ridoutt and Sands, 1994. Quantification of the Processes of Secondary Xylem Fibre Developmenr in *Eucalyptus Globulus* at two Height Levels. *International Association of Wood Anatomists (IAWA) Journal*, 15 (4), 417-424.

Salmenoja, K., and Makela, K. 2000. "Chlorine-induced superheater corrosion in boilers fired with biomass," In: Proceedings of the fifth European Conference on Industrial Furnaces and Boilers, April 2000, INFUB, Porto, Portugal, 200.

Seth, F.N. and Page, H. 1988. Hardwood fibre length and pulpsheet properties. Tappi 5 (1): 19-25.

Sjostrom, E. 1993. Wood Chemistry, Fundamentals and Applications. 2nd Edn., San Diego, USA.

Stamn, A. J. 1964. Wood and cellulose Science. Reinhod Press Co. New York 54p.

Stone, J. E., and Scallan, A. M. (1968). "A structural model for the cell wall of waterswollen wood pulp fibers based on their accessibility to macromolecules,"*Cellulose Chemical Technology* 2(3), 343-358.

Sridach, W. 2010. "Pulping and Paper properties of Palmyra palm fruits fibers" Songklanakarin. *Journal of Science and Technology,* 32 (2): 201-205.

Tam Doo, P. A., and Kerekes, R. J. 1982. "The flexibility of wet pulp fibers," *Pulp Paper Canada* 83(2), T37-T42.

Ververis, C., Georghiou, K., Christodoulakis, N., Santas, P. and Santas, R. 2004. Fiber dimensions, lignin and cellulose content of various plant materials and their suitability for paper production. *Industrial Crops Products* 19: 245-254.

Wan, J.Q., Wang, Y. and Xiao, Q. 2010. Effects of hemicellulose removal on cellulose fiber structure and recycling characteristics of eucalyptus pulp, *Bioresources Technology* 101: 4577-4583.