PHYSICAL PROPERTIES OF SOME WOOD SPECIES OF NIGER DELTA, NIGERIA.

Aleru, K. K., Owoyemi, J.M., Olufemi, B.
Department of Forestry and Wood Technology, Federal University of Technology Akure, Ondo State, Nigeria.
alerukennedy@gmail.com, jmowoyemi@futa.edu.ng, bolufemi@futa.edu.ng

Abstract
This study evaluated the Physical properties of Musanga cecropoides (African Corkwood), Pterocarpus milbreadi (African Rosewood), Ficus exasperata (Sandpaper tree) in Niger Delta, Nigeria in a bid to determine its prospects for utilization in Nigeria. Test samples obtained and considered from their axial (top, middle, base) and radial (inner and outer) positions. The results on both the axial and radial orientations in Density showed that Pterocarpus milbreadi has the highest mean density value of 806.62 Kg/m^3 and 841.60 Kg/m^3 followed by Ficus exasperate with values of 677.82 Kg/m^3 and 742.78 Kg/m^3 and least with Musanga cecropoides having 618.89 Kg/m^3 and 618.61 Kg/m^3 for the axial and radial positions respectively, and with an increase upwards along the longitudinal axis, as well as a slight increase from innerwood to outer wood respectively. Pterocarpus milbreadi has the highest mean specific gravity value of 0.83,0.83 followed by Ficus exasperate with the value of 0.80, 0.79 and least as Musanga cecropoides 0.80,0.78 at the axial and radial positions respectively. For water absorption (WA) of the wood species along (axial) and across(radial) the bole, Musanga cecropoides recorded the highest WA values of 0.85% and 0.90%, followed by Ficus exasperate (0.52% and 0.46%), while the least WA is observed for Pterocarpus milbreadi (0.31% and 0.33%) respectively. The percentage volumetric shrinkage was highest with Musanga cecropoides (6.28 and 5.98%) followed by Ficus exasperate (3.28% and 2.86%) and then Ficus exasperate with 2.88% and 2.79% respectively. The findings of this study show that these species may find a use for different applications ranging from furniture to construction works.

Keywords: *Physical properties, Musanga cecropoides, Pterocarpus milbreadi, Ficus exasperate.*

Introduction

Wood is an indispensable material that man cannot do without owing to the utilisable advantages it possesses over other common materials such as steel and concrete. Hence, it remains one of the most versatile raw material the world has ever known with a wide range of physical and mechanical properties, as well as a renewable resource with an exceptional strength-to-weight ratio, economically available, easily machinable; amenable to fabrication into an infinite variety of sizes and shapes using simple on-site building techniques. (Jamal, 2017; Owoyemi*et al* 2016; Winandy, 1994).

Physical properties are the quantitative characteristics of wood and its behaviour to external influences other than applied forces. (Winandy, 1994). They remain the fundamental factors influencing its performance and behavioural characteristics in the service environment. Principally, the physical properties of wood are commonly observed in its specific gravity or density, moisture content, dimensional stability among others (Nwiisuator and Emerhii, 2015).

The overexploitation of well-known and durable wood species due to excessive logging and indiscriminate felling down of trees etc. has led to their scarcity and hence, higher costs of timber in the markets today. This is accompanied by an influx of several other lesser-used wood species. As such, it is imperative to ascertain the physical properties (density, specific gravity, % volumetric shrinkage) of these species to determine their suitability for certain applications and the need for certain properties enhancements where necessary, which will, in turn, serve as baseline information to wood users and furniture makers in making decisions concerning materials selection.

Materials and Methods

Study Area

The test samples were obtained from three locations in the Niger-Delta region of Nigeria viz Obugwo Forest, Egbeda, Emouha Local Government Area of Rivers State, Nigeria as which lies between Latitude 5° 14' 5' N and Longitude 6°45' 9 E, Subai Igbangi Forest in Kolokuma/Opokuma Local Government Area of Bayelsa State which lies between Latitude 5° 11' 54' N and Longitude 6°30' 21'E and Patani Forest, Patani Local Government Area of Delta State and lies between Latitude 5° 13' 43"N and Longitude 6°11' 33 E. The locations are mainly agrarian with standing trees of *Musanga cecropoides, Pterocarpus milbreadi, Ficus exasperate* which were selected and felled for this study.

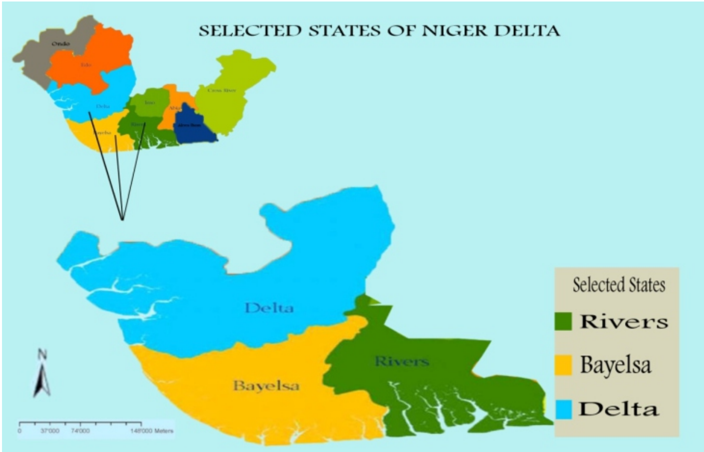

Figure 1: Map Showing the Niger Delta States from which the study will be conducted

Preparation of Samples

The trees were felled, the logs cross-cut into billets, and the billets representing the top, middle, and base stem positions of the log along the longitudinal direction at the stump site due to transport challenges. The billets were on the spot subsequently flitched into planks which were then transported to the Ilaoubuchi Sawmill Industry, Port Harcourt, Rivers State for further conversion into sample sizes of 20 mm x 20 mm x 60mm in the LxTx R directions following the American Society of Testing Materials (ASTM, 2014) and British standard BS: EN 408 (2012). Samples were immediately preserved against the loss of moisture by putting them in a nylon bag. Thereafter, transported to the Forestry and Environment Department, Rivers State University, Port Harcourt for the physical properties investigation.

Data Analysis

The data collected were subjected to Analysis of variance (ANOVA) and the experiment was laid out in Randomised Complete Block Design (RCBD) with samples replicated three times.

I. Density

Wood samples of dimensions 20 mm x 20 mm x 20mm were weighed and oven-dried at a temperature of 105°C for 24 hours until constant weight and dimensions were obtained. The wood density of the species was calculated using;

$$\rho = \frac{M}{V}\ Kgm^3 \quad \text{...Equation 1}$$

Where;

ρ= Density of wood

M= Weight of Oven-dried wood

V= Volume of wood. (L x B x W)

(L (longitudinal) x B (Radial) x W (Tangential))

Wood Specific Gravity (SG)

The specific gravity of the species was determined in line with the gravimetric method as developed by Smith (1954). Cubes of 20x20x20mm from different parts axially along the lengths of trees (Top, middle and base) and radially (inner and outer) across the trees were sampled. The specimens were completely saturated in distilled water by boiling. Cubes were removed from the water, blotted to remove excess water, weighed and oven-dried to a constant weight at 103°C.

$$\text{Thus; SG} = \frac{1}{\frac{ws - wo}{wo} + \frac{1}{1.53}} \quad \text{...Equation 2}$$

Where;
SG = Specific Gravity
W_S = Saturated Weight of wood
W_O = Oven dry Weight of wood
1.53= Constant developed by Stamm (1929) as the weight of the wood substance

Dimensional Properties

The dimensional characteristics i.e. the volumetric shrinkage and swelling were obtained by soaking the oven-dry wood samples of 25x25x100mm for 24 hours and thereafter oven-dry the samples again to a constant weight according to ASTMD143 (2009).

$$VS_h = \frac{Ivw - Fvw}{Ivw} \times \frac{100}{1} \quad \text{Equa.3}$$

Where:
VS_h=Volumetric Shrinkage
Ivw=Initial volume of wood
Fvw=Final volume of wood

iv. Water Absorption

The water absorption test was determined according to ASTM D570-98(2010) wherein the weight test specimens of dimensions50mmx50mmx150mm was measured. Thereafter the specimen was immersed in water under room conditions for 24 hours to attain equilibrium. Specimens were removed, patted dry with a lint-free cloth, and weighed.

$$\text{Percent Water Absorption} = \frac{\text{wet weight} - \text{Dry weight}}{\text{Dry weight}} \times \frac{100}{1} \quad \text{Equa. 4}$$

Results and Discussions

Density is the single most important indicator of wood strength with a strong influence on all other wood properties. The mean values of wood density of different wood species are presented in Table1, it can be observed that all the three investigated species viz *Pterocarpus milbreadii*, *Ficus exasperata,* and *Musanga cecropoides* were of high-density range according to the wood grade classification of Panshin and DeZeew (1980); making them suitable for use as materials in applications requiring medium to high-density wood species e.g.cladding, panelling, fencing, boats and outdoor decks, columns and beams, as well as other structures that require wood of suitable strength performance.

These results are similar to those reported of Afzelia *africana* wood by Akpan, *et al*(2013), as well as other species such as *Eribroma ablonga* (670kg/m^3), *Chlorophora excelsa* (660kg/ m^3)*, Mansonia altissima* (615kg/ m^3)*, Khaya ivorensis* (485kg/ m^3), *Terminalia superba* (580kg/ m^3). *Mitragyna ciliata* (560kg/ m^3) (Akpan, 2010; Desh, 1992; Ghelmeziu,1981).It is also in consonance with the generic range of wood densities (i.e. 160kg/m^3 – 1250kg/m^3) as opined by Desch(1992).

Concerning the specific gravity, as shown in Table 3, it can be observed that the specific gravity of the wood species followed a similar pattern as their density, confirming the fact that both are related (Jamal *et al*,2013). The high specific gravity values of these species is an indication that they would find utility in applications of high strength and mechanical performance requirement; as the specific gravity and density serves as excellent indices for the assessment of the physical and mechanical properties of wood(Green *et al*., 2003).

On the other hand, the results for the percentage water absorption of the wood species as presented in Table 4 shows that on a species basis, water absorption decreased in the order *Musanga cecropoides >Ficus exasperate > Pterocarpus milbreadii.* This trend is in agreement with Wahab (2016). This shows that wood with a larger particle or fibre size absorbs more water (Tajvidi, 2006). Larger fibres lead to greater hydrophilic exposures and poor adhesion between wood particles and the matrix generates void spaces among wood particles. The dimensional stability as determined by the percentage volumetric shrinkage revealed that shrinkage decreased in the order *Musanga cecropoides > Ficus exasperata>Pterocarpus milbreadii* on species basis. These values are however, lower than those reported for other indigenous wood species such as *Khaya ivorensis* and *Celtis mildbraedii* with percentage volumetric shrinkage values of 12.94% and 12.29%respectively as reported by Jamala (2013) and *Afzelia africana*(18.70%)recorded by Akpan, *et al.*(2013), as well as *Sterculia rhinopetala* (20.9%), *Distemonanthus benthamianus* (20.6%), *Uapaca guineensis* (19.9%), *Lophira alata* (19.8%)*,Strombosia pustulata* (19.7%) (Ghelmeziu ,1981). This implies that *Musanga cecropoides*, *Ficus* exasperata, and *Pterocarpus milbreadii* wood are more dimensionally stable than the other species reported in this literature; making them suitable for use in applications such as windows, doorposts and furniture making where movements in service could lead to failure and of course with cost implications.

Table 1: Mean Density of Different Wood Species at Different Orientation

AXIAL	*Musanga cecropoides*	*Pterocarpus milbreadii*	*Ficus exasperata*
TOP	661.67^{a}±0.08	803.47^{a} ±0.09	688.06^{a} ±0.07
MIDDLE	625.56^{a} ±0.13	760.69^{a} ±0.11	649.58^{a} ±0.26
BOTTOM	569.44^{a} ±0.23	855.69^{a} ±0.04	695.83^{a} ±0.14
AVERAGE	**618.89^{k}** ±0.15	**806.62^{i}** ±0.08	**677.82^{ij}** ±0.16
RADIAL	***Musanga cecropoides***	***Pterocarpus milbreadii***	***Ficus exasperata***
INNER	593.89^{a} ±0.20	819.86^{a} ±0.03	738.75^{a} ±0.06
OUTTER	643.33^{a} ±0.17	863.33^{a} ±0.04	746.81^{a} ±0.21
AVERAGE	**618.61^{j}** ±0.18	**841.60^{i}** ±0.04	**742.78^{ij}** ±0.13

Means with the same letter are not significantly different (Duncan's Multiple Test at *P*=.05) *: Significant

Table 2: Mean Specific Gravity of Different Wood Species at Different Orientation

AXIAL	*Musanga cecropoides*	*Pterocarpus milbreadii*	*Ficus exasperata*
TOP	0.80^{a} ±0.01	0.82^{a} ±0.02	0.80^{a} ±0.01
MIDDLE	0.79^{a} ±0.02	0.83^{a} ±0.03	0.81^{a} ±0.01
BOTTOM	0.79^{a} ±0.01	0.83^{a} ±0.02	0.80^{a} ±0.03
AVERAGE	**0.80^{j}** ±0.01	**0.83^{i}** ±0.02	**0.80^{j}** ±0.02
RADIAL	***Musanga cecropoides***	***Pterocarpus milbreadii***	***Ficus exasperata***
INNER	0.79^{a} ±0.02	0.83^{a} ±0.02	0.79^{a} ±0.02
OUTTER	0.78^{a} ±0.03	0.82^{a} ±0.02	0.80^{a} ±0.03
AVERAGE	**0.78^{j}** ±0.02	**0.83^{i}** ±0.02	**0.79^{j}** ±0.02

Means with the same letter are not significantly different (Duncan's Multiple Test at *P*=.05) *: Significant

Table 3: Mean Water Absorption of Different Wood Species at Different Orientation

AXIAL	*Musanga cecropoides*	*Pterocarpus milbreadii*	*Ficus exasperata*
TOP	0.83^{a} ±0.17	0.29^{a} ±0.13	0.52^{a} ±0.22
MIDDLE	0.91^{a} ±0.04	0.29^{a} ±0.12	0.53^{a} ±0.21
BOTTOM	0.81^{a} ±0.17	0.34^{a} ±0.12	0.52^{a} ±0.23
AVERAGE	**0.85^{i}** ±0.13	**0.31^{j}** ±0.12	**0.52^{k}** ±0.22
RADIAL	***Musanga cecropoides***	***Pterocarpus milbreadii***	***Ficus exasperata***
INNER	0.92^{a} ±0.05	0.30^{a} ±0.16	0.47^{a} ± 0.06
OUTTER	0.88^{a} ±0.10	0.36^{a} ±0.14	0.45^{a} ±0.10
AV ERAGE	**0.90^{i}** ±0.07	**0.33^{k}** ± 0.15	**0.46^{j}** ±0.08

Means with the same letter are not significantly different (Duncan's Multiple Test at *P*=.05) *: Significant

Table 4: Mean Volumetric Shrinkage of Different Wood Species at Different Orientation

AXIAL	*Musanga cecropoides*	*Pterocarpus milbreadii*	*Ficus exasperata*
TOP	5.85[a] ±0.84	2.80[a] ±0.40	3.06[a] ±1.01
MIDDLE	6.48[a] ± 0.23	2.66[a] ±0.23	3.19[a] ±0.69
BOTTOM	6.50[a] ± 0.19	3.18[a] ±0.39	3.58[a] ±0.68
AVERAGE	**6.28[i]** ±0.42	**2.88[j]** ±0.34	**3.28[j]** ±0.79
RADIAL	***Musanga cecropoides***	***Pterocarpus milbreadii***	***Ficus exasperata***
INNER	5.57[a] ± 0.80	3.19[a] ±0.70	2.79[a]± 1.05
OUTTER	6.38[a] ± 0.03	2.39[a] ±0.01	2.92[a] ±0.93
AVERAGE	**5.98[i]** ± 0.41	**2.79[j]** ±0.35	**2.86[j]** ±0.99

Means with the same letter are not significantly different (Duncan's Multiple Test at *P*=.05) *: Significant

Conclusion

The results of this study have provided baseline qualitative and quantitative information on the physical properties of Nigerian grown *Musanga cecropoides*, *Ficus exasperate,* and *Pterocarpus milbreadii* wood species found in the Niger-Delta region, and which can be very useful to wood users, industries, and other stakeholders in the wood industry.

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