MODULUS OF RUPTURE AND MODULUS OF ELASTICITY OF *Allanblackia floribunda* OLIV, WOOD AT THE AXIAL AND TANGENTIAL PLANES IN OYIGBO, RIVERS STATE

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Abstract

The study was carried out in Marihu Ndoki at Oyigbo Local Government Area of Rivers State aimed at assessing modulus of rupture (MOR) and modulus of elasticity (MOE) Allanblackia floribunda. Three mature Allanblackia floribunda trees were selected randomly from Marihu Ndoki forest in Oyigbo Local Government Area of Rivers State: samples collected randomly from the felled trees were trimmed to standard test specimens 20 x 20 x 300mm and taken to Forestry Research Institute of Nigeria (FRIN), Ibadan where Hounsfield Tensometer was used to measure MOR, MOE. The results showed that MOR was highest at the top (63.12 N/mm^2) followed by bottom (48.75N/mm^2), middle was the lowest (28.32N/mm^2) in the axial direction. There was significant difference ($P<0.05$) in modulus of rupture in the axial direction within trees, but within the trees there was no significant difference ($P>0.05$) in MOR. The result showed that MOR on the tangential plane outer wood had the highest (78.75 N/mm^2) followed by core wood (67.50 N/mm^2), middle wood was the lowest (50.63 N/mm^2) in the radial direction. There was significant difference ($P<0.05$) in MOR in the tangential direction within trees and among trees. The result of modulus of elasticity (MOE) was highest at the bottom (25836.96 N/mm^2) followed by top (23991.00N/mm^2), middle was the lowest (13289.12N/mm^2) in the axial direction. There was no significant difference ($P>0.05$) in MOE in the axial direction and within trees.MOE was highest at the middle wood and core wood (33219.00 N/mm^2) followed by outer wood (16609.41N/mm^2) in the radial direction. There was significant difference ($P<0.05$) in MOE in the tangential direction and within trees. This implies that the wood has high bending strength and stiff especially withstanding load perpendicular to grain-how much weight it carry without breaking along the grain. The wood is recommended for moderate or heavy load.

Key words: *Modulus of Rupture, Modulus of Elasticity, Axial and Tangential planes*

Introduction

Basically, mechanical properties of wood refer to the strength behaviour of wood under applied forces, the behaviour is modified in a number of ways, depending upon the kind of force exerted on the wood and the basic differences in the organization of wood have already been noted. Force, expressed on the basis of unit area or volume, is known as stress (Jessome, 2007). According to Samuel (2004) the mechanical properties of wood are its fitness and ability to resist applied or external forces. By external force is meant any force outside of a given piece of material which tends to deform it in any manner. It is largely such properties that determine the use of wood for structural and building purposes and innumerable other uses of which furniture, vehicles implements, and tool handles are a few common examples.

In Nigeria, many of our wood species are over exploited and threatened to extinction. The utilization of other lesser-used and lesser known wood species like *Allanblackia floribunda* needs to be looked at as urgently as possible in order to increase the wood resource base of the country. Successful expansion of the resource base is dependent on adequate knowledge of the properties of wood.

This study assessed modulus of rupture and modulus of elasticity of *Allanblackia floribunda* wood at the axial and tangential planes at Marihu Ndoki forest at Oyigbo Local Government Area of Rivers State.

Materials and Methods

Three matured *Allanblackia floribunda* trees were selected randomly from Marihu Ndoki forest in Oyigbo Local Government Area of Rivers State. The sample trees were felled with power saw; samples collected randomly from the felled trees were trimmed to the specified dimensions. The samples were taken to Forestry Research Institute of Nigeria (FRIN), Ibadan. The wood specimens were oven dried at 103^{o}C and conditioned to required moisture content of 19-21% in order to reduce wood defects or dimensional instabilities.

Modulus of rupture (MOR)

The standard test specimens 20 x 20 x 300mm (L x W x T) were extracted from felled trees and MOR was measured using a Hounsfield Tensometer.
MOR was calculated using this formula

$$MOR = \frac{3PL}{2bd^2}$$

Where

P = maximum load at failure (N)

L = span of the material between the supports (mm)

b = width of the material (mm)

d = thickness of the material (mm)

The unit of MOR is N/mm^2

Modulus of elasticity (MOE)

The samples were cut to 20 x 20 x 300mm. The Modulus of Elasticity was calculated from the values obtained at the point of failure was recorded during tests for MOR. MOE was calculated using the formula

$$MOE = \frac{PL^3}{\Delta bd^3}$$

Where

P = maximum load at failure (N)

L = span of the material between the supports (mm)

b = width of the material (mm)

d = depth in (mm)

Δ = the deflection of beam at proportional load

Experimental Design and Data Analysis

The experiment was carried using the Completely Randomized Design-CRD involving four treatments in three replicates. The data collected were analyzed by means of the one-way analysis of variance (ANOVA) of Steel and Torrie (1982). Significantly different mean values were statistically separated using the SPSS (2011) new Duncan's Multiple range Tests technique.

Results

The results showed no significant difference (P<0.05=0.0005) in Modulus of Rupture in the axial direction, but within the trees there was no significant difference (P>0.05=0.2687) in Modulus of Rupture in axial direction (Table 1). There was significant difference (P<0.05) in modulus of rupture in the tangential direction within trees and among trees (Table 1).

Table 1: Summary table of ANOVA of wood mechanical properties

	MOR	MOE
Within trees	$P>0.05^{NS}$	$P>0.05^{NS}$
P-value	0.2687	0.2515
Axial direction	P<0.05*	$P>0.05^{NS}$
P-value	0.0005	0.3293

*Significant Difference at Probability level of 0.05. P-value-probability values

Modulus of Rupture

The result showed MOR that is load the wood can withstand perpendicular to grain was highest at the top (63.12 N/mm^2) followed by bottom (48.75N/mm^2), middle was the lowest (28.32N/mm^2) in the axial direction (Figure 1).

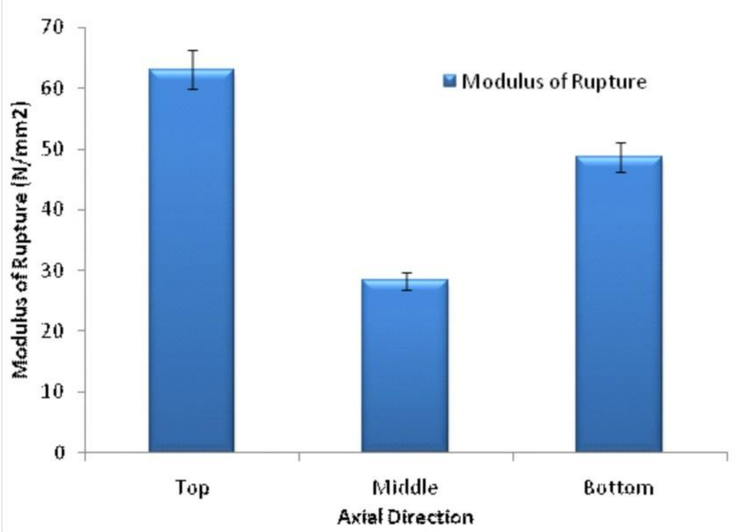

Figure 1: Modulus of rupture in axial direction

Modulus of Rupture-Tangential Plane

The result showed that outer wood had the highest MOR (78.75 N/mm^2) followed by core wood (67.50 N/mm^2) middle wood was the lowest (50.63 N/mm^2) in the radial direction (Figure 2).

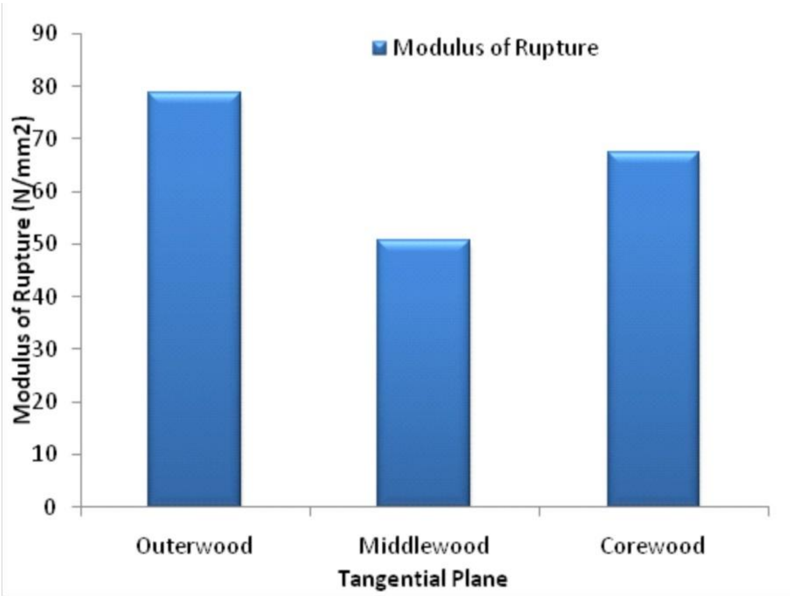

Figure 2: Modulus of rupture in tangential plane

Modulus of elasticity

The modulus of elasticity (MOE) was highest at the bottom (25836.96 N/mm^2) followed by top (23991.00N/mm^2), while the middle of trees had the lowest (13289.12N/mm^2) in the axial direction (Figure 3). Though, there was no significant difference (P>0.05) in modulus of elasticity in the axial direction and within trees (Table 1).

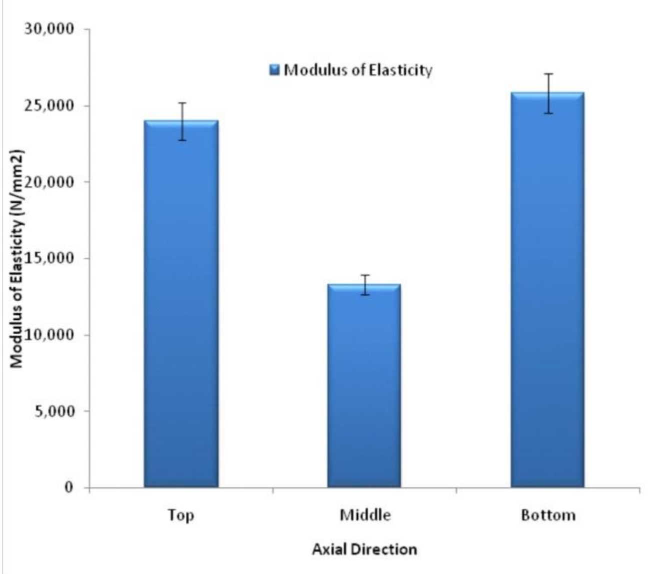

Figure 3: Modulus of elasticity in axial direction

Modulus of Elasticity-Tangential Plane

The Modulus of Elasticity (MOE) was highest at the middle wood and core wood with the same value (33219.00 N/mm^2) followed by outer wood (16609.41N/mm^2) in the radial direction (Figure 4). This shows that the middle wood and core wood deflected (sagged) than the outer wood. There was significant difference ($P<0.05$) in Modulus of Elasticity in the tangential direction and within trees.

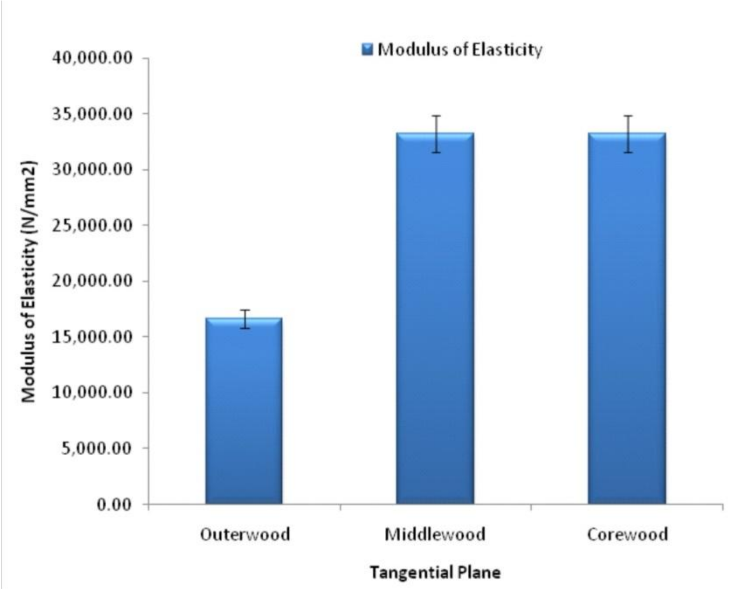

Figure 4: Modulus of elasticity in tangential plane

Discussion

Results showed that the wood of *Allanblackia floribunda* can withstand load perpendicular to grain (MOR) which ranged from 28.32N/mm^2 to 48.75N/mm^2 which is lower than wood of *Allanblackia parviflora* with MOR ranging from 85.00N/mm^2 to 94.00N/mm^2 (Kwaku, *et al.*, (2014). The result of test of significance shows that there was significant difference within the topmost part of the wood which means that uppermost part of the species is the strongest: would carry much load without breaking than any other parts on the radial and axial planes. This finding indicates that the topmost part of the wood would carry much load without breaking than any other parts on the radial and axial planes. On the tangential plane, the modulus of rupture (MOR) result ranged from 67.50 N/mm^2 to 78.75 N/mm^2. The Modulus of Rupture in the tangential direction within trees and among trees there was no much difference within them. This shows that the outer wood could withstand highest load perpendicular to grain. This shows that the outer wood could withstand highest load perpendicular to grain.

The Modulus of Elasticity (MOE) which is the measure of resistance of the wood, this ranged from 13289.12N/mm^2 to 25836.96 N/mm^2 higher than those of *Allanblackia parviflora* and *Terminalia ivorensis* with MOEs of 8875.00 N/mm^2 and 9300.00 N/mm^2 respectively (Kwaku, *et al.,* 2014). Since difference in the wood in both axial direction and within trees was not much, this indicates that stiffness or how much load the wood will deflect when a load is applied perpendicularly to grain; the bottom deflected load than the rest parts axially Panshin, and De Zeeuw, (1980).

Summary and Conclusion

The study of *Allanblackia floribunda* wood has revealed that it exhibits some outstanding strength properties that would enhance its general utilization characteristics. The topmost part of the tree has more strength properties-MOR, MOE than other parts, followed by the middle. Across the wood sections, the core wood near the pith being the strongest indicates that it could withstand load than any other parts tangentially. This implies that the wood has high bending strength and stiff especially withstanding load perpendicular to grain-how much weight it carry without breaking along the grain. The wood is recommended for moderate or heavy load.

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