Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 75 (2014) 27367-27370

ISSN: 2229-712X

Mechanical properties of *Chrysophyllum albidum*: a lesser used species

Aguda l. O*, Adejoba O.R, Areghan, S. E, adejoba, A. L and Areo A. S
Forestry Research Institute of Nigeria, P.M.B. 5054, Ibadan, Oyo State, Nigeria.

ARTICLE INFO

Article history:
Received: 28 November 2012;
Received in revised form:
20 September 2014;
Accepted: 29 September 2014;

Keywords
Chrysophyllum albidum,
Lesser Used Species,
Mechanical Properties,
Tensometer,
Corewood,
Middlewood,
Outerwood.

ABSTRACT
This study investigates the mechanical properties of Chrysophyllum albidum to determine its potential for utilization in Nigeria. The test samples were obtained from tree at breast height. Results of test on Chrysophyllum albidum showed that the mean impact bending was 1.08m which increased from the corewood to the outerwood and remained constant upward along the tree. The mean MOR was 155.18N/mm^2, which ranged from 151.46 to 157.53N/mm^2 radially. Also the axial values ranged from 158.77 to 152.58N/mm^2. There was an increase in MOR from the corewood to the outerwood and there is a decrease in MOR from the top of the tree (25%) to the base (75%). The mean MOE was 39309.04N/mm^2, and ranged from 36303.84 to 40409.65N/mm^2 radially and from 40993.7 to 39547.57N/mm^2 axially. There was an increase in MOE from corewood to the outerwood. Conversely, there was a decrease from the base to the top of the tree.The mean maximum compression strength parallel to the grain was 45.55N/mm^2, the highest value was obtained at the middlewood and decrease from the base (25%, 46.91N/mm^2) to the top (75%, 43.95N/mm^2) of the wood. In conclusion, a comparison of the strength properties values obtained with economic tree species such as Milicia excelsa, Mansonia altissima, Khaya species e.t.c shows that Chrysophyllum albidum wood has almost the same values with these economic species.

Introduction

Wood is a substance of a greater complexity than any other major engineering materials, and its utilization under the competitive conditions of modern technology calls for a degree of scientific and technical understanding not possessed by most of its competitors. It exhibits a lot of variations in properties like durability, strenght, figure, density and grain (Eberhardt, 2007). Due to these diversities in natural and character, exploitation of trees for structural and construction purposes was selective and limited to the very strong and durable species such as Milicia excelsa, Khaya sp., Afzelia africana, Nauclea diderrichii, Triplochiton scleroxylon, Terminalia sp. and Cordia millenii (Ifebueme, 1997; Onilude and Ogunsanwo, 2002). The over exploitation of these species has led to their scarcity in the timber market and their high cost.

The rate at which the forest is being depleted due to population growth, indiscriminate logging, removal for constructional purposes and farming is alarming (Adekunle et al, 2002). NEST (1991) puts the annual lost at 30,000 ha. Today the 10% of land area under reserve (9.5 million ha), falls short of the 25% originally proposed by FAO (1989) policy.

Therefore, this has given way to the introduction of Lesser-Used Species (LUS) into the timber market as demand for wood and its products for building and construction purposes are increasing (Oluwadare and Somorin, 2007). They also serve as a potential substitute to the endangered wood species. As stated by Hansom (1983), LUS is defined as that wood species that is not being put to best advantage (although many commercial wood species are not being put to best advantage either). The term “Lesser Used Species” does not imply wood species that are not known but are currently not commonly exploited for utilization (Adejoba, 2007). There have been attempts to commercialize many more less ultilised wood species as it was belief to be the main weapon against the scarcity and escalating cost of the already known wood species (Lucas, 1983). The availability of mechanical properties, physical properties and technical wood processing information are important factors in promoting the acceptance of LUS by manufacturers (along with long-term resource supply) (Smith, 2000).

Chrysophyllum albidum a lesser-used species belongs to the family of SAPOTACEAE a fruit tree with dearth of information on its wood properties. Its use for making roof components have become fashionable in low cost building in emerging areas in Ibadan, Oyo state, Nigeria because of its abundance (Adewole and Baruwa, 2010). It is imperative that evaluation of its mechanical properties are determined prior to utilization as the incessant collapse of buildings and other structures and its attendant problems portent grievous dangers for the end users (Adetogun, 2010). This study therefore determines the mechanical properties of Chrysophyllum albidum to ascertain its proper utilization.

Materials and Methods

Th wood species for this study was obtained from Onigambari Forest Reserve, Oyo state Nigeria. Standing trees of chrysophylum albidum was selected and cut for this study. Three trees was felled and converted at the spot because of the transportation problem. The planks were then transported to the department of Forest Products Development and Utilization (FPD&U) FRIN for further conversion.

Selection of Bolt

Bolt of 1.2 m (4 ft) was selected from strategic positions, at the base (25%), middle (50%) and top (75%) of merchantable height (Mitchell and Danne, 1997). The cross sectional surfaces of the bolt were prevented from decay by spraying them with a 5% solution of sodium pentachlorophenate and transported for further conversion and processing to experimental samples

Tele:
E-mail addresses: larryall2000@yahoo.com

Conversion and Allocation to Test Specimen

The bolts of 50cm long were marked and cross-cut at three different possition along the mechantable length of the tree. The bolt were label UP and LP representing the upper and lower portions of the test materials. The label portion were maintained throughout the wood conversion process. The 100 mm X 400 mm radial strips were converted to the test specimens of standard size of 20 mm X 20 mm X 300 mm and 20 mm X 20 mm X 60 mm in accordance with British Standard (BS 373) 1989 with some adoptions from the proceedures described by Okigbo and Comben (1965) using a circular saw at the workshop of the Forestry Research Institute of Nigeria, FRIN, Ibadan. From each tree, 90 samples (20 mm x 20 mm x 300 mm) were gotten, 45 samples for impact bending strength test determination using the Hatt- Turner Impact Testing Machine, 45 samples were for static bending strength and 45 samples for maximum compresssive strength test pararell to grain using Hounsfield Tensometer machine at the Forestry Research Istitute of Nigeria, Ibadan.

Tests For Mechanical Properties

All test samples were selected from the centre plank. The test samples were converted to standard sizes of 20 mm X 20 mm X 300 mm and 20 mm X 20 mm X 60 mm in the workshop of the Forestry Research Institute of Nigeria using Tensometer machine according to the British Standard BS373 (1989). Ten test specimens were taken each from the corewood, middlewood and outerwood for each height level at the base 25%, 50% and 75%.

Determination Of Modulus Of Rupture (Mor)

The MOR was determined using specimen size 20 mm X 20 mm X 300 mm taken from the centre plank in accordance with the British Standard Method BS373 (1989). The test samples were prepared such that growth rings were made parallel to one edge.

The load was applied at the rate of 0.1mm/sec using the Hounsfield tensometer at the Forest Product Development and Utilization department of FRIN. The maximum load was noted. The bending strength of wood is usually expressed as MOR, which is the equivalent fibre stress in the extreme fibres of the specimen at the point of failure and it is calculated using the formula;

$$MOR = \frac{3PL}{2bd^2} \quad N/mm^2$$

Where P = Maximum load at the moment of failure
L = Length between support (mm)
b = Breadth of beam (mm)
d = Depth of beam (mm)

Determination of Modulus Of Elasticity (Moe)

The samples used for MOR (20 mm X 20 mm X 300mm) in the tensometer were left to fail. The values obtained at the point of failure during the test for MOR were used to calculate the

Modulus of Elasticity

The load deflection graph plotted on the testing machine during the MOR test provides the calculation for the delta an addition to the parameter that were earlier defined in MOR. The MOE was then calculated using the formula

$$MOE = \frac{PL^3}{4\Delta bd^3} \quad N/mm^2$$

Where P = Load in Newton
L = Length between support (mm)
b = Width of beam (mm)
d = Depth of beam (mm)
Δ = the deflection at the centre of the beam.

Determination Of Compression Strength

The test samples of 20 mm X 20 mm X 60 mm were used according to the provision of BS 373 (1989) method of testing small clear specimen of timber. A tensomer with a special jig was used. This was to ensure uniform distribution of load over the cross section so as to prevent buckling. Load was applied and the corresponding force at the point of failure was taken directly on the scale and recorded. The maximum compressive strength parallel to grain was obtained by dividing the force at point of failure by the cross-sectional area (N/mm^2).

Determination Of Impact Bending Test

This was done using the impact testing machine at Forestry Research Institute of Nigeria (plate 4). Test samples of 20 mm X 20 mm X 300 mm, according to BS 373 (1989), were supported over a span of 240 mm on a support with a radius of 15 mm. This was subjected to repeat drops of a weight of 1.5 kg at increasing height until complete failure occurred. This height was noted and recorded as the height of maximum hammer drop.

Results and discussion

Table 1: mean values of selected mechanical properties of chrisophyllum albidum

Wood property	Wood Type Base	Sample 25%	Height 50%	75%	Mean
Impact Bending	Core wood	1.04	1.04	1.04	1.04
	Middle wood	1.09	1.09	1.09	1.09
	Outer wood	1.12	1.12	1.12	1.12
	Mean	1.08	1.08	1.08	1.08
MOR	Core wood	158.62	149.27	146.27	151.39
	Middle wood	158.20	156.16	155.24	156.53
	Outer wood	159.48	157.09	156.02	157.53
	Mean	158.77	154.17	152.58	155.15
MOE	Core wood	37601.76	36002.33	35307.41	36303.83
	Middle wood	41846.97	41143.11	40650.81	41213.63
	Outer wood	43532.37	35012.10	42684.48	40409.65
	Mean	40993.70	39547.57	37385.85	39309.04
MCS//	Core wood	46.20	45.40	43.80	45.13
	Middle wood	46.70	46.34	44.36	45.80
	Outer wood	47.83	45.61	43.68	45.71
	Mean	46.91	45.78	43.94	45.55

Impact Bending Strength

The mean value of impact bending was 1.08m ranging from 1.04 to 1.12m across the tree, with an increase from the corewood to the outerwood and remain constant from base to the top. The result of the analysis of variance for the radial direction shows no significant difference at 5% level. Meanwhile, within the sampling height all the values are the same while the outerwood also recorded the highest mean value of 1.12m. Impact bending strength generally increased from the corewood to the outerwood. The increase in impact bending strength across the tree agrees with the findings of Ogunsanwo (2000), Adedipe (2004) and Adejoba (2008) which show an increase in impact bending strength from corewood to outerwood for

Triplochiton scleroxylon, Gmelina arborea and Ficus mucuso respectively.

Modulus of Rupture (Mor)

The mean MOR was 155.18N/mm^2, which ranged from 151.46 to 157.53N/mm^2 radially. Also the axial values ranged from 158.77 to 152.58N/mm^2. There was an increase in MOR from the corewood to the outerwood and there is a decrease in MOR from the top of the tree (25%) to the base (75%). The result of the analysis of variance shows that sampling height position and radial position have no significant difference at 5% level of significance. Samples taken at 25% have the highest mean values (158.77 N/mm^2) while outerwood sample also recorded highest mean value of 157.53 N/mm^2 as against corewood (151.46 N/mm^2).

The increase in modulus of rupture from the corewwod to the outerwood, agrees with the findings of Fuwape and Fabiyi (2003) on Nauclea diderrichii which had a similar increase in the MOR. Ogunsanwo (2000), Bada (1990), Adejoba (2008), Adedipe (2004) reported a similar trend of MOR increase from corewood to outerwood on Triplochiton scleroxylon, Ficus mucuso and Gmelina arborea wood. The MOR increases from the base upward. This pattern of variation disagree with the finding of Fuwape and Fabiyi (2003) on Nauclea diderrichii and of Ogunsanwo (2000), and Adedipe (2004) on the axial variation of Triplochiton scleroxylon, Ficus mucuso and Gmelina arborea. According to Biblis (1994), MOR decreases as the position of sampling moves up the tree. The reports further noted that defects such as knots which affect flexural properties could limit the relationship between MOR and sampling height, hence the variation observed might be due to the effects of defect in the tree. The variation may also be due to the fact that wood is a natural material hence: it is subject to many changing influences (Green et al, 1999).

Modulus Of Elasticity (Moe)

The mean MOE was 39309.04 N/mm^2, and ranged from 36303.84 to 40409.65 N/mm^2 radially and from 40993.7 N/mm^2 to 39547.57N/mm^2 axially. There was an increase in MOE from corewood to the outerwood. Conversely, there was a decrease from the base to the top of the tree. Analysis of variance in shows that sampling height position and radial position have no significance difference at 5% level of significance. This trend of variation was observed in the work of Fuwape and Fabiyi (2003) on Nauclea diderrichii, Adejoba (2008) on Ficus mucuso, Ogunsanwo (2000) on Triplochiton scleroxylon and Adedipe (2004) on Gmelian arborea.

Compression Strength Parallel To Grain (Cs//)

The mean of maximum compression strength parallel to grain was 45.55 N/mm^2, which varies from 45.13 to 45.80N/mm^2 across the tree and 46.91 N/mm^2 to 43.95 N/mm^2 along the tree. The compression strength increased from corewood to outerwood while the CS// along the tree decreased from base to top of the tree. The analysis of variance shows that there was no significant difference in terms of the CS// for both the sampling height and the sampling parts.

CS// increased from the corewood to the outerwood in agreement with the report of Adedipe (2004) on Gmelina arborea. Similarly, the decrease in CS// from the base to the top agrees with Adedipe (2004) on Gmelian arborea. This variation maybe due to the natural variation in the wood and the variability in wood properties, especially morphological characteristics (Adejoba, 2008).

Conclusion

The impact bending strength remains constant at 1.08m from the base upward while increased from the corewood to the outerwood. Modulus of rupture showed an inconsistent decrease from the base upward while an increase was observed from the corewood to the outerwood. Modulus of Elasticity showed a decrease from the base (25%) to middlewood (50%) and increased from middlewood to the outerwood with the base 25% and the outerwood (75%) having the highest values. The compression strength parallel to the grain decreased from the base upward and increased from the corewood to the middlewood and thereafter decreased.

The compression strength was found at the base and middlewood. A comparison of the strength values with other economic tree species shows that Chrysophyllum albidum has high strength.

Generally, strength values obtained were almost the same with those of the economic tree species such as Milicia excels, Khaya species and Mansonia altissima etc.

References

Adedipe, O.E. 2004. Machining and mechanical properties of plantation grown

Gmelina arborea wood. Thesis submitted for the Award of Master of Agricultural Technology, Department of Forestry and Wood Technology, Federal University of Technology, Akure. 81.

Adejoba, O.R. and Onilude, M.A. (2010). Selected Machining Properties of Ficus mucuso; a lesser-Used Wood Species. Proceedings of 2nd Biennial National Conf. of the Forests and Forest Products Society: 330-333

Adejoba, O.R. (2008). Lesser-Used wood species in Akure and their relevance to Sustainable Forest management. Journal of Nigeria environmental society vol4, No 2 Pp. 181-186

Adejoba, O.R. (2008). Evaluation of Ficus Mucuso`s (Welw.Ex Ficalho) Wood Properties And Their Variations Ph.D. Thesis, Dept. of Agriculture and Environmental Engineering, University of Ibadan, 197pp.

Adekunle, V.A., Akande S.O. and Fuwape J.A. (2002). Impacts of over exploitation on biodiversity yield and sustainable use of tropical rainforest ecosystem: A case study of Omo Forest Reserve, South West Nigeria. Proceedings of the 28th annual conf: Forestry Association of Nigeria: 252-263.

Adewole A.N. and M.A. Baruwa. (2010). Suitability of Chrysophyllum albidum Wood For Fabrication of Howe truss for use in simple roof systems. Proceedings of the 33rd Annual conf. Of the Forestry Association of Nigeria: vol 2. Pp106-119.

Aguda, L.O., Baiyewu, R.A., Adejoba, O.R.,Opara,I.U. and Jayeoba, W.A. (2010).

Lesser known wood species: How Bright is their future. Proceedings of 2nd Biennial National Conf. of the Forests and Forest Products Society: 178-182.

ASTM, 1994. American Society for Testing and Materials Standard Methods of conducting machining test of wood based materials. Annual Book of ASTMD 166-87. ASTM, West Conshohocken PA. 226-245.

British Standard Institution (1989). BS373 Methods of Testing clear small specimen of Timber. British Standard Institution, London. 20pp.

Fuwape, J.A. and Fabiyi, J.S. (2003). Variation in strength properties of plantation grown Nauclea diderichii wood. Journal of Tropical Forest Products 9 (1&2): 45-53.

Ogunsanwo, O. Y. 2000. Characterization of wood properties of plantation grown Obeche (Triplochiton scleroxylon K. schum) in Omo Forest Reserve, Ogun State, Nigeria. Ph.D. Thesis. Dept. of Forest Resources Management University of Ibadan. 272pp.

Oluwadare A. Oluwafemi and Somorin O. Adegbenga (2007): Preliminary report on Ultilization Potential of Gliricidia sepium (Jacq.) Steud for timber. Research Journal of Forestry.

Onilude, M.A., Dada, S. A., Ogunwusi, A. A. 1988. Wood properties of five selected Nigeria tree species grown in the Savanna belt. Nigeria Journal of Forestry Vol.18 (1&2): 24-27.