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

Environment and Forestry

Elixir Environ. & Forestry 86 (2015) 35075-35077

ISSN: 2229-712X

Influence of Mechanical Properties on Utilisation Potential of Mangifera indica L. Wood for Furniture Industries

Areo, O.S[1], Adejoba[1], O.R and Omole, O.A[2]

[1]Forestry Research Institute of Nigeria, P.M.B 5054, Jericho hill, Ibadan.

[2]Forest Resource Management Department University of Ibadan, Ibadan, Nigeria.

ARTICLE INFO

Article history:

Received: 8 July 2015;
Received in revised form:
1 September 2015;
Accepted: 11 September 2015;

Keywords

Mangifera indica L,
modulus of elasticity,
modulus of rupture,
Impacts bending,
Lesser-used Species (LUS).

ABSTRACT

Wood properties of plantation grown (Mangifera indica L.) were evaluated in this study to determine the utilization potentials of this species in Nigeria. Five standing trees of Mangifera indica, were sampled at the butt, 50% merchantable length ML and 75% ML, and were radially partitioned into corewood, middlewood and outerwood, on the basis of distance from pith. Result obtained was analyzed using ANOVA at 5% level. MOR, MOE and MCS// decreased generally from base to top for all the sampled and variation in MOE was inconsistent. All properties studied increased from corewood to outerwood. The mean modulus of rupture (MOR) was 25.88N/mm^2 which ranged 18.73 to 31.88 N/mm^2 radially and the axial values ranged from 23.30 to 25.29 from 32.89 N/mm^2.The mean modulus of elasticity (MOE) was 4628.20 N/mm^2 and ranged from 7135.20 to 3665.60 N/mm^2 radially and axially ranged from 4077.90 to 7334.20 N/mm. The mean maximum compressive test (MCS//) parallel to the grain was 13.00 N/mm^2, it ranged from 11.50 to 18.0 N/mm^2 radially while axially ranged from 11.30 to 14.60N/mm^2. In particular, it was observed that Mangifera indica compared favourably with some economic tree species such as Chrysophyllum albidum, Hevea brasiliensis, Antaris africana and Hildergedia barteri but lower than those of economic tree species such as Milicia excelsa, khaya species, e.t.c. Woods of Mangifera indica varied significantly along and across the bole, and should be treated as such in their conversion and utilization. The wood is good in the production of low-to-medium items such as cabinet, chair frames and plywood production.

Introduction

Wood is one of the oldest and most satisfying craft (Green, et. al., 1999). Wood possesses quite a number of advantages which render it more suitable than metals for structural and constructional purpose, it is obvious that wood is cheap to produce and to purchase than metals. Wood is also much lighter in weight and does not rust as the case of metal but it is susceptible to fungi and insect attack (Nunez and Elisea, 1997). Wood remains the major product from most forest and knowledge of its nature form the basis for its improvement both in quality and better utilization (Koliman and Cote, 1968). Wood and wood products play important roles in many developing economy; first as a source of domestic energy (fuelwood), and as foreign exchange earner and employment Exploitation of Nigerian forest has been centred on the commercially known wood species, this constant demand for these wood species has rendered some of them endangered and the once rich natural forest of Nigeria has now become seriously depleted (Oke and Oyun, 1997). There is need therefore to explore the forest resources in the country to shift attention to the lesser-used wood species (LUS) in order to allow time for the economic trees to mature (Adejoba, 2009). Furthermore, Nigerian timber merchants have embarked on efforts at shifting toward utilization of substitute species which have been identified through indigenous knowledge. These species are lesser-used and not popular at the intended market because of inadequate knowledge about their properties and performances in service (Ajala, 2006). In order to further promote these LUS, information on their wood quality as revealed in the wood mechanical properties must be available to expand the market resource base and make more raw materials available to the timber industry while taking some of the pressure off the few economical timber species. According to Addae-Mensah, (1998). Mangifera indica (Anacardiaceae) is an indigenous tree commonly grown in most countries. M. indica trees are long-lived evergreen trees that can reach 15-30m (50-100ft) high. Most cultivated mango trees are between 3 and 10m (10-30ft) tall, when fully matured, depending on the variety and the amount of pruning. Wild, non-cultivated seedlings trees often reach 15m (50ft) when found in favourable climates and can reach 30m (100ft) in forest situations. Mangifera indica can live for over 100 years and develop trunk girths of over 4m (13ft) (Kartesz, 1996). The availability of technical wood processing information will further promote the acceptance of lesser-used species (LUS) by wood merchants and manufacturers along with long-term resource supply (Smith, 2000). The right and efficient use of Mangifera indica as well as the determination of its end use demands a full knowledge of its physical and mechanical properties (Oluyide et. al., 1982; Ogunsanwo, 2000). This study therefore investigates the mechanical properties of Mangifera indica as a LUS 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

Materials for the study were obtained from Forestry Research Institute Arboretum of Forestry Research Institute of Nigeria, Oyo State, Nigeria. Four trees of Mangifera indica were

Tele:
E-mail addresses: areosola73@gmail.com

randomly selected and felled to obtain the sample required. From each felled tree, bolt were obtained at the base (25%), middle (50%) and top (75%) of the merchantable height according to Smalian principle. The radial strips were partitioned into three zones on the relative distance from the pith. Ten samples each were obtained and tested for compressive, static bending and impact bending test in accordance with BS 373 (1989).

Data obtained were subjected to analysis of variance and mean comparism test, which provide adequate scientific explanation for the effects of the sources of variation as well as their interaction influences on the specimen strength.

Results and Discussion

Table 1. Mean values of selected mechanical properties of Mangifera indica

Property	Wood type	Sampling height				N
		Top	Middle	Base	Mean	
Modulus of rupture MOR (N/mm^2)	Corewood	36.54	26.22	32.89	31.88	120
	Middlewood	21.31	43.13	16.66	27.03	120
	Outerwood	18.01	17.82	20.34	18.73	120
	Mean	25.29	29.06	23.30	25.88	360
Modulus of elasticity MOE (N/mm^2)	Corewood	564.9	5767.0	15076.7	7136.2	120
	Middlewood	2334.9	2933.0	3980.4	3082.8	120
	Outerwood	2546.7	3333.0	3605.6	3665.6	120
	Mean	1815.5	4077.9	7334.2	4628.2	360
Maximum compressive strength parallel to grain (N/mm^2)	Corewood	10.8	1.8	21.9	11.5	120
	Middlewood	11.1	1.6	13.3	8.7	120
	Outerwood	11.3	35.3	8.5	18.6	120
	Mean	11.3	13.0	14.6	13.0	360
Impact bending strength IBM (m)	Corewood	0.3	0.2	0.3	0.3	120
	Middlewood	0.4	0.4	0.4	0.4	120
	Outerwood	0.4	0.4	0.4	0.4	120
	Mean	0.4	0.3	0.4	0.4	360

Note: N - total number of samples.

The results of the selected mechanical properties of the wood species are presented in Table 1, similarly the result of analysis of variance for all properties of Mangifera indica is presented in Table 2.

The decrease in modulus of rupture from the corewood to the outerwood is in accordance with the findings of Fuwape and Fabiyi (2003) on Nauclea diderrichii and Adejoba and Onilude, (2009) on Ficus mucuso. The MOR decreases axially (base to top). This pattern of inconsistent of variation agrees with Adedipe, (2004) on the axial variation of Gmelina arborea. This variation may also be due to the fact that wood is a natural material hence; it is subject to many consistently changing influences (Green, et. al; 1999).

Analysis of variance in Table 2 reveals that there was no significant difference among the four trees for all the parameter tested. There was no significant difference as well for the interaction between trees to tree position and between trees to sampling height for all the parameters measured.

The modulus of elasticity (MOE) increases from the corewood to the outerwood which is in line with trend of variation observed by Ogunsanwo (2000) on Triplochiton scleroxylon and Adejoba and Onilude (2009) on Ficus mucuso. Analysis of variance (Table 2) shows that there is no significant difference between all sources of variation tested on the MOE at 5% probability level. Maximum Compressive Strength Parallel to the Grain (MCS //) increases significantly from the corewood to the outerwood in agreement with Adejoba and Onilude (2009) on Ficus mucoso and submission of Adedipe (2004) on Gmelina arborea. Similarly, the decrease in MCS from the base to the top agrees with Adejoba and Onilude (2009). The variation may also be due to the fact that natural variation exists in the wood and the variability in wood properties, especially their morphological characteristics.

Table 2. ANOVA for the test parameters

Dependent variable	*Source*	*Type III sum of square*	*df*	*Mean Square*	*F*	*Sig.*
Modulus of Rupture	Tree position	1529.404	2	764.702	211.883	0.000*
	Sampling height	302.586	2	151.293	41.920	0.000*
	Tree * Tree Position	0.566	2	0.283	0.078	0.925
	Tree * Sampling Height	0.828	2	0.414	0.115	0.892
	Tree Position * Sampling Height	2418.316	4	604.579	167.516	0.000*
	Tree *Tree position * Sampling Height	1.257	4	0.314	0.087	0.986
Modulus of Elasticity	Tree position	5187037.825	2	2593518.912	22479.057	0.000*
	Sampling height	65212927.0	2	32606463.48	282613.1	0.000*
	Tree * Tree Position	0.672	2	0.336	0.003	0.997
	Tree * Sampling Height	2.107	2	1.054	0.009	0.991
	Tree Position * Sampling Height	42956347.4	4	10739086.84	93079.923	0.000*
	Tree *Tree position * Sampling Height	2.534	4	0.634	0.005	1.000
Max. Compressive Strength	Tree position	895.234	2	447.617	1219.081	0.000*
	Sampling height	110.644	2	55.322	150.668	0.000*
	Tree * Tree Position	0.667	2	0.333	0.908	0.412
	Tree * Sampling Height	0.095	2	0.048	0.130	0.879
	Tree Position * Sampling Height	4176.195	4	1044.049	2843.456	0.000*
	Tree *Tree position * Sampling Height	0.788	4	0.197	0.537	0.710
Impact Bending	Tree position	0.045	2	0.023	133.054	0.000*
	Sampling height	0.241	2	0.121	707.489	0.000*
	Tree * Tree Position	0.000	2	0.000	0.533	0.592
	Tree * Sampling Height	0.000	2	0.000	0.207	0.814
	Tree Position * Sampling Height	0.155	4	0.039	226.870	0.000*
	Tree *Tree position * Sampling Height	0.000	4	0.000	0.435	0.783

Analysis of variance in Table 2 however shows that there is no significant difference in the interaction between tree to tree position and sampling height. This inconsistency in pattern of variation was noticed by Panshin and Dezzeuw (1980) on the cell wall thickness of the mechanical properties especially the MCS//.

Impact Bending Strength (IB) increases from the middlewood to the outerwood for the tree position and decreases from the base to the top of the sampling position of the wood species. Table 2 shows that the mean for sampling height and the tree position.

Conclusion and Recommendations

The MOR showed an inconsistent increase from base to the top while the MOR at the middle has the highest value which means the MOR is more significant at the middle for the sampling height. However, this behaviour is not unexpected, as it is similar to reports given on some tropical hardwood species (Sanwo, 1986, Ogunsanwo, 2000, Ogunsanwo, et. al., 2005). But the tree position at the corewood shows the highest significance. MOE showed a decrease from the base upward and a decrease from the outerwood to the corewood. The highest values for MOE were also observed at the base of the sampling height at the corewood. Maximum compression strength (MCS) shows an inconsistent value along the tree position. The MCS shows an increase from the corewood to the outerwood. The MCS strength was observed at the base of the tree and at the outerwood portion of the tree.

Table 3. Comparison of strength properties of commercial timber species with Mangifera indica

Name of species	MOR (N/mm^2)	MOE (N/mm^2)	IMB (m)	MCS// (N/mm^2)
Hildergedia barteri	33.6	32.90	0.25	16.94
Antiaris africana	39.9	45.50	0.25	30.45
Daniella oliveri	68.6	55.30	0.58	34.44
Milicia excels	83.3	79.10	0.48	55.09
Khaya senegalensis	95.9	81.20	0.89	50.40
Afromosia laxiflus	125.3	116.2	0.91	71.54
** Mangifera indica*	25.9	46.28	0.49	13.00

Source: Ajala, 2012

The impact bending strength decreases at the middle while it increases from the corewood to the outerwood. The values obtained compared with the strength values of other economic species shows that Mangifera indica strength properties compared favourably with some economic species such as Antiaris africana and Hildergadia bateri. While such species as Milicia excelsa,and Khaya spp has their strength values higher than that of Mangifera indica. It was observed that the strength properties along and across the tree varied significantly. In all, it was observed that Mangifera indica compared favourably with some economic tree species such as Antaris africana and Hildergedia barteri but lower than those of economic tree species such as Milicia excelsa, khaya species, Mansonia altissima e.t.c as shown in table 3. Mangifera indica being a fruit tree can however be utilized for items subjected to low-medium furniture products such as cabinet making, chair and composite products. It is thereby recommended that further work should be done on the working properties of the tree as well as proper silvicultural management to enhance and ensure good form formation and reduced knot along the growth pattern of the tree.

References

Addae-Mensah (1998): M. indica varieties, Green Eating Queensland department of primary industries, Brisbane, Australia.

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 Wood Products Technology, Federal University of Technology, Akure. Pp 81

Adejoba, O. R and Onilude, M. A (2009): Axial and Radial variations in Mechanical property of Ficus Mucuso. Journal of Agricultural technology and Rural Development, Vol 1No 1 pg 32.

Ajala, O. O (2012): Evaluation of the physical and mechanical properties of Aningeria robusta (A.chev) M Phil Thesis at the Department of Forest Resource Management, University of Ibadan. Pg 130.

Green, D. W., Winandy, J. E and Krestchmann, D. E. (1999): Mechanical properties of wood. Wood handbook: wood as an engineering material. Madison, WI: USDA Forest service, Forest Products Laboratory, 1999. General technical report FPL; GTR-113: pg1-4, 45.

Kartesz John (1996): Biota of North America Project (BONAP), University of North Carolina,

Koliman, F. F. P., and Cote Jr., W. A. (1968): Principle of wood science and technology. Pub. Springer Verlag Berlin. Pp 592.

Nunez, N. R. and Elisea, O. K. (1997): Reproductive Physiology of Mango. In: Litz, Op. Australia.

Ogunsanwo, O. Y. (2000): Wood processing and Utilization in Nigeria. The Nigeria Journal of Foretsry Vol 2 No 3 pg 55.

Ogunsanwo, O. Y., Erakhrumen, A. A., Adetogun, A.C. and Ajala, O. O. (2005): Strength properties of "tapped" rubber Wood (Hevea braziliensis muel. Arg.) : In the University of Ibadan rubber plantation. Ibadan Journal of Agricultural Research. 1(2) 56-60

Oluyide, A. O., Nurudeen, A. A and Thanni, Y. A., (1982): Fundamental of wood work practice. Evans Brothers Ltd pg19.

Panshin, A. J. and Dezeeuw (1980): Test book of wood technology, fourth edition. Mc. Gray Hill Book Company. Pp 722.

Sanwo, S. K. (1986): Prediction of modulus of elasticity for plantation grown Teak in Nigeria. Journal ofTropical Forest Resources, Vol. 2, pp.18-22.

Smith, P.M. (2000): Utilization of Lesser-used species as alternative raw materials for forest based industries. International Tropical Timber Org. Yokohama, Japan.pg 95.