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Preliminary Report on Utilization Potential of *Gliricidia sepium* (Jacq.) Steud for Timber

Oluwadare A. Oluwafemi and Somorin O. Adegbenga
Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria

Abstract: Declining availability of the prime economic species in timber market has led to the introduction of Lesser-Used-Species (LUS). Their acceptability demands information on their wood technical properties. This study investigates wood properties of *Gliricidia sepium* to determine its potential for timber in Nigeria. Test specimens obtained from three trees at breast height were prepared according to BS 373 standard and Poku *et al*. (2001). Hatt-Turner impact machine and Hounsfield Tensometer were used to determine mechanical properties. Mean Moisture Content (MC) of 8.62% was insignificantly lower in the wood nearest the pith. Wood Basic Density (WBD) was significantly ($p<0.05$) heavier (1062.7 kg m^{-3}) nearest the pith than nearest the bark (987.8 kg m^{-3}) with a mean of 1025.3 kg m^{-3}. Tangential (TS) and Volumetric Shrinkage (VS) were significantly higher in the wood nearest the bark with mean of 4.3 and 6.9%, respectively. Mean impact bending was 0.65 m with no significant difference between the wood samples. Modulus Of Rupture (MOR) and elasticity (MOE) were significantly higher (153.8, 7678.1 N mm^{-2}) nearest the pith than 85.8 and 5580.21 N mm^{-2} for wood nearest the bark, respectively. Significant correlation exists between MC vs WBD, $r = -0.82$; RS vs TS, $r = 0.91$ and VS, $r = 0.97$; TS vs VS, $r = 0.97$; IB vs MOR/MOE, $r = -0.83$ and MOR, $r = 0.89$; MOR vs MOR/MOE, $r = 0.90$; MOR/MOE vs RS, $r = -0.91$ and MOR/MOE vs VS, $r = -0.86$. *G. sepium* has potential to be a major LUS timber and could substitute some economic species in Nigeria's timber market.

Key words: Basic density, lesser-used species, strength properties, shrinkage, *Gliricidia sepium*

INTRODUCTION

Wood as a natural lingo-fibrous material produced by tree has been one of the earliest structural materials discovered by man. It exhibits a lot of variations in properties in terms of durability, strength, figure, density and grain (George, 1975). Due to this diversity in nature and character of wood, 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, 1977; Onilude and Ogunsanwo, 2002). The over exploitation of these species has led to their scarcity in the timber market. This has given way to the introduction of Lesser-Used Species (LUS) in the timber market as demand for wood and its products for building and construction purposes are increasing daily.

Plantation forestry has become the practicable tool for meeting the wood requirements of many nations and mechanical properties of wood aid in the selection of any species for building and construction (FPL, 1987). *Gliricidia sepium* is an exotic species introduced into Nigeria as a source of

Corresponding Author: Oluwadare A. Oluwafemi, Department of Forestry, Faculty of Agriculture, Shabu-Lafia, Nasarawa State University, Keffi, Wildlife and Fisheries, P.M.B. 135, Lafia, Nasarawa State, Nigeria Tel: +234-803-570-8930

fuelwood. However, its use has been mainly for fodder, life-fencing, manure and shades (Glover, 1989; Stewart and Simons, 1996). It can grow to a height of 15 m if not pollarded, tolerate dry season and fire and can be propagated easily from seeds and branches (Lavini, 1996; Simons, 1996). It has a distinctly dark brown heartwood and yellowish band of sapwood which could be mistaken for *Milicia excelsa, Afzelia africana* and *Nauclea diderichii* planks. The heartwood is resistant, very hard and heavy, strong, coarse-textured, with an irregnlar grain. It seasons well and takes high polish (Elevitch and Francis, 2006).

It has been mentioned by Quintanar *et al*. (1997), Elevitch and Francis (2006) and Greijmans (2007) that the wood is good for building, construction and furniture making however there are no quantitative data to support this claims. The provision of such data on the mechanical properties of *G. sepium* will be of great significance to knowing the uses that this species conld be put to. Also, there have been a lot of studies on the chemical and livestock uses of this species (Bennison and Paterson, 1993; Elevitch and Francis, 2006; Greijmans, 2007) however, information on the strength properties is virtually lacking. The dearth of information on the technical properties of this species perhaps is responsible for its non availability in the timber market in Nigeria.

Wood structures that are well constructed without adequate knowledge of the strength properties of the wood used performed poorly when compared with engineered structures (Soltis, 1994). The success of LUS in the timber market requires technical information that relates to utilization about the species (Poku *et al*., 2001). It is therefore imperative that the provision of technical information on this species is necessary as this will enhance its success and acceptability in the timber market. This study investigates selected indices of strength properties of *Gliricidia sepium* wood as a preliminary step to unveil its technical properties for building and construction purposes. The linear relationships between these properties were equally discussed in the study.

MATERIALS AND METHODS

The study site is University of Ibadan Campus, it is situated at about 5 km North of Ibadan city on Latitude 7°27′N and Longitude 3°54′E at an altitude of 200 m. The mean annual rainfall is 1200 mm with distinct wet (April-October) and dry (November-March) seasons. Mean monthly temperature is between 26- 28°C with February being the hottest month.

Wood samples of *G. sepium* were obtained within University of Ibadan Campus. They were those planted as life fencing poles which have been pollarded severally. A bolt of 45 cm from three trees obtained at breast height was cut and later sawn to obtain wood specimens for characterization according to BS 373 (BSI, 1989; Poku *et al*., 2001).

Determination of Physical and Mechanical Properties

Wood bolts sawn and cut into 20×20×300 mm dimension according to British standard specification BS 373 (BSI, 1989; Poku *et al*., 2001) were prepared. A cube specimen measuring 20×20×20 mm was cut from failed test specimens to study moisture content, wood basic density and shrinkage for woods nearest the pith and bark, respectively. All the test specimens from each tree were pooled together to determine the mechanical properties namely impact bending, Modnlus Of Rupture (MOR) and elasticity (MOE). The Hatt-Turner impact Testing machine and Hounsfield Tensometer machine were used to determine the tests. Basic wood density was determined by the oven-dry weight to volume measurements.

Statistical Analysis

ANOVA was used to test the significance of the treatment means (wood nearest the pith and wood nearest the bark) at $p<0.05$ probability level. Correlation analysis was used to test the relative association among the parameters selected.

RESULTS AND DISCUSSION

Physical Properties

Table 1 shows the physical properties measured. Moisture content was low with a range of 8.44 to 8.80% and a mean of 8.62%. It is more in the wood nearest the bark than in the heartwood zone. The mean value is less than 12.0% often reported in literatures for most hardwood species (Ogunsanwo, 2000). Quintanar *et al*. (1997) opined that the abundance of crystals in the heartwood zone may be responsible for a low hygroscopic capacity of the wood from this zone. This may be one of the reasons for its resistance to termite and decay. Wood with high moisture content is highly susceptible to greater degree of decay unless it is well seasoned. The Wood Basic Density (WBD) was significantly different ($p<0.05$) between the wood zones. The wood (mainly heartwood) nearest the pith had higher value of 1062.7 kg m^{-3} than those nearest the bark (987.8 kg m^{-3}).The mean of 1025.3 kg m^{-3} is higher than most economic species in the timber market in Nigeria and West African coast (Brown, 1978; Poku *et al*., 2001; Ogunsanwo and Onilude, 2002; Amartey *et al*., 2004) but within the range of 0.2 to 1.2 kg m^{-3} for hardwoods (Valkomies, 2006). This result supports the remarks made by Quintanar *et al*. (1997), Elevitch and Francis (2006) and Greijmans (2007), that the wood is heavy. The greater value of the wood from the pith zone may be due to deposition of extraneous materials (crystals) in conjuction with occulusion of the cell lumina and wall arising from growth of tyloses. These with cell wall thickness which has been reported to be thicker in this species (Quintanar *et al*., 1997) to greater extent could have influenced the density of the wood; this calls for further investigation. The wood of *G. sepium* conld be compared with those of *Dalbergia melanoxylon*, *Diospyrus* sp. and *Lophira alata* (Brown, 1978; Ogunsanwo and Onilude, 2002). Density has been shown to be a good indicator for selection of wood for use (Poku *et al*., 2001). It means that the wood of *G. sepium* could find use in areas where heavy wood is required for construction. Therefore, the wood of *G. sepium* could be a major LUS in the timber market and conld substitute those economic species which are already scarce in the timber market. Since density of wood has been used as a single indicator to express wood quality and utilization potential of any species for different end-uses, it may be interesting that timber from Gliricidia may find more uses for different building and construction purposes.

In Table 1, radial shrinkage showed no significant difference between the wood zones. However, tangential shrinkage was higher in the wood nearest the bark (4.6%) than wood nearest the pith (3.9%). The average value of 4.3% was moderate for a denser wood like *G. sepium* compared with 6.9% obtained for the wood of *Petersianthus macrocarpus* with a specific gravity of 0.69 (Poku *et al*., 2001). It is most likely that the wood of *G. sepium* will be stable in service as depicted by the ratio of tangential shrinkage to radial shrinkage in Table 1. This may be one of the reasons why the wood of Gliricidia seasons very well with little or no defect as wood which are low in tangential shrinkage tend to have low movement in service. The wood conld be useful for exterior purposes as claimed by Quintanar *et al*. (1997), Elevitch and Francis (2006) and Greijmans (2007).

Mechanical Properties

In Table 2, impact bending was insignificantly different between the wood zones with a mean of 0.65 m, though it is higher in wood nearest the bark. This may be due to the presence of sapwood in some of the specimens from this zone. The mean value is similar to that of *Triplochiton scleroxylon* (Ogunsanwo, 2000). However, MOR was significantly ($p<0.05$) higher in the wood nearest the pith (153.85 N mm^{-2}), than in the wood at the periphery (85.8 N mm^{-2}). The mean value of 119.8 N mm^{-2} is almost twice the value (61.9 N mm^{-2}) obtained for *Triplochiton scleroxylon* (Ogunsanwo and Onilude, 2002), but less than 136.1 N mm^{-2} obtained for wood of teak from slow growing provenance in India (Bhat and Priya, 2004). Similarly, MOE was significantly higher in the wood closest to the

Table 1: Physical properties of *Gliricidia sepium* wood

Physical properties	Wood zones		Mean	F-value	p-value
	Nearest the pith	Nearest the bark			
Moisture content (%)	8.44a	8.80a	8.62	0.994	0.421ns
Basic density (kg m^{-3})	1062.70a	987.80b	1025.30	5.260	0.029*
Radial shrinkage (%)	2.30a	2.80a	2.60	0.987	0.430ns
Tangential shrinkage (%)	3.90a	4.60b	4.30	4.637	0.039*
Volumetric shrinkage (%)	6.20a	7.40b	6.90	4.644	0.039*
Ratio of tangential/radial shrinkage	1:1.70	1:1.64	1:1.65		

*: Significance at p<0.05, ns = not significance, Means with the same letter(s) within row are not significantly different LSD p<0.05

Table 2: Mechanical properties of *Gliricidia sepium* wood

Mechanical properties	Wood zones		Mean	F-value	p-value
	Nearest the pith	Nearest the bark			
Impact bending, IB (m)	0.61a	0.68a	0.65	1.104	0.302ns
Modulus of Rupture, MOR (N mm^{-2})	153.80a	85.80b	119.80	2.974	0.025*
Modulus of elasticity, MOE (N mm^{-2})	7678.10a	5580.20b	6629.20	7.850	0.021*
Ratio of MOR/MOE	1:50	1:65	1:55		

*: Significance at p<0.05, ns = not significance, Means with the same letter(s) within row are not significantly different LSD p<0.05

Table 3: Simple correlation coefficients indicating linear relationships among selected physical and anatomical properties

	MC	WBD	RS	TS	VS	IB	MOR	MOE	MOR:MOE
MC	-								
WBD	-0.82*	-							
RS	0.65	-0.15	-						
TS	0.47	-0.04	-0.08	-					
VS	0.54	-0.08	0.97*	0.97*	-				
IB	0.52	-0.07	0.77	0.46	0.64	-			
MOR	0.74	-0.47	0.68	0.38	0.57	0.89*	-		
MOE	0.40	-0.24	0.23	-0.18	0.04	0.77	0.79	-	
MOR:MOE	-0.78	-0.78	-0.91	-0.74	-0.86*	-0.83*	0.90*	-0.46	-

*: Significant relationship at p<0.05

pith (7678.1 N mm^{-2}) compared with 5580.2 N mm^{-2} for the wood nearest the bark. The mean value of 6629.2 N mm^{-2} is higher than 6239.4 N mm^{-2} obtained for *Triplochiton scleroxylon* plantation wood. However, the wood is inferior to that of Teak (Sanwo, 1986; Bhat and Priya, 2004), the ratio of MOR: MOE further stressed this as shown in Table 2. The higher values obtained for both MOR and MOE for wood specimens nearest the pith may not be unconnected with the higher wood density obtained within this zone. In Ghana and Nigeria, *Triplochiton scleroxylon*, *Milicia excelsa*, *Khaya* sp. and *Tectona grandis* are major economic timbers for export and for various end-uses locally. However, Poku *et al.* (2001), Ogunsanwo (2002) and Amartey *et al.* (2004) argued that these species are fast declining in the timber market, there is need to find suitable substitute for them. The results obtained in this study may eventually provide wider avenues to explore the technical characteristics of Gliricidia wood rather than limiting it to the traditional uses of life fencing, fodder crops mulch and agro-forestry.

Correlation of Wood Properties

The simple correlation coefficients in Table 3 elucidate the extent of linear relationships among the wood properties. Moisture content significantly and negatively correlated with wood basic density (r = -0.82) and ratio of MOR/MOE (r = -0.78). On the contrary wood basic density had weak and negative correlation with all the wood properties with MOR having the highest correlation (r = -0.47). The shrinkage directions (radial and tangential) were highly correlated (r = 0.91 and 0.97). Of the three mechanical properties, impact bending was more correlated with radial shrinkage (r = 0.77), ratio of

MOR/MOE (r = -0.83) and MOR (r = 0.89). MOR had greater correlation with moisture content (r = 0.74) and MOE (r = 0.79). The linear relationships among the indices measured may be used as indicator of their predictive power one from the other.

CONCLUSIONS

This preliminary study has shown that the wood of *Gliricidia sepium* is a potential LUS that could find a major value in the timber market. The density of the wood is high and could be put into useful purposes where heavy wood is needed for construction. The mechanical properties were comparable and superior to other hardwood species and thus make it a potential substitute to those over-exploited species that are fast disappearing from the timber market. The results obtained in this study has provided quantitative information on the mechanical properties of Gliricidia which hitherto has not been provided to support claims that the wood is strong, heavy and useful for building and construction.

With this preliminary study, there may be need to consider *G. sepium* as a plantation species for timber production.

More trees will be sampled for axial and radial variation. This should be done in both pollarded and non-pollarded trees.

There would be need to investigate the anatomical and chemical properties of the wood and how this relate to strength properties.

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