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Original Article

Evaluation of wood qualities of *Tectona grandis* Linn. F. plantation in University of Ibadan, Nigeria

OPEN ACCESS

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A B S T R A C T

This study examined selected wood qualities of *Tectona grandis* Linn. F. plantation in the University of Ibadan, Nigeria for sustainable management. Five even-aged merchantable teak stands with diameter at breast height (DBH) ≥ 50 cm were randomly felled. Wood samples from DBH, base (10%), middle (50%), and top (90%) axial positions and partitioned into radial zones (core, middle, and outer growth rings). The physical properties: Moisture Content (MC), Density (D), Longitudinal Shrinkage (LS), Radial Shrinkage (RS), Tangential Shrinkage (TS), and Volumetric Shrinkage (VS), and mechanical properties: Dimensional Stability (DS), Modulus of Elasticity (MOE), Modulus of Rupture (MOR), and Maximum Compressive Strength (MCS) were determined using standard procedures. Data collected were subjected to descriptive, analysis of variance and correlation analyses. Significant means were separated using the least significant difference. The results revealed that MC, D, LS, RS, TS and VS had pooled means (axial and radial variations) of 12.18%, 636.08 kg/m^3, 2.22%, 3.98%, 3.84%, and 7.81%, respectively. Wood density and shrinkage coefficients varied slightly across the axial and radial positions of the stands. The DS, MOE, MOR and MCS (parallel to the grain) had pooled means of 1.85, 985.46 N/mm^2, 43.30 N/mm^2, and 49.20 N/mm^2, respectively. Significance ($p<0.05$) was recorded across all the radial axis. A positive and significant correlation was observed between MOE and MOR. The study concludes that the plantation had more dense wood, which contributes to stronger and more durable wood, making it suitable for various structural applications. Hence, regular silvicultural management practices are recommended to maintain the wood stiffness, strength and dimensional stability.

K E Y W O R D S : *Axial and Radial Variations, Mechanical Properties, Physical Properties, Shrinkage*

INTRODUCTION

Wood, a natural polymer and fibrous material forms a core part of a living tree primarily around the trunk area, protected and covered by the bark (Mongam, 2017). The intrinsic properties, including its mechanical, physical, and anatomical characteristics, have made it a widely used resource in both the tropics and temperate regions for various applications, especially in construction and building (Riki *et al.,* 2020). Its physical properties encompass colour, lustre, odour, taste, density of wood, hardness, shrinkage, equilibrium moisture content. Mechanical (strength) properties, which reflect changes when any external force is applied to wood, are great indicators of timber quality for structural purposes (Hassani, 2018).

Teak is a renowned tree species and as a result of its fine structure and value as a wood utilised for timber production (Shukla & Viswanath, 2023.). Due to its many

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positive traits and qualities, such as fine grain and longevity, as well as its resistance to weather, insects, and fungi (Choudhary *et al.,* 2023), teak wood is appropriate for a variety of uses. As a result of these, Teak is, nonetheless, being planted in many nations as a quick-growing species in diverse plantations due to its high demand and numerous uses. It is known for its strong dimensional stability, durability, and natural mechanism against rot (Sasidharan, 2021). *Tectona grandis*, a well-known timber species in the tropics widely utilised in the wood industry for construction, furniture and buildings, boat building, and also for carbon sequestration is faced with this recent rising problem such as over-stretching of the species which is a great concern to timber users, it is widely destroyed in the course of sourcing for high quality ones. It is a ring-porous tree with visible rings that serve as a proxy to depict its age and also density for the computation of other mechanical attributes. It was discovered that the ones in the tropics are stronger and more durable (Bhat, 2001).

The increasing prominence of teak in the timber market highlights the need for a thorough understanding of its physical and mechanical properties, which are key indicators of its strength and suitability for various applications. Despite teak's well-known properties, comprehensive knowledge about how properties such as wood density, specific gravity, modulus of elasticity, ring width, compressive strength parallel to the grain, shrinkage behaviour, and modulus of rupture vary and relate to its sustainable utilisation is still limited. The gap in knowledge is key as it affects sustainable management and utilisation practices. This study evaluates the physio-mechanical properties and relationship between wood density and other selected physical and mechanical properties to inform sustainable management practices of *Tectona grandis* (teak) in the University of Ibadan Teak Plantation.

MATERIALS AND METHODS

Study Area

The study area is the teak plantation on the University of Ibadan campus, Nigeria with Teaching, Research, and Conservation of forest resources as the main objective of its establishment. It is a man-made plantation of over 70 years old with a mean density of 759 tree ha^{-1}, lying between Latitudes of 7º 45.106' N to 7º 45.834' N and Longitudes of 3º 90.942' E to 3º 90.508' E with a total area of 47.21ha (Chukwu *et al.,* 2018). It has a mean altitude of 227m above sea level. The climate of Ibadan, the city in which the plantation is located is characterised by two seasons, wet and dry season. The wet season lasts from March to October, whereas the dry season begins in November and ends in February. The average annual temperature is 31.3°C, while the average annual rainfall is 1258 mm (Adejuwon, 2022). In the mid-wet season of July and August, there is also a slight dry season that predominates in the area. The plantation is bounded by the Ajibode community in the west, the University of Ibadan in the East, the botanical garden in the North, and the Orogun stream, Laniba settlement in the South.

Sampling Technique

Purposive sampling was adopted because the teak plantation consists of even-aged trees. Wood samples were selected from five *Tectona grandis* trees of the same age and an average DBH of 50.36 cm in the University of Ibadan Teak plantation. Destructive sampling was employed to fell the trees to appropriately examine the variation in the mechanical properties within the tree and between the trees. The trees with straight bole, no buttress, and standing uprightly not leaning trees were selected to avoid selecting reaction woods. From the felled trees at the DBH, five bolts of 50 cm size were harvested and wood discs were cut with a thickness of 5cm for the ring analysis (Adenaiya & Ogunsanwo, 2016). Also, bolts of 50cm size were harvested from different levels of the trees axially, 10% (base), 50% (middle), and 90% (top) of the tree trunk. In total, 20 bolts were harvested. The wood billets were transported to the departmental sawmilling workshop for wood processing into the various dimensions needed using a circular saw.

Methods of Data Collection

The specimens for wood density were obtained by using dimensions of 2cm × 2cm × 6cm test specimens from the outer, middle, and inner growth ring regions. In total, 120 samples were obtained, 24 samples from each tree.

Determination of Physical Properties

Wood Density (Basic Density)

Each of the bolts was partitioned based on the relative distance from the pith radially; inner, middle, and outer depending on the age of the tree (Adenaiya & Ogunsanwo, 2016). Wood samples were obtained from each of these wood zones with dimensions of 2cm × 2cm × 6cm and oven-dried for 18 hours at 103°C. In the total, the basic density was estimated using this formula;

$$\rho = \frac{Oven-dried\ weight\ of\ wood}{Green\ volume\ of\ wood} \qquad (1)$$

The unit is kgm^{-3}

Moisture Content

An electronic weighing balance was used to weigh each test specimens of 2 cm by 2 cm by 6 cm. After the test specimens were originally weighed and their initial weight was recorded, they were heated to 103°C for 18 hours, cooled in a desiccator with silica gel, and then weighed again. It was then put back in the oven for a further two hours. Measured after being chilled in a desiccator. This procedure was carried out again until a steady weight was reached. The moisture content was determined using ASTM D 4442-84 (1984).

This formula was used:

$$Mc= \frac{Wm-Wo}{Wo} \times 100 \quad (2)$$

Where: MC=Moisture Content, Wm = Weight of the test wood samples before oven-drying (g) Wo = Weight of the test wood samples after oven-drying (g)

Shrinkage Coefficient Determination

Standard procedures were used to carried out the shrinkage and the dimensional shrinkage in longitudinal, radial, and tangential directions was calculated using the correlation below:

$$TGS = \frac{Dt-dt}{dt} \text{ x } \frac{100}{1} \quad (3)$$

$$RDS = \frac{Dr-dr}{dr} \text{ x } \frac{100}{1} \quad (4)$$

$$LGS = \frac{Dl-dl}{dl} \text{ x } \frac{100}{1} \quad (5)$$

Where:
TGS =Tangential shrinkage
RDS = Radial shrinkage
LGS = Longitudinal shrinkage
Dt = Tangential dimension (mm) at MMC
Dr = Radial dimension (mm) at MMC
Dl = Longitudinal dimension (mm) at MMC
dt = Tangential dimension(mm) at oven-dry at MMC
dr = Radial dimension (mm) at oven-dry MMC
dl = Longitudinal dimension (mm) at oven-dry MMC method adopted from Riki *et al*., (2019)
MMC- Maximum Moisture Content ≥ 30%

$$VS = S_R + S_T \quad (6)$$

Where: VS=Volumetric Shrinkage, S_R=Radial Shrinkage, S_T=Tangential Shrinkage. This is in accordance with approximations done by Dinwoodie (1989).

Determination of Mechanical Properties

Dimensional stability was calculated by dividing the Tangential (T) shrinkage by the Radial (R) shrinkage. Tangential values are typically double those of radial, therefore the T/R ratio ranges from 1.4 to 2 according to method adopted by Adi *et al.,* (2020).

Determination of Modulus of Rupture (MOR)

British Standard Method BS 373 (1957), was followed for describing the MOR. This required employing a Universal Testing Machine and standard test specimens measuring 2 cm by 2 cm by 30 cm (20 × 20 × 300 mm). The growth rings of the test specimen were parallel to the direction of loading when the load was applied at a rate of 0.1 mm/sec.

The following formula was used to determine the bending strength of wood, expressed as MOR:

$$MOR= \frac{3PL}{2bd2} \quad (7)$$

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

Determination of Modulus of Elasticity (MOE)

The Modulus of elasticity was calculated from the values obtained at the point of failure recorded during tests for MOR according to BS 373 (1957). The MOE was calculated using the formula:

$$MOE= \frac{PL3}{\Delta bd3} \quad (8)$$

Where:

P= Maximum Load at failure (N), L=Span in mm, b=Width in mm, d= Depth in mm

Δ= The deflection of the beam centre at a proportional limit is calculated as the gradient of the load-deformation curve plotted during the MOR test.

Determination of Maximum Compressive Strength (MCS) Parallel to Grain

A test specimen of 2 cm by 2 cm by 6 cm (20 X 20 X 60 mm) was used to measure the maximum compressive strength parallel to the grain according to BS 373 (1957). Up until failure, the load was applied at a rate of 0.01 mm/sec, and the associated force was measured at this time. Next, using the following formula, the Maximum Compression (MCS) parallel to grain was determined:

$$CS= \frac{Pmax}{ab} \quad (9)$$

Where: CS=Compressive strength (N/mm^2), Pmax= Maximum Load (N), a=length of sample mm, b= breadth of sample mm

RESULTS AND DISCUSSION

Axial and Radial Variations of Wood Physical and Mechanical Properties

Table 1, 2, 4 and 5 depict the summaries of the mean values of selected physical properties and mechanical properties of wood samples of *Tectona grandis* along the axial and radial directions. The physical properties: moisture content (MC), density(D), longitudinal shrinkage (LS), radial shrinkage, tangential shrinkage, and volumetric shrinkage had pooled mean of 12.14%, 636.03kg/m^3, 2.22%, 3.84%, 3.94%, and 7.78% axially and 12.22%, 636.13 kg/m^3, 3.84%, 2.22%, 4.01% and 7.84% along radial direction respectively. Meanwhile selected mechanical properties: Dimensional stability had a pooled mean of 2.037, 986.225 N/mm^2 for Modulus of Elasticity, 43.479 N/mm^2 for Modulus of Rupture and 49.23 N/mm^2 for Maximum Compressive Strength along the axial direction and with 1.670, 984.691 N/mm^2, 43.213 N/mm^2 and 49.160 N/mm^2 for dimensional stability, modulus of elasticity, modulus of rupture and for maximum compressive strength respectively across the radial direction of the sampled species.

There are significant differences among all the selected physical and mechanical properties ($P < 0.05$) axially except for the density, tangential and volumetric shrinkages of all the sampled species while all the selected properties show a different pattern of variation across the radial direction (Table 3).

The mean wood density and moisture content of *Tectona grandis* obtained in this study indicated the amount of water present in the wood, which is similar to the average values of 622.20 kg/m^3 at 12 % moisture content reported by Sharma & Shukla (2024). Wood density is an important indicator of wood quality and is closely related to its mechanical properties, such as strength and stiffness. Dense woods such as *Tectona grandis* are generally stronger and more durable, making it suitable for structural applications. This is why this tree species is renowned in the timber market in the tropics as stated by Adetan *et al.,* (2018) and Global Teak Study (2023). This study provides an understanding of variation in density along different axial and radial positions of the sampled trees which can help in optimising sustainable wood utilisation both within the selected physical and mechanical properties. This is supported by the previous research by Riki *et al.* (2019) which reported that the wood density of *P. carribaea* varies significantly along the radial direction from the pith to the bark, but not along the height direction. The mechanical support that wood provides in the stem and branches of living trees is one of its primary uses; hence, even after wood is converted into a product, this feature remains crucial for a variety of applications (Telles Antonio *et al.,* 2017). The DS, MOE, MOR and MCS found in this study are high according to classification by Dávalos & Bárcenas (1998) and they are comparable with mechanical properties of *Tectona grandis* wood from a commercial plantation in the State of Michoacán in Mexico (Telles Antonio *et al.,* (2017).

Table 1: Summary of Mean values of selected Physical Properties of Wood Samples of *Tectona grandis* on the Axial Position

Wood properties	Axial position	T1	T2	T3	T4	T5	Pooled Mean
Moisture Content (%)	DBH	10.511	11.801	11.013	8.714	4.691	9.346[a]
	BASE(10%)	11.679	10.933	13.857	13.337	10.060	11.973[b]
	MIDDLE (50%)	15.623	13.213	20.741	7.163	11.242	13.596[c]
	TOP(90%)	13.512	16.429	11.951	15.338	10.909	13.628[c]
	Pooled mean	12.831	13.094	14.391	11.138	9.226	12.136
Density (kg/m^3)	DBH	646.871	663.197	627.770	622.950	625.301	637.218[a]
	BASE(10%)	647.124	675.302	606.257	549.836	774.957	650.695[a]
	MIDDLE(50%)	623.593	635.779	630.133	597.316	622.724	621.909[a]
	TOP (90%)	614.590	664.113	607.806	644.299	640.685	634.299[a]
	Pooled mean	633.044	659.598	617.992	603.600	665.917	636.030
Tangential Shrinkage (%)	DBH	4.700	3.300	5.514	6.465	1.188	4.233[a]
	BASE (10%)	3.700	5.158	1.171	4.542	2.816	3.477[a]
	MIDDLE (50%)	6.377	3.914	3.395	3.470	3.268	4.085[a]
	TOP(90%)	3.108	6.384	1.883	3.691	2.692	3.552[a]
	Pooled mean	4.471	4.689	2.991	4.542	2.491	3.837
Longitudinal Shrinkage (%)	DBH	0.961	3.510	1.570	5.132	0.382	2.311[b]
	BASE (10%)	3.720	5.409	2.729	3.067	1.809	3.347[b]
	MIDDLE (50%)	2.037	0.688	2.497	0.996	1.832	1.610[a]
	TOP (90%)	0.527	1.331	1.364	0.947	3.891	1.612[a]
	Pooled mean	1.811	2.735	2.040	2.536	1.978	2.220
Radial Shrinkage (%)	DBH	4.204	3.316	2.726	1.420	1.909	2.715[a]
	BASE (10%)	3.633	4.568	2.840	6.295	4.844	4.436[b]
	MIDDLE (50%)	3.070	3.996	7.912	3.404	4.630	4.602[b]

	TOP (90%)	1.975	3.866	4.039	2.774	7.465	4.024^{b}
	Pooled mean	3.221	3.937	4.379	3.473	4.712	3.944
Volumetric Shrinkage (%)	DBH	8.904	6.616	8.240	7.885	3.097	6.949^{a}
	BASE (10%)	7.334	9.726	4.011	10.837	7.660	7.914^{a}
	MIDDLE (50%)	9.446	7.910	11.307	6.874	7.898	8.687^{a}
	TOP (90%)	5.084	10.250	5.922	6.464	10.157	7.575^{a}
	Pooled mean	7.692	8.626	7.370	8.015	7.203	7.781

Notes: *Values with the different alphabet are significantly different at (P<0.05)

Table 2: Summary of Mean values of selected Mechanical Properties of Wood Samples of *Tectona grandis* on the Axial Position

Wood properties	Axial position	T1	T2	T3	T4	T5	Pooled Mean
Dimensional Stability	DBH	2.322	1.952	1.824	1.743	2.431	2.054^{ab}
	BASE (10%)	1.302	1.625	2.034	3.101	1.312	1.875^{a}
	MIDDLE (50%)	2.013	2.622	1.222	2.533	2.582	2.194^{b}
	TOP (90%)	2.052	2.104	2.345	1.623	2.001	2.025^{ab}
	Pooled mean	1.922	2.076	1.856	2.250	2.082	2.037
Modulus of Elasticity (N/mm^2)	DBH	876.156	978.097	911.664	842.778	1178.091	957.357^{a}
	BASE (10%)	1083.095	936.140	939.669	937.194	1095.376	998.295^{a}
	MIDDLE (50%)	1043.357	937.275	889.009	898.294	1041.959	961.979^{a}
	TOP (90%)	987.438	1056.102	1103.324	1029.876	959.601	1027.268^{b}
	Pooled mean	997.511	976.904	960.916	927.035	1068.756	986.225
Modulus of Rupture (N/mm^2)	DBH	41.748	43.001	55.102	34.409	57.025	46.257^{a}
	BASE (10%)	56.728	38.456	41.248	37.189	46.478	44.020^{b}
	MIDDLE (50%)	47.401	31.451	50.112	24.801	42.040	39.161^{a}
	TOP (90%)	42.558	49.517	44.135	51.045	35.140	44.479^{b}
	Pooled mean	47.108	40.606	47.649	36.861	45.171	43.479
Maximum Compressive Strength (Nmm^2)	DBH	53.818	53.646	37.665	51.986	49.661	49.355^{b}
	BASE (10%)	44.300	58.926	39.965	49.543	43.761	47.299^{a}
	MIDDLE (50%)	46.216	60.052	41.840	54.939	59.257	52.461^{c}
	TOP (90%)	50.462	48.541	47.210	48.724	44.099	47.807^{a}
	Pooled mean	48.699	55.291	41.670	51.298	49.194	49.230

Notes: *Values with the different alphabet are significantly different at (P<0.05)

Table 3: Results of Analysis of Variance for Wood Properties of Sample Wood of *Tectona grandis along the Axial*for Trees Axially

Source of variation	Axial Direction		Radial Direction	
Within trees	df	p-Value	df	p-Value
MC	3	0.005*	2	0.019*
Density	3	0.899 ns	2	0.021*
TS	3	0.579 ns	2	0.011*
LS	3	0.004 *	2	0.022*
RS	3	0.002 *	2	0.017*
VS	3	0.273 ns	2	0.044*
DS	3	0.003*	2	0.043*
MOE	3	0.001 *	2	0.012*
MOR	3	0.003 *	2	0.025*
MCS	3	0.002 *	2	0.033*

Notes: *=Significant (P<0.05), ns= not significant (p>0.05), Df = Degree of freedom

Table 4: Summary of Mean values of Wood Physical Properties of Wood Samples of Tectona grandis on the Radial Axis

Variables	Radial position	T1	T2	T3	T4	T5	Pooled mean
Moisture Content(%)	Core	20.613	12.483	11.860	11.654	10.464	13.415[b]
	Middle	6.565	11.082	17.427	13.011	11.874	11.992[a]
	Outer	12.645	15.717	13.885	8.750	5.338	11.267[a]
	Pooled Mean	13.226	13.094	14.391	11.138	9.226	12.215
Density(kgm3)	Core	600.621	659.487	616.140	624.616	624.178	625.008[b]
	Middle	657.576	636.712	643.315	561.746	593.783	618.626[a]
	Outer	640.667	682.595	594.520	624.440	779.791	664.402[c]
	Pooled Mean	633.548	659.598	617.992	603.600	665.917	636.131
Tangential Shrinkage (%)	Core	2.985	3.284	2.889	3.886	2.283	3.065[a]
	Middle	3.673	4.869	3.029	6.386	2.635	4.118[b]
	Outer	6.291	5.914	3.054	3.355	2.554	4.234[b]
	Pooled Mean	4.468	4.689	2.991	4.542	2.491	3.836
Longitudinal Shrinkage (%)	Core	0.344	3.211	1.178	1.794	1.228	1.551[a]
	Middle	1.631	3.326	2.113	3.151	3.867	2.817[b]
	Outer	3.136	1.668	2.829	2.662	0.840	2.227[b]
	Pooled Mean	1.814	2.735	2.040	2.536	1.978	2.221
Radial Shrinkage (%)	Core	2.777	3.248	3.664	3.299	3.182	3.234[a]
	Middle	3.593	4.232	6.395	5.116	8.995	5.666[b]
	Outer	4.059	4.330	3.080	2.005	1.960	3.087[a]
	Pooled Mean	3.521	3.937	4.379	3.473	4.712	4.005
Volumetric Shrinkage (%)	Core	5.762	6.532	6.553	7.185	5.465	6.299[a]
	Middle	7.266	9.101	9.424	11.502	11.630	9.785[c]
	Outer	10.350	10.244	6.134	5.359	4.515	7.320[b]
	Pooled Mean	7.990	8.626	7.370	8.015	7.203	7.841

Notes: *Values with the different alphabet are significantly different at (P<0.05)

Table 5: Summary of Mean values of Wood Mechanical Properties of Wood Samples of *Tectona grandis* on the Radial Axis

Variables	Radial position	T1	T2	T3	T4	T5	Pooled mean
Dimensional Stability	Core	1.241	1.601	0.734	1.642	0.930	1.230[a]
	Middle	1.034	1.404	1.322	3.206	0.297	1.453[b]
	Outer	2.948	1.689	0.954	2.414	3.346	2.270[b]
	Pooled Mean	1.834	1.565	1.004	2.421	1.525	1.670
Modulus of Elasticity (N/mm^2)	Core	1032.686	980.312	987.228	869.701	1092.166	992.419[a]
	Middle	953.300	1043.308	1021.582	1006.179	978.177	1000.509[c]
	Outer	984.810	907.091	873.939	905.226	1135.927	961.399[b]
	Pooled Mean	989.845	976.904	960.916	927.035	1068.756	984.691
Modulus of Rupture(%)	Core	58.205	40.456	57.316	28.907	44.154	45.808[b]
	Middle	31.962	42.034	52.547	32.785	39.799	39.825[c]
	Outer	46.888	39.328	33.084	48.890	51.559	43.950[a]
	Pooled Mean	45.778	40.606	47.649	36.861	45.171	43.213
Maximum Compressive Strength(N/mm^2)	Core	55.645	53.743	46.874	54.793	46.496	51.510[b]
	Middle	48.578	63.941	50.496	52.008	43.253	51.655[b]
	Outer	42.322	48.190	27.640	47.094	57.833	44.616[a]
	Pooled Mean	48.346	55.291	41.670	51.298	49.194	49.160

Notes: *Values with the different alphabet are significantly different at ($P<0.05$)

Relationship between Wood Physical and Wood Mechanical Properties

The results in Table 6, reveals a significantly strong positive correlation between volumetric shrinkage with correlation coefficient (r) of 0.808 and 0.679 and tangential and radial shrinkage respectively. This implies that as one variable increases, the other increases by the same amount. The moisture content was significantly correlated with the radial shrinkage and volumetric shrinkage at correlation coefficient (r) of 0.417 and 0.397 respectively at 1% probability level. The MOE was significantly with MOR with r of 0.557, as well as with MCS with r of 0.333 at 1% probability level. The longitudinal shrinkage was significantly correlated with volumetric shrinkage with an r-value of 0.270 at 5% probability level.

Table 6: Correlation analysis of Wood properties of *Tectona grandis*

	MC	D	TS	LS	RS	VS	DS	MOE	MOR	MCS
MC										
D	-0.357**	1								
TS	0.150	-0.080	1							
LS	0.101	0.003	0.232	1						
RS	0.417**	-0.278*	0.116	0.179	1					
VS	0.397**	-0.253	0.679**	0.270*	0.808**	1				
DS	-0.138	0.168	0.580**	0.227	-0.423**	0.031	1			
MOE	0.002	0.148	-0.250	-0.246	-0.052	-0.186	-0.129	1		
MOR	0.118	0.082	-0.117	-0.203	-0.119	-0.158	-0.031	0.557**	1	
MCS	-0.059	0.075	-0.125	-0.109	-0.024	-0.091	-0.074	.333**	0.070	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The linear relationships among the indices measured may be used as an indicator of the prediction power of one wood property from the other. MC was observed to have a significant influence on wood dimensional changes as supported by a work by Huč (2019). As moisture content increases, the swelling capacity of wood increases and results in higher radial and volumetric shrinkage as observed. Also, as moisture content decreases, wood shrinks. This relationship underscores the importance of moisture control strategies in minimizing dimensional instability and ensuring the quality of wood products. The findings from this research imply a slightly significant relationship between wood's physical properties, which is contrary to the reports from previous literature of a strong correlation between wood's physical properties and mechanical properties (Sotannde & Riki 2019; Fasiku & Ogunsanwo, 2020). This suggested that this could be attributed to various factors while computing data fluctuating environmental conditions and human oversight. The significant correlation between MOE and MOR indicated a strong relationship between stiffness and strength of wood.

CONCLUSION AND RECOMMENDATIONS

This research on teak wood (*Tectona grandis*) from the University of Ibadan plantation has yielded significant findings with valuable implications for its sustainable management and utilisation. The understanding of the variations in these properties across different tree sections can be utilised for optimal wood utilisation based on specific end-use requirements. This research underscored the key role of wood density as a reliable predictor of strength properties. This finding highlighted the importance of incorporating density measurements into wood selection processes for specific applications. There was a significant relationship between wood density and key physical and mechanical properties, such as modulus of elasticity, compressive strength, and shrinkage behaviour. It reveals that more dense wood contributes to stronger and more durable wood, making it suitable for various structural applications. It is recommended that proper maintenance such as regular silvicultural management practices be adopted in the plantation.

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Authors' contributions

JTBR & SAE managed data collection, interpretation of data, data analysis and writing of the manuscript. AOO managed the development of methodology and reviewed the manuscript.

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