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Mechanical Properties of Selected Indigenous Timber Species from Southwestern Nigeria: A Comparative Study for Structural Applications

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Abstract

The demand for sustainable and cost-effective construction materials in Nigeria has renewed interest in the structural use of indigenous timber species. However, the absence of standardized mechanical data on many local timbers has limited their acceptance in structural applications, often resulting in reliance on traditional knowledge rather than empirical evidence. This study investigates the mechanical properties of four indigenous timber species from Southwestern Nigeria—Anogeissus leiocarpus (Ayin), Albizia ferruginea (Alakrity), Pterocarpus erinaceus (Ayere), and Ricinodendron heudelotii (Eru)—to evaluate their suitability for structural use. Standard laboratory tests were conducted to determine the modulus of rupture (MOR) and modulus of elasticity (MOE) under both wet and oven-dried conditions using uniformly dimensioned specimens. The results revealed significant differences in strength and stiffness among the species. In the oven-dried condition, Anogeissus leiocarpus recorded the highest MOR of 3.1 MPa, outperforming Albizia ferruginea by 22.6%, Ricinodendron heudelotii by 9.7%, and Pterocarpus erinaceus by 38.7%. Similarly, in MOE, Anogeissus leiocarpus showed the highest value of 50.8 MPa, exceeding Albizia ferruginea by 2.6%, Ricinodendron heudelotii by 5.5%, and Pterocarpus erinaceus by 7.9%. Across all species, oven-dried samples consistently exhibited superior mechanical performance compared to wet samples. These findings provide critical comparative data to inform material selection in construction and promote the effective utilization of indigenous timber resources. The study contributes to advancing sustainable construction practices in Nigeria by encouraging reliance on locally sourced materials, reducing dependence on imported timber, and supporting environmentally responsible building solutions.

Keywords: Timber, Mechanical Properties, Structural Suitability, Flexural Strength, Construction

Introduction

Timber remains one of the oldest and most versatile construction materials known to humankind. In many developing countries, including Nigeria, it plays a crucial role in both rural and urban construction due to its accessibility, costeffectiveness, and ease of use. The growing interest in sustainable construction has further underscored timber's relevance, particularly as a renewable alternative to high-carbon materials such as steel and concrete. However, to maximize its potential in structural applications, it is essential to understand the mechanical behavior of the different timber species available locally.

In Southwestern Nigeria, a wide variety of indigenous timber species are used in construction, yet comprehensive comparative data on their structural performance remains scarce. Builders and engineers often rely on traditional knowledge or availability rather than scientifically validated criteria when selecting timber for structural applications. This gap presents a challenge in ensuring safety, durability, and efficient use of resources in timber-based construction.

This study aims to conduct a comparative analysis of the mechanical properties, specifically the Modulus of Rupture (MOR) and Modulus of Elasticity (MOE) of four indigenous timber species commonly used in Southwestern Nigeria. By subjecting these species to standardized mechanical tests under controlled conditions, the research provides empirical evidence of their relative performance in terms of strength and stiffness. Such comparative evaluation is essential for material specification, structural design decisions, and enhancing confidence in the structural application of local timber. Ultimately, this study contributes to a more evidence-based approach to timber selection in construction, supporting the broader goal of promoting sustainable and resilient infrastructure using locally available resources.

Mechanical properties such as the Modulus of Rupture (MOR) and Modulus of Elasticity (MOE) are vital indicators of timber's structural performance. MOR quantifies the maximum bending strength a material can withstand before failure, while MOE measures stiffness which is how resistant a material is to deformation under load [1]. These parameters are essential in classifying and grading timber for structural use in buildings, bridges, and furniture [2].

Higher MOR and MOE values imply better strength and rigidity, making such timbers preferable in load-bearing applications like beams and trusses [3]. According to Green and Evans [4], these properties are influenced by several factors, including wood species, moisture content, density, growth conditions, and even the age and maturity of the tree. For instance, denser species generally show higher mechanical resistance, while increased moisture tends to reduce both MOR and MOE [5, 6].

Globally, the application of standardized grading systems such as EN 338, BS 5268, and ASTM D198 ensures consistency and reliability in structural timber use [7]. However, in countries like Nigeria, the lack of widespread testing facilities and awareness of these standards has limited their application, leading to the use of ungraded or poorly assessed timber in construction [8].

Several comparative studies have been conducted to assess the structural suitability of indigenous timber species in Nigeria. Jimoh and Ibitolu [9] examined Vitex doniana, Ceiba pentandra, and Pseudocedrela kotschyi, classifying them

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under EN 338. They found significant variations in strength properties, with Pseudocedrela kotschyi rated D35 and Ceiba pentandra rated C16.

Lamidi et al. [10] tested underutilized species such as Brachystegia eurycoma, Pterocarpus erinaceus, and Guarea cedrata, assigning strength classes from D50 to C16, while Rahmon and Jimoh [11] characterized Albizia zygia and Funtumia elastica using both British and European standards.

Other researchers have validated similar results. Ogunwusi and Jolaoso [12] emphasized that poor documentation and grading often lead to the undervaluation of otherwise strong indigenous species. Ezeudu and Nwankwo [13] evaluated Milicia excelsa (Iroko) and Tectona grandis (Teak), both widely used, confirming high MOR and MOE values. Ogunleye et al. [14] added that even lesser-known species like Triplochiton scleroxylon have shown moderate strength class ratings.

The overreliance on popular species like Mahogany and Iroko has led to overexploitation, while numerous underutilized species remain untapped [15]. Aguda et al. [16] reported that Ficus vallis-choudae showed promising MOR and MOE values (85.8 N/mm^2 and 709 N/mm^2), supporting its use in structural applications.

Mohammed et al. [17] classified Terminalia ivorensis under strength class D18, revealing its suitability for moderate-load structural elements. Similarly, Akpan and Ekong [18] found that Afzelia africana demonstrated high durability and moderate stiffness, making it a candidate for truss systems.

Beyond Nigeria, Hoadley [19] and Ross et al. [20] have extensively documented the potential of underutilized tropical hardwoods, emphasizing the role of empirical evaluation in diversifying the timber industry. These findings underscore the urgent need for more comprehensive testing to reduce pressure on a few overused species.

Despite growing research interest, many indigenous Nigerian timber species remain unclassified, especially in regions like the Southwest, where timber is heavily used but rarely scientifically assessed. According to Wilson et al. [21], who graded four Northern Nigerian species using BS 5268, variations in performance exist even within the same ecological zones, emphasizing the need for localized data.

Adedeji and Adeyoju [22] stressed the lack of standardized mechanical evaluation in Nigeria’s timber trade, often replaced with anecdotal knowledge and visual assessment. This presents a significant risk in structural applications, particularly for public infrastructure projects.

The situation is worsened by inadequate access to mechanical testing equipment, limited industry collaboration with research institutions, and the absence of a centralized database for Nigerian wood properties [23, 24]. Akinyemi et al. [25] recommended regional timber classification centers to promote data-driven construction practices.

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Thus, this study aims to contribute to bridging this gap by comparing the MOR and MOE values of four timber species commonly used in Southwestern Nigeria, using standardized testing procedures. The goal is to support more reliable and evidence-based structural applications in line with global best practices.

Materials and Methodology

Study Area

Location

Timber Species used for this research were obtained from Johnson Sawmill, Ikurin-Ekiti, Ekiti State, Nigeria.

Geology

Ikole-Ekiti, as illustrated in Figure 1, is situated in Ekiti State in the southwestern region of Nigeria. The area lies within the tropical rainforest climatic zone, characterized by two distinct seasons: a prolonged wet season (typically from April to October) and a shorter dry season (November to March). During the wet season, Ikole receives substantial rainfall that supports dense vegetation and agricultural activities. Conversely, the dry season is marked by reduced precipitation, elevated temperatures, and occasional harmattan winds, which may lead to moderate water stress and lower soil moisture levels. These seasonal variations influence not only ecological processes but also the physical and mechanical properties of timber sourced from the region.

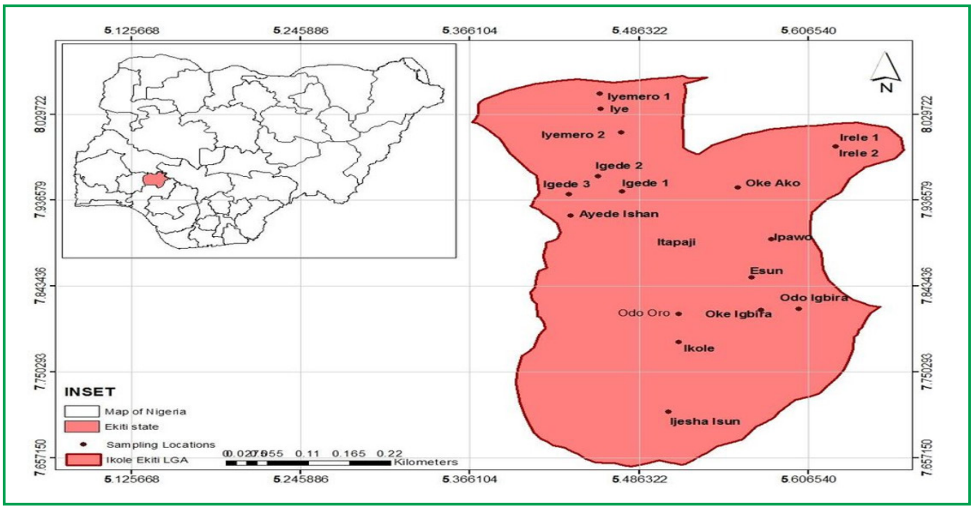

Figure 1. Nigeria map showing timber collection location

Materials

The main materials and equipment that were used in the course of this research work include the following:

Timber species

Four hardwood species were procured from Ekiti State within Southwestern Nigeria. The selected hardwood species are namely: Ayin (Anogeissusleiocarpus); Ayere(Pterocarpuserinaceus); Eru (Ricinodendronheudelotii) and Alacrity

(Albiziaferrugin). The selection was based on their availability, perceived mechanical potential, and underrepresentation in documented structural performance data. Each timber species is illustrated in Figures 2 to 5. Figure 2 shows Pterocarpus erinaceus (Ayere), Figure 3 presents Albizia ferruginea (Alacrity), Figure 4 displays Anogeissus leiocarpus (Ayin), and Figure 5 shows Ricinodendron heudelotii (Eru). The harvested logs were sawn into standard specimen sizes suitable for mechanical testing, as depicted in Figures 6, 7, and 8. This standardization ensured consistency in dimension and test conditions across all samples used in the study.

Figure 2. Timber species (Ayere)

Figure 3. Timber species (Alacrity)

Figure 4. Timber species (Ayin)

Figure 5. Timber species (Eru)

Figure 6. Cutting of the timber log into standard sizes

Figure 7. Cutting of the timber log into standard sizes

Figure 8. Cutting of the timber log into standard sizes

Testing Equipment

Universal Testing Machine

A Universal Testing Machine, often referred to as a UTM, is a device designed to test the mechanical properties of materials, as shown in Figure 9. It can perform various tests, including tension, compression, flexure, and more. UTMs are widely used in quality control, research, and development to assess the strength, durability, and elasticity of materials. The working principle involves subjecting a test specimen to a controlled force or load while measuring its response. This allows for the determination of critical material properties.

Figure 9. Universal Testing Machine

Oven

A well-ventilated oven as shown in Figure 10 below with precise temperature control was used to achieve the targeted moisture content. The oven's temperature control capabilities help to ensure consistent drying throughout the sample volume to minimize internal stresses.

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Figure 10. Oven

Methodology

Physical Characteristics Test

Visual color assessment of the timber species

Table 1 presents the visual color characteristics of the timber species observed immediately after cutting. Colors were recorded under natural daylight conditions to minimize distortion and aid species identification. This evaluation aimed to document the inherent color differences, which can influence species identification and potential aesthetic applications in construction. The observed colors are presented in Table 1, with Albizia ferruginea (Alakrity) showing a creamy white color, Pterocarpus erinaceus (Ayere) a pale yellow, Anogeissus leiocarpus (Ayin) a cream yellow, and Ricinodendron heudelotii (Eru) a reddish-brown appearance.

Table 1. Visual color assessment of the timber species

Timber Species	Scientific Name	Color
Alacrity	Albiziaferruginea	Creamy White
Ayere	Pterocarpuserinaceus	Pale Yellow
Ayin	Anogeissusleiocarpus	Cream yellow
Eru	Ricinodendronheudelotii	Reddish brown

Sample size distribution

The selected timber samples were cut into standardized dimensions of 1500 mm length × 75 mm width, with varying thicknesses of 20 mm, 25 mm, 50 mm, and 75 mm as shown in Table 2. For each timber species and thickness, three specimens were prepared for testing under wet conditions and another three specimens for the oven-dried condition, making a total of 12 specimens per species. This sampling ensured a balanced representation across species and conditions, providing reliable data for comparative analysis.

Table 2. Sample distribution by timber species

Timber Species	Thickness (mm)	Wet Condition	Dry Condition
Alacrity	20 / 25 / 50 / 75	3 x 4 = 12	3 x 4 = 12
Ayere	20 / 25 / 50 / 75	3 x 4 = 12	3 x 4 = 12
Ayin	20 / 25 / 50 / 75	3 x 4 = 12	3 x 4 = 12
Eru	20 / 25 / 50 / 75	3 x 4 = 12	3 x 4 = 12
Total		48	48

Testing procedure

The mechanical testing of the timber specimens was conducted in accordance with ASTM D198 – Standard Test Methods of Static Tests of Lumber in Structural Sizes [26]. The primary focus was on determining the Modulus of Rupture and Modulus of Elasticity through static bending tests.

Each specimen was simply supported on to distribute the applied load evenly and minimize localized compression at the bearing points. The span length was set approximately 17 times the depth of each specimen, as recommended by the standard, to ensure a uniform stress distribution during testing. A single-point load was applied at the mid-span using a Universal Testing Machine equipped with a load cell and deflection measurement system. The load was applied continuously and uniformly at a controlled rate, adjusted to ensure that specimen failure occurred within 5 ± 2 minutes from the start of loading. During the test, both the applied load and the corresponding mid-span deflection were recorded automatically by the machine’s data acquisition system.

Modulus of rupture determination

Rectangular timber specimens were prepared for each of the four indigenous species investigated in this study. The specimens were cut to standardized dimensions of 1500 mm in length, 75 mm in width, and varying thicknesses of 20 mm, 25 mm, 50 mm, and 75 mm, representing the selected timber species. To account for the influence of moisture on mechanical properties, two distinct sets of specimens were prepared:

- Set 1 (Wet condition): Tested in their natural state, without drying.
- Set 2 (Oven-dried condition): Subjected to oven drying before testing.

The moisture content of all specimens was determined prior to testing, following ASTM D4442 – Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials [27]. The density of each specimen was also recorded before testing, based on mass-to-volume ratio.

The Modulus of Rupture (MOR) for both sets of specimens was determined using a three-point bending test, conducted in accordance with ASTM D198 – Standard Test Methods of Static Tests of Lumber in Structural Sizes (Figure 11). Each specimen was simply supported over a span approximately 17 times its depth, and a central load was applied until failure occurred. The maximum load at rupture was recorded.

For the oven-dried specimens, drying was performed at 103 ± 2°C following ASTM D4442, until the specimens reached a moisture content of approximately 12%, as recommended for structural timber testing. Drying continued until constant weight was achieved, typically within 48 to 96 hours depending on thickness. The MOR values obtained from both wet and oven-dried specimens were used to compare the bending strength of the timber species under varying moisture conditions, thereby providing insights into their structural performance in practical applications.

Figure 11. Laboratory setup for modulus of rupture determination

Figure 12. Displacement values from MOR test used for modulus of elasticity

Modulus of elasticity determination

During the MOR test, the Universal Testing Machine (UTM) provided deformation data (usually expressed as strain or elongation) for each timber specimen. This deformation corresponds to the amount of bending experienced by the specimen under the applied load. The MOE is determined based on the stress-strain relationship. The Stress is the force per unit area (load divided by the cross-sectional area), and strain is the deformation relative to the original length of the specimen. These MOE values as shown in Figure 12 quantifies the timber's stiffness and its ability to resist deformation under an applied load.

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Mode of failure during modulus of rupture test

The Modulus of Rupture (MOR) test is a standard method used to evaluate the flexural strength of timber. It provides insight into how different timber species respond to bending stresses until failure. During the MOR testing of selected constructional timber species from Southwestern Nigeria, several distinct failure modes were observed, predominantly occurring at or near the midpoint of the specimens—where the bending moment and tensile stresses are typically greatest.

a) Tensile Rupture at Mid-Span

The most frequently observed mode of failure was tensile rupture at the mid-span of the specimens, characterized by a sudden and clean fracture along the grain. This failure indicates that the tensile strength of the timber fibers at the extreme tension zone had been exceeded (Figure 13). Timber species with higher densities, such as Ayin (Anogeissus leiocarpa), were more prone to this mode of failure, reflecting their greater ability to resist applied loads until the point of ultimate failure. The brittle nature of this failure suggests limited plastic deformation prior to rupture, highlighting the stiffness and high mechanical strength of these denser species.

b) Shear Failure

Shear failure was another notable failure mode, especially prevalent in specimens with relatively lower density and higher moisture content, such as Ayere. This failure type typically manifested as an angular crack forming parallel to the direction of applied load, often near the neutral axis of the specimen. The relative movement between two parts of the timber, indicative of sliding failure along shear planes, underscores the susceptibility of such species to internal shear stresses. Figure 14 clearly illustrates this angular separation, which is consistent with classical shear failure patterns in timber beams under flexural loading.

c) Buckling and Kinking

Some specimens, particularly those with slender cross-sections or exposed to point loading, displayed signs of local instability in the form of buckling or kinking. As seen in Figure 15, localized compressive stresses caused deformation and misalignment of the grain structure, leading to delamination and longitudinal splitting. This failure mode typically results from instability under high compressive stress, especially in sections where lateral support is insufficient. It is more common in timber species with heterogeneous grain patterns or those prone to fiber misalignment.

d) Crushing Failure

Crushing, as shown in Figure 16, occurred when compressive stresses at the supports or near the loading point exceeded the compressive strength of the wood fibers. This led to localized compression, deformation, and permanent damage of the cellular structure. Crushing failures are generally gradual, with visible signs of compaction and fiber distortion. Timber species with lower compressive strength exhibited this failure more readily, especially when moisture content was high.

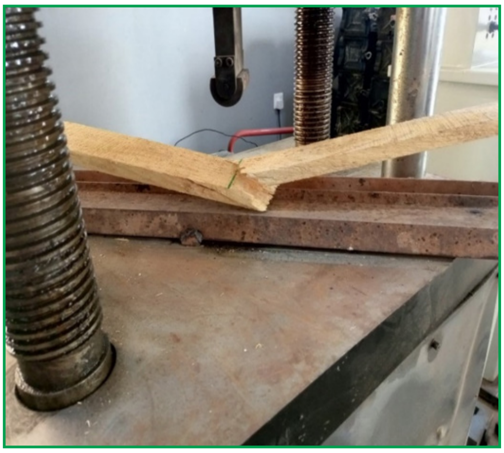

Figure 13. Tensile failure

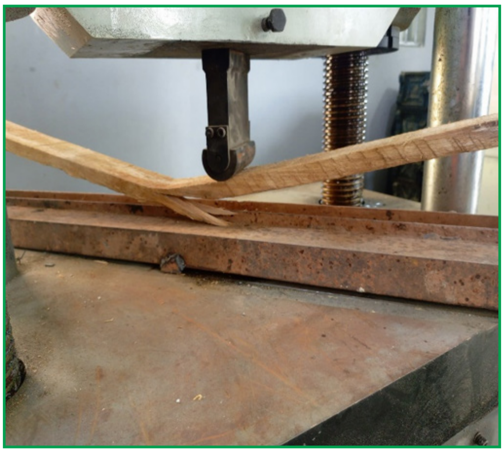

Figure 14. Shear failure

Figure 15. Buckling

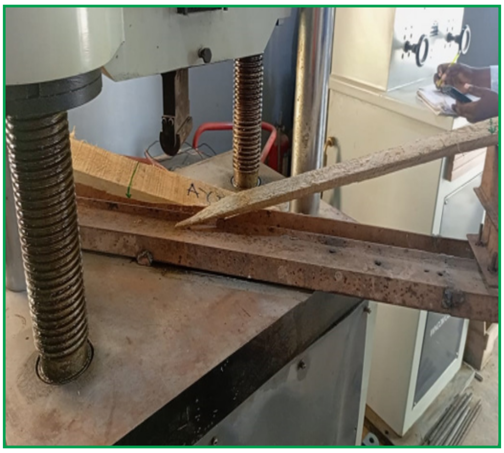

Figure 16. Crushing

Results and Discussion

Modulus of Rupture across the Timber Species

Table 3 and Figure 17 shows the MOR values for both the wet and oven-dried samples of each timber species. The Modulus of Rupture results for both wet and oven-dried samples demonstrated clear distinctions in flexural strength among the four timber species. In the oven-dried condition, Anogeissus leiocarpus (Ayin) exhibited the highest average MOR of 3.1 MPa, establishing it as the strongest species in terms of bending capacity. Albizia ferruginea (Alakrity) followed with an average MOR of 2.4 MPa, which is approximately 22.6% lower than Ayin. Ricinodendron heudelotii (Eru) recorded an average MOR of 2.8 MPa, representing a 9.7% reduction compared to Ayin. Pterocarpus erinaceus (Ayere) showed the lowest MOR at 1.9 MPa, which is about 38.7% lower than Ayin. These findings reveal a clear mechanical ranking with Ayin at the top, suggesting its suitability for load-bearing structural applications, such as beams, joists, and other primary structural members. The relatively higher MOR of Eru and Alakrity indicates their potential for moderate structural use, whereas the significantly lower MOR of Ayere suggests its application may be best limited to non-load-bearing or decorative purposes. This performance trend aligns with the findings of Jimoh and Ibitolu [9], who classified indigenous species with MOR values above 3.0 MPa into medium-strength structural timber classes, highlighting Ayin's structural viability.

Table 3. Modulus of rupture across timber species

Timber Species	Sample ID	L (m)	W (m)	D (m)	Area (m)	Wet Sample		Oven Dried Sample	
						Load at Failure (KN)	Average MOR (Mpa)	Load at Failure (KN)	Average MOR (Mpa)
T1-ALAKRITY	T1l-a	1.5	0.075	0.020	0.0015	9.43	1.3	13.685	1.9
	T1l-b			0.025	0.0019	0.675	1.4	15.885	2.1
	T1l-c			0.050	0.0038	13.66	1.9	17.48	2.4
	T1l-d			0.075	0.0056	17.64	2.4	21.755	2.9
T2- AYERE	T2l-a	1.5	0.075	0.020	0.0015	8.615	1.2	13.24	1.8
	T2l-b			0.025	0.0019	10.42	1.4	14.275	1.9
	T2l-c			0.050	0.0038	11.565	1.6	15.735	2.1
	T2l-d			0.075	0.0056	15.07	2.0	19.95	2.7
T3- AYIN	T3l-a	1.5	0.075	0.020	0.0015	9.575	1.3	3.95	1.9
	T3l-b			0.025	0.0019	12.33	1.7	6.45	2.1
	T3l-c			0.050	0.0038	4.635	2.0	8.735	2.5
	T3l-d			0.075	0.0056	9.665	2.7	23.43	3.1
T4- ERU	T4l-a	1.5	0.075	0.020	0.0015	9.15	1.2	3.275	1.8
	T4l-b			0.025	0.0019	0225	1.4	14.52	2.0
	T4l-c			0.050	0.0038	12.64	1.7	16.32	2.3
	T4l-d			0.075	0.0056	16.65	2.2	0.765	2.8

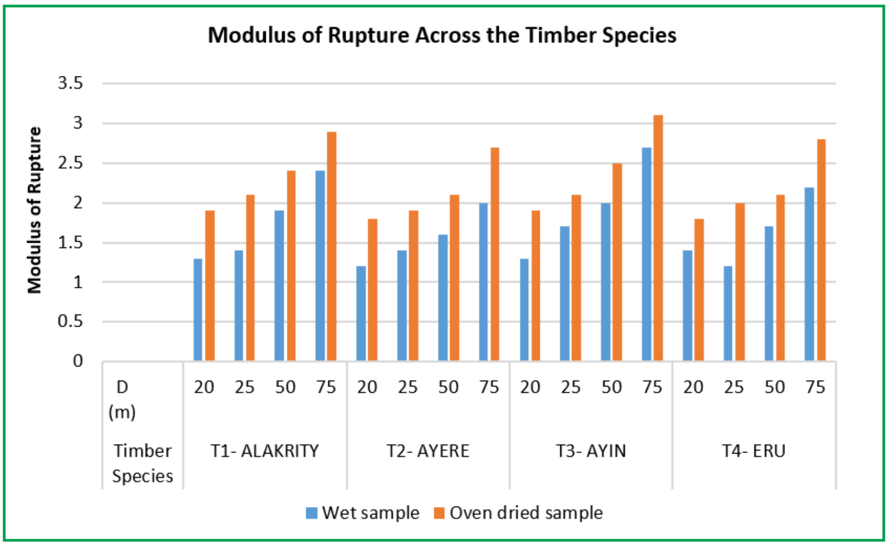

Figure 17. Modulus of rupture across the timber species

Modulus of Elasticity (MOE) across Timber Species

Table 4 and Figure 18 presents Modulus of Elasticity (MOE) measurements for T1-Alakrity, T2-Ayere, T3-Ayin, and T4-Eru- under both wet and oven-dried sample conditions. The Modulus of Elasticity results also exhibited performance variations among the timber species, though the differences were less pronounced than those observed for MOR. Anogeissus leiocarpus (Ayin) had the highest average MOE of 50.8 MPa, confirming its superior stiffness. Albizia ferruginea (Alakrity) followed with 49.5 MPa, which is 2.6% lower than Ayin. Ricinodendron heudelotii (Eru) recorded 48.0 MPa, showing a 5.5% decrease, while Pterocarpus erinaceus (Ayere) had the lowest MOE at 46.8 MPa, about 7.9% lower than Ayin. Despite the relatively small differences, these results indicate that Ayin possesses the highest resistance to deformation under load, making it suitable for applications where stiffness is critical, such as long-span beams and load-carrying members subject to deflection limits. This observation is consistent with the study by Lamidi et al. [10], who reported similar MOE ranges for structurally viable indigenous timbers in Nigeria, reinforcing the mechanical suitability of Ayin for structural applications. The performance of Alakrity and Eru also suggests their potential use in moderately stressed applications, while Ayere's lower stiffness positions it for secondary or aesthetic purposes.

Table 4. Modulus of elasticity across timber species

Timber Species	Sample ID	Area (m)	Wet Sample		Oven Dried Sample	
			Displacement (m)	Average MOE (Mpa)	Displacement (m)	Average MOE (Mpa)
T1- ALAKRITY	T1l-a	0.0015	0.039	48.2	0.055	48.8
	T1l-b	0.0019	0.044	48.5	0.064	49.1
	T1l-c	0.0038	0.056	48.9	0.071	49.3
	T1l-d	0.0056	0.073	49.1	0.088	49.5
T2- AYERE	T2l-a	0.0015	0.034	45.4	0.054	45.8
	T2l-b	0.0019	0.042	45.8	0.059	46.0
	T2l-c	0.0038	0.046	46.0	0.065	46.4
	T2l-d	0.0056	0.061	46.4	0.081	46.8
T3- AYIN	T3l-a	0.0015	0.038	49.4	0.056	49.8
	T3l-b	0.0019	0.05	49.8	0.067	50.0
	T3l-c	0.0038	0.059	50.0	0.077	50.6
	T3l-d	0.0056	0.082	50.4	0.054	50.8
T4- ERU	T4l-a	0.0015	0.038	46.4	23.43	46.8
	T4l-b	0.0019	0.042	46.8	13.275	47.2
	T4l-c	0.0038	0.051	47.2	14.52	47.6
	T4l-d	0.0056	0.067	47.6	16.32	48.0

Comparison of Modulus of Rupture across Timber Species

The data from Table 5 and Figure 19 shows that the MOR values were higher for the oven-dried samples compared to the wet samples. For Alakrity (T1), the MOR increased from 1.3 MPa in the wet condition to 1.9 MPa in the oven-dried condition. Also, Ayere (T2) and Eru (T4) both experienced increased MOR from 1.2 MPa in the wet state to 1.8 MPa in the oven-dried state. Ayin (T3) as well demonstrated an increase in MOR from 1.3 MPa in the wet condition to 1.9 MPa after oven-drying, matching the improvement seen for Alakrity (T1).

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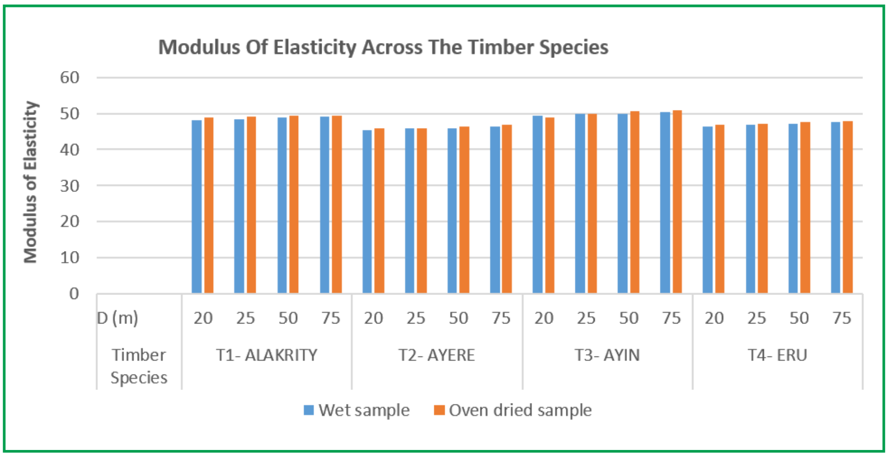

Figure 18. Modulus of elasticity across the timber species

Table 5. Comparison of modulus of rupture for 20 mm depth

Modulus of Rupture		
Timber Species	**Wet sample (Mpa)**	**Oven dried sample (Mpa)**
Alacrity	1.3	1.9
Ayere	1.2	1.8
Ayin	1.3	1.9
Eru	1.2	1.8

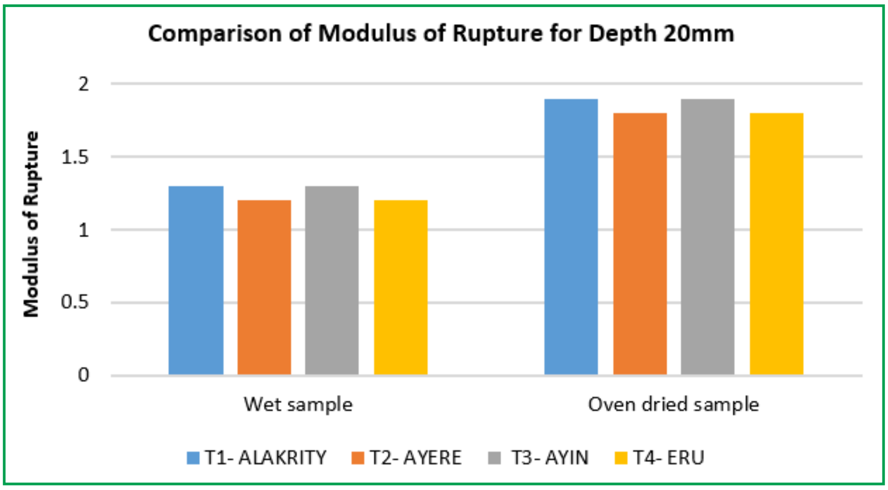

Figure 19. Comparison of modulus of rupture for 20 mm depth

The data from Table 6 and Figure 20 shows that the MOR values were higher for the oven-dried samples compared to the wet samples across all four timber species. For Alakrity and Ayin, the MOR increased from 1.4 MPa and 1.7 MPa respectively in the wet condition, and to 2.1 MPa in the oven-dried state. This represents a significant improvement in the bending strength of these timber materials after the oven-drying process. Ayere and Eru also exhibited increase in MOR, though not as noticeable as Alakrity and Ayin. Ayere's MOR increased from 1.4 MPa in the wet state to 1.9 MPa after oven-drying, while Eru increased from 1.4 MPa to 2.0 MPa.

Table 6. Comparison of modulus of rupture for 25 mm depth

Timber Species	Modulus of Rupture	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	1.4	2.1
T2- AYERE	1.4	1.9
T3- AYIN	1.7	2.1
T4- ERU	1.4	2.0

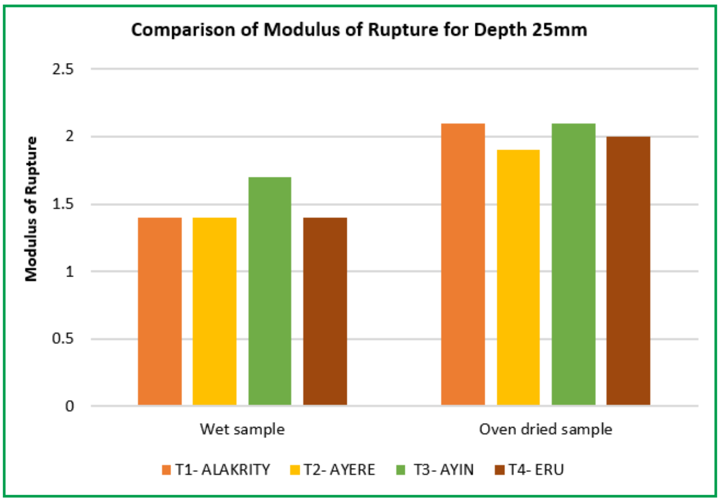

Figure 20. Comparison of modulus of rupture for 25 mm depth

The data from Table 7 and Figure 21 shows that Ayin exhibited the highest MOR, increasing from 2.0 MPa in the wet state to 2.5 MPa after oven-drying. Alakrity also demonstrated a significant increase in MOR, rising from 1.9 MPa in the wet condition to 2.4 MPa in the oven-dried state. For Ayere and Eru, the MOR values increased from 1.6 MPa and 1.7 MPa respectively in the wet condition to 2.1 MPa in the oven-dried state.

Table 7. Result of the comparison of modulus of rupture for 50 mm depth

Timber Species	Modulus of Rupture	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	1.9	2.4
T2- AYERE	1.6	2.1
T3- AYIN	2.0	2.5
T4- ERU	1.7	2.1

The data from Table 8 and Figure 22 shows that Ayin exhibited the highest MOR, increasing from 2.7 MPa in the wet state to 3.1 MPa after oven-drying. Alakrity also saw a noticeable improvement, with the MOR rising from 2.4 MPa in the wet condition to 2.9 MPa in the oven-dried state. Ayere and Eru demonstrated similar patterns, with their MOR values increasing from 2.0 MPa and 2.2 MPa respectively in the wet samples to 2.7 MPa and 2.8 MPa in the oven-dried samples.

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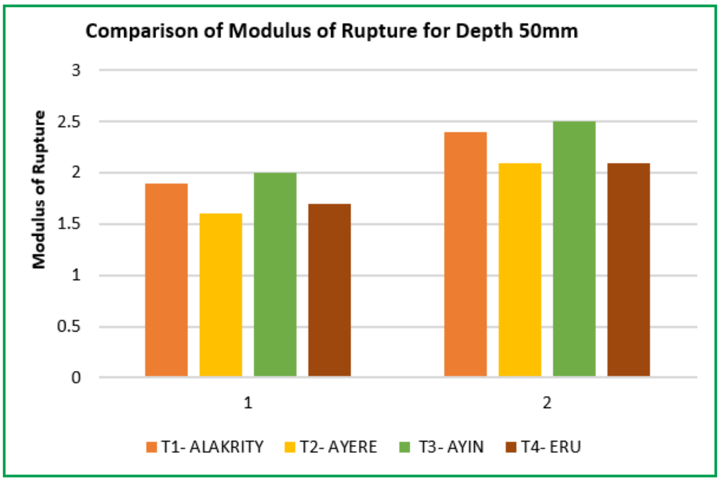

Figure 21. Comparison of modulus of rupture for 50 mm depth

Table 8. Result of the comparison of modulus of rupture for 75 mm depth

Timber Species	Modulus of Rupture	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	2.4	2.9
T2- AYERE	2.0	2.7
T3- AYIN	2.7	3.1
T4- ERU	2.2	2.8

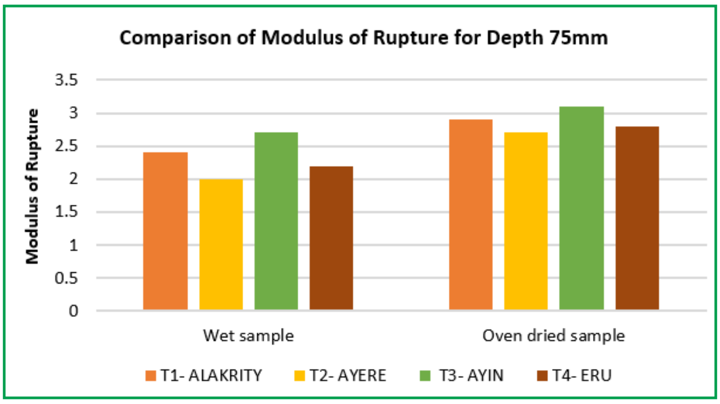

Figure 22. Comparison of modulus of rupture for 75 mm depth

Comparison of Modulus of Elasticity across Timber Species

Table 9 and Figure 23 shows that Ayin demonstrates the highest MOE values with wet sample MOE of 49.4 increasing to 49.8 for the oven-dried sample. Alakrity has the next highest MOE, with a wet sample value of 48.2 and an oven-dried sample value of 48.8. Conclusively, the comparative analysis from Figure 23 indicates that Ayin consistently exhibits the highest MOE, followed by Alakrity and Eru, while Ayere has the lowest MOE values.

https://doi.org/10.70028/sgm.v1i2.45

Table 9. Result of the comparison of modulus of elasticity for 20 mm depth

Timber Species	Modulus of Elasticity	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	48.2	48.8
T2- AYERE	45.4	45.8
T3- AYIN	49.4	49.8
T4- ERU	46.4	46.8

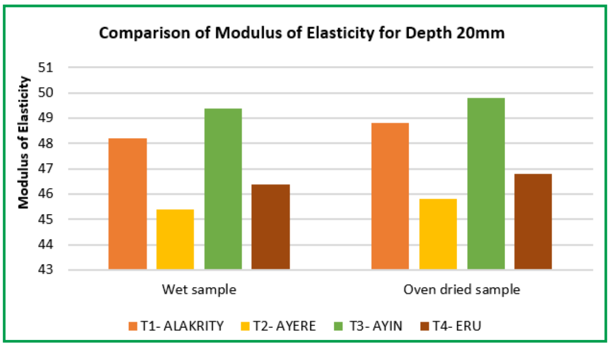

Figure 23. Comparison of modulus of elasticity for 20 mm depth

From Table 10 and Figure 24, Ayin shows the highest MOE values with an increase in MOE values from 49.8 wet sample to 50.0 oven-dried sample. Followed by it is Alakrity with a slight decrease in MOE samples values. Eru experiences an increase in MOE values from 46.8 for wet sample to 47.2 for the oven-dried sample. Ayere exhibits the lowest MOE values, with a wet sample of 45.8 and an oven-dried sample of 46.0. The comparative analysis across species from Figure 24 indicates that Ayin consistently exhibits the highest Modulus of Elasticity, followed by Alakrity and Eru, while Ayere has the lowest MOE values.

Table 10. Result of the comparison of modulus of elasticity for 25 mm depth

Timber Species	Modulus of Elasticity	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	48.5	49.1
T2- AYERE	45.8	46.0
T3- AYIN	49.8	50.0
T4- ERU	46.8	47.2

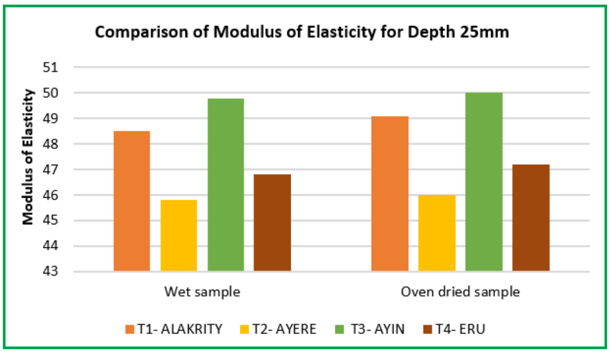

Figure 24. Comparison of modulus of elasticity for 25 mm depth

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According to Table 11 and Figure 25, Ayin consistently exhibited the highest MOE values with wet sample of 50.0, increasing to 50.6 for the oven-dried sample. Alakrity and Eru were observed to have similar MOE values, with Alakrity wet sample at 48.9 and the oven-dried sample at 49.3, while Eru wet sample is 47.2 and the oven-dried sample is 47.6. Followed by Ayere with the lowest MOE values of 46.0 wet sample and 46.4 oven-dried sample. From the comparative analysis across species in Figure 25, Ayin consistently exhibits the highest MOE, followed by Alakrity and Eru, while Ayere has the lowest MOE values.

Table 11. Result of the comparison of modulus of elasticity for 50 mm depth

Timber Species	Modulus of Elasticity	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	48.9	49.3
T2- AYERE	46.0	46.4
T3- AYIN	50.0	50.6
T4- ERU	47.2	47.6

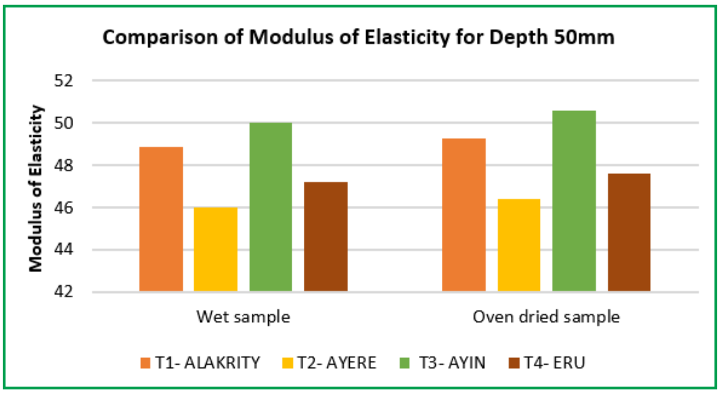

Figure 25. Comparison of modulus of elasticity for 50 mm depth

As shown in Table 12 and Figure 26, the MOE value of Alakrity increased slightly from 49.1 for the wet sample to 49.5 for the oven-dried sample, and a similar trend was observed for the Ayere species as well. Ayin consistently had the highest MOE values, increasing from 50.4 for the wet sample to 50.8 for the oven-dried sample. Also, for Eru, the MOE value also increased. Overall, the data indicates that the oven-drying process resulted in a slight increase in the Modulus of Elasticity for all four timber species, with the T3-Ayin species maintaining the highest MOE values compared to the other timber species.

Table 12. Result of the comparison of modulus of elasticity for 75 mm depth

Timber Species	Modulus of Elasticity	
	Wet Sample (MPa)	Oven Dried Sample (MPa)
T1- ALAKRITY	49.1	49.5
T2- AYERE	46.4	46.8
T3- AYIN	50.4	50.8
T4- ERU	47.6	48.0

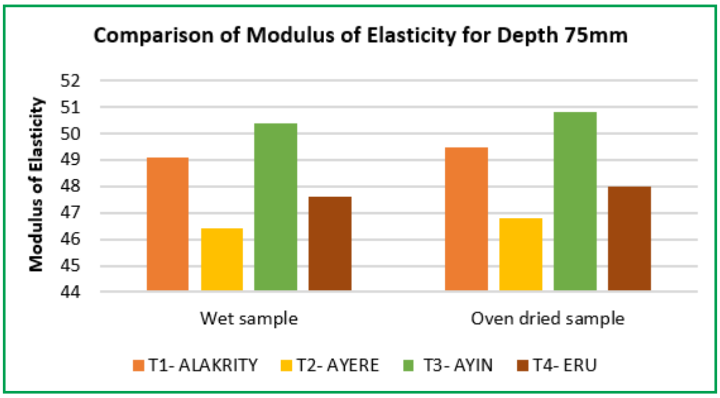

Figure 26. Comparison of modulus of elasticity for 75 mm depth

Conclusion

This study presented a comparative analysis of the mechanical properties, specifically the Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) of four indigenous timber species from Southwestern Nigeria: Anogeissus leiocarpus (Ayin), Albizia ferruginea (Alakrity), Pterocarpus erinaceus (Ayere), and Ricinodendron heudelotii (Eru. The results revealed distinct variations in performance among the species. Ayin consistently exhibited the highest mechanical strength, making it the most suitable for structural applications where load-bearing and stiffness are critical. Alacrity followed closely, showing commendable mechanical properties, while Eru and Ayere demonstrated comparatively lower values, suggesting limited use in high-stress structural contexts.

Based on the results, Ayin's average Modulus of Rupture exceeds 3.0 MPa in oven-dried condition, positioning it within the range of strength classes applicable for medium-duty structural timber, as classified by standards like EN 338 and BS 5268. Therefore, Ayin can be recommended for moderately loaded beams, joists, and structural framing in residential or light commercial construction, particularly in regions seeking sustainable, locally sourced materials. Conversely, Alacrity, Eru, and Ayere may be more suitable for secondary applications such as interior joinery, paneling, or non-critical structural components.

This study underscores the potential of indigenous timber species in contributing to sustainable construction practices and encourages further classification testing against international standards to facilitate their broader adoption in engineering applications.

Contribution to Knowledge

This research advances the body of knowledge on the structural utility of Nigerian timber by offering one of the few comparative analyses of multiple local species based on standardized mechanical performance metrics. Unlike isolated studies focused on a single species or general timber behavior, this study evaluated four commonly used but under-researched indigenous species under the same testing conditions. The result is a direct, data-driven comparison that enables stakeholders—engineers, architects, builders, and policymakers—to make informed decisions regarding species selection for structural use.

The study also fills a crucial gap in existing literature by providing quantified mechanical property benchmarks for these species, particularly Ayin and Alacrity, which demonstrated high performance. These insights are pivotal in efforts to diversify material choices, reduce construction costs, and encourage local resource utilization, thereby contributing to sustainable infrastructure development and reducing dependence on imported or non-renewable materials.

Recommendations

1. Adoption of High-Performing Species in Construction: Based on the superior mechanical performance observed, it is recommended that Ayin and Alakrity be prioritized for structural applications, particularly in residential and low- to medium-rise buildings. Their strength characteristics make them suitable alternatives to conventional materials in Nigeria's building sector.
2. Further Comparative Studies: Additional research should expand the comparative scope to include more indigenous species across different ecological zones in Nigeria. This would support a comprehensive national database for structural timber classification, improving the reliability of timber selection in design and construction.
3. Standardization and Grading: There is a need to integrate the findings into national timber grading systems and update design codes to reflect the mechanical distinctions among indigenous species. This would ensure safer and more efficient use of timber in engineering applications.
4. Policy and Industry Engagement: Stakeholders in government and the construction industry should invest in awareness and promotion campaigns that highlight the mechanical viability of indigenous timber species. Incentives for using tested, high-performing local species could foster innovation, sustainability, and economic growth within the timber sector.

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Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Tomisin Victor Kehinde: writing-original draft, conceptualization, methodology, investigation, data curation, writing-reviewing and editing.

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Data Availability Statement

The data used to support the findings of this study are included within the article.

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