Plant
2026, Vol. 14, No. 3, pp. 67–71
https://doi.org/10.11648/j.plant.20261403.12

Research Article

Assessment of Tree Species Variation of Specific Wood Gravity of Mango (*Mangifera indica*) and Tamarind (*Tamarindus Indica*) in Three (3) Zones of Kano State

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Abstract

The study was carried out on Variation in Wood Specific Gravity of Selected Species in three zones of Kano State, Nigeria. The study focuses on the effects of wood volume, mass, wood density, and specific gravity on two different tree species name Mango (Mangifera indica) and Tamarind (Tamarindus indica). The result shows that, the tree species with the highest mass was recorded in tamarind in sample 5 with 169.0g. The highest tree volume recorded was mango tree in sample 6 with 198.91cm^3. The wood species with the highest density was recorded in tamarind in sample 2 with 1.83 g/cm^3. The wood species with the highest specific gravity was recorded in tamarind in sample 2 with 1.83. The research found that Tamarind has the highest specific gravity making it suitable for various application. Wood specific gravity is an important wood property that influences timber quality, mechanical strength, biomass estimation, and carbon storage. This study assessed variations in specific wood gravity of Mango (*Mangifera indica*) and Tamarind (*Tamarindus indica*) collected from three zones of Kano State, Nigeria. Wood samples were obtained from mature trees and analyzed for mass, volume, density, and specific gravity. Comparative statistical analysis was used to evaluate differences between the two species. The results showed significant variation in wood properties between the species. Tamarind exhibited higher density and specific gravity values than Mango. The findings suggest that Tamarind wood is more suitable for heavy-duty applications requiring dense and strong timber, whereas Mango wood may be preferred for applications where lighter wood is advantageous. This study can aid researchers in selecting higher quality timber for industrial sector and provide information for selecting wood component for implement and tools.

Keywords

Tamarind, Mango, Tree Species Variation, Specific Wood Gravity, Seedlings

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Received: 24 May 2026; **Accepted:** 3 June 2026; **Published:** 28 September 2026

1. Introduction

Wood is a renewable natural resource that plays an important role in human society. It is widely utilized in construction, furniture production, tool manufacturing, paper making, and as a source of energy. In addition to its economic importance, wood contributes to environmental sustainability by storing carbon and reducing atmospheric carbon dioxide. Specific gravity is one of the most important indicators of wood quality because it is strongly associated with strength, hardness, durability, and several other mechanical properties. Recent studies have increasingly used wood specific gravity as a functional trait for understanding ecological processes and species performance [3, 7, 11].

Wood specific gravity is also an important parameter in forest biomass and carbon stock assessment. Since it reflects the amount of dry matter present in a given volume of wood, it is frequently used in estimating carbon storage within forest ecosystems [2, 5, 6]. Variation in specific gravity may occur among species, among trees of the same species, and within different parts of a single tree. Such differences can arise from tree age, climatic conditions, soil characteristics, growth rate, and the presence of extractive substances such as gums and resins [7, 12, 13].

Specific gravity is commonly defined as the ratio of oven-dry wood weight to the weight of an equal volume of water [14]. This property serves as a useful indicator of timber quality and suitability for applications such as lumber production and pulping [4]. Furthermore, wood specific gravity is widely used in biomass estimation models and forest inventory studies because it assists in converting forest volume measurements into biomass values [1, 2, 5, 8, 10].

Despite the increasing importance of wood specific gravity in forestry research, information on the variation of this property among commonly occurring tree species in Kano state remains limited. Understanding species-specific differences in wood density and specific gravity is essential for effective timber utilization, biomass estimation, and sustainable forest resource management. Mango (Mangifera indica) and Tamarind (Tamarindus indica) are widely distributed and economically valuable tree species in Northern Nigeria, yet comparative information on their wood properties is scarce [7, 12].

Therefore, this study was conducted to evaluate and compare the wood specific gravity, density, mass, and volume of Mango and Tamarind trees across selected zones of Kano State. The findings are expected to provide useful baseline information for foresters, researchers, wood industries, and policy makers involved in forest conservation, carbon accounting, and timber resource development.

2. Materials and Methods

2.1. Data Collection

Samples of wood was collected from the two (2) different species of tree in the study area. The samples were collected by cutting cross from the tree branch and the main bole sections from the same species. Wood specific gravity within individual tree often varies vertically along the main axis of the stem and/or radically from the pith to the bark. For each tree species, three samples each of the cross section and branch samples were taken from mature trees of same girth classes. The mean of the two samples was collected as the specific gravity of that species.

2.2. Materials Used

1) Sample
2) Axes
3) Meter rule
4) Air Ovum machine
5) Record book
6) Marker

2.3. Data Analysis

Comparative analysis was used to compare the specific gravity of different species and across different zones within Kano State. This analysis will help identify similarities and differences in specific gravity between species and across zones, providing valuable insights into the factors that influence specific gravity. By comparing specific gravity across multiple dimensions, the research provides a comprehensive understanding of how species, location, and environmental factors interact to influence specific gravity.

3. Results and Discussion

3.1. Effect of Mass (Dry Weight) on Different Trees Species.

From the research performed, the mass of wood was obtained after the woods have been subjected to oven drying where the final weight was recorded. The result shows that highest wood sample with the highest mass in tamarind is sample 5 with 169.0g Followed by sample 1 with 166.0g, sample 2 with 162.0g, sample 6 with 160.0g, sample 3 with 159.0g, sample 4 with 152.0g was recorded respectively as shown in Table 1.

In mango species, the result shows that the highest wood sample with highest mass is sample 2 with 158.0g, then followed by sample 6 with 155.0g, sample 4 with 151.0g, sample 5 with 149.0g, sample 3 with 144.0g, sample 1 with 141.0g as shown in Table 1.

***Table 1**. Mass table.*

Sample	Tamarind Mass (g)	Mango Mass (g)
1	166	141
2	162	158
3	159	144
4	152	151
5	169	149
6	160	155

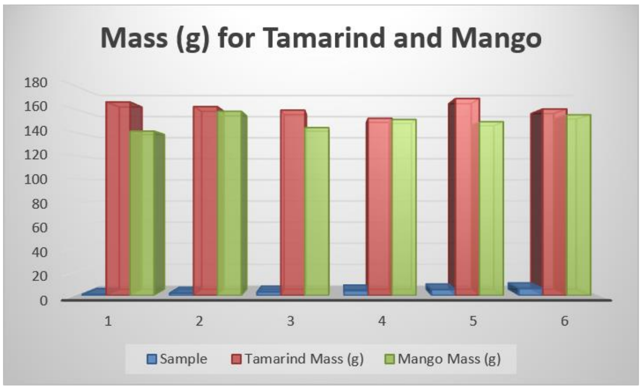

***Figure 1**. Comparison of wood mass between Tamarind and Mango samples.*

3.2. Effect of Wood Volume on Different Tree Species Wood Volume

From the research conducted, the volume of wood was calculated by multiplying the product of length, breadth, and the height of wood sample. The result shows the highest tree volume mango tree was sample 6 with 167.06cm^3, followed by sample 5 with 158.89cm^3, sample 1 with 129.36cm^3, sample 3 with 104.78cm^3, sample 4 with 103.63cm^3, sample 2 with 88.36cm^3 respectively as shown in Table 2.

Tamarind tree volume the result show that the highest tree volume was sample 6 with 198.91cm^3 then followed by sample 1 with 195.69cm^3, sample 5 with 177.99cm^3, sample 2 with 167.06cm^3, sample 4 with 163.43cm^3, sample 3 with 138.88cm^3 as shown in Table 2.

***Table 2**. Volume table.*

Sample	Tamarind Volume (cm^3)	Mango Volume (cm^3)
1	129.36	195.69
2	88.36	167.06
3	104.78	138.88
4	103.63	163.43
5	158.89	177.99
6	167.06	198.91

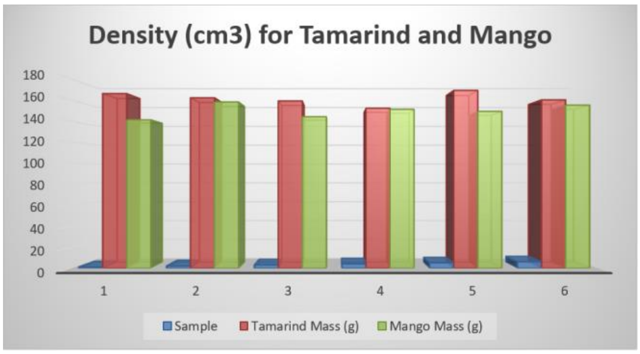

***Figure 2**. Comparison of wood volume between Tamarind and Mango samples.*

3.3. Variation of Wood Density on Different Tree Species

Wood density is greatly regarded as one of the most influential properties affecting strength and several other wood characteristics. The wood density was obtained by dividing mass with the volume. Statistically the variation was recorded among the treatment; the wood with highest density was recorded in tamarind was sample 2 with 1.83 g/cm^3, followed by sample 3 with 1.52 g/cm^3, sample 4 with 1.47 g/cm^3, sample 1 with 1.28 g/cm^3, sample 5 with 1.06 g/cm^3, and the least density was recorded at sample 6 with 0.96 g/cm^3 as shown in Table 3.

The result shows highest wood density in mango was sample 3 with 1.04 g/cm^3, followed by sample 2 with 0.95 g/cm^3, sample 4 with 0.92 g/cm^3, sample 5 with 0.84 g/cm^3, sample 6 with 0.78 g/cm^3 and the treatment with least specific gravity was found sample 1 with 0.72 g/cm^3 as shown in Table 3.

***Table 3**. Density table.*

Sample	Tamarind Density (g/cm^3)	Mango Density (g/cm^3)
1	1.28	0.72
2	1.83	0.95
3	1.52	1.04
4	1.47	0.92
5	1.06	0.84

Sample	Tamarind Density (g/cm³)	Mango Density (g/cm³)
6	0.96	0.78

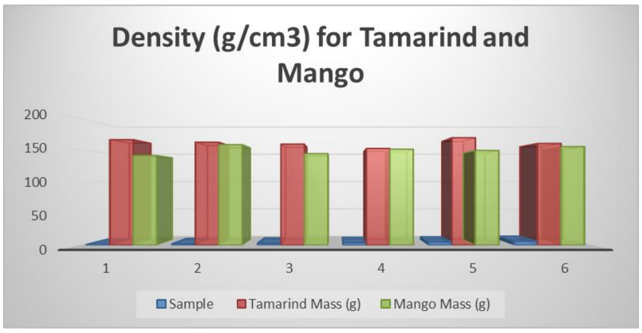

Figure 3*. Variation in wood density between Tamarind and Mango samples.*

3.4. Variation of Wood Specific Gravity on Different Tree Species

Wood specific gravity is determined by how much wood substance is present per unit volume, and it's most important within species wood characteristics because knowledge about it allowed the prediction of greater number of properties than any other traits [14]. The specific gravity of wood was obtained by dividing the density of the substance all over the density of water, which is equal to 1. During the study, the specific gravity varies within different treatment, the wood with the highest specific gravity in tamarind was sample 2 with 1.83, followed by sample 3 with 1.52, sample 4 with 1.47, sample 1 with 1.28, sample 5 with 1.06 and the least specific gravity was sample 6 with 0.96 as shown in Table 4.

The highest wood specific gravity in mango was sample 3 with 1.04 followed by sample 2 with 0.95, sample 4 with 0.92, sample 5 with 0.84, sample 6 with 0.78, and the treatment with least specific gravity was found sample 1 with 0.72 as shown in Table 4.

Table 4*. Specific Gravity Table.*

Sample	Tamarind Specific Gravity	Mango Specific Gravity
1	1.28	0.72
2	1.83	0.95
3	1.52	1.04
4	1.47	0.92
5	1.06	0.84
6	0.96	0.78

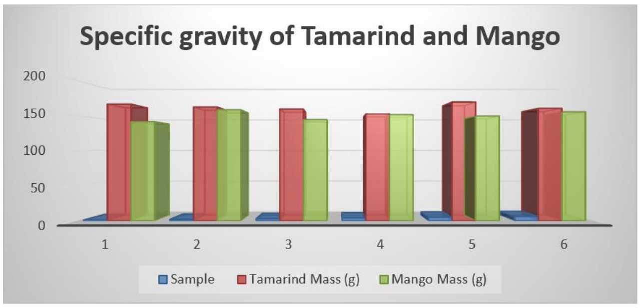

Figure 4*. Variation in specific gravity between Tamarind and Mango samples.*

4. Discussion

Wood specific gravity which is a way of expressing how much wood substance is present per unit volume and the most important within wood characteristics, because knowledge allows the production of a greater number of properties than any other tract [2, 14]. Some wood properties that are closely related to wood specific gravity are strength, dimension stability with moisture content change, ability retain paint, fibre yield per unit volume, suitability as raw material for making proper (Bowyer and Smith, 1998). During the study the specific gravity varied among different treatment, the wood with highest specific gravity was recorded for tamarind and mango.

In this study; Variation in wood specific gravity may be due to the following factors such as soil fertility, rainfall, temperature and moisture content which varies by species, age and stem position. The variation in wood specific gravity has also been reported by [7]. Another similar result was also reported by [10]. The analysis reveals that Tamarind wood samples generally have a higher mass, density, and specific gravity than Mango wood samples. The higher density and specific gravity of Tamarind indicate a compact structure, making it potentially more suitable for applications requiring strong, durable materials. The significant T-test results support the conclusion that Tamarind and Mango wood differ substantially in these properties, which may affect their usage in various applications.

The correlation analysis indicates that for Tamarind, mass and volume are closely linked, while Mango's mass correlates more with density. This suggests that Tamarind's denser structure is consistent across different sample sizes, while Mango wood properties may vary based on density rather than volume alone.

5. Conclusion

The study was carried out on specific gravity, the effects of wood volume, mass, wood density, and wood specific gravity on different trees Species. The highest tree volume was found (Tamarind), and the lowest volume was observed was (Mango). In summary, Tamarind wood exhibits higher mass, density, and specific gravity compared to Mango. The findings suggest Tamarind's suitability for heavy-duty applications due to its compact nature, while Mango may be more suitable for applications where lighter, less dense wood is advantageous. These results align with previous studies, suggesting that Tamarind wood's denser structure provides higher strength-to-weight ratios, while Mango's lower density makes it easier to handle and process for flexible applications.

Abbreviations

SG	Specific Gravity
WD	Wood Density
DOI	Digital Object Identifier
cm^3	Cubic Centimeter
g/cm^3	Gram per Cubic Centimeter

Author Contributions

Muhsin Hassan Kafinga: Conceptualization, Formal Analysis, Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing

Mujittafa Lawan Ibrahim: Conceptualization, Formal Analysis, Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing

Sagir Ado Danturai: Data curation, Methodology, Formal Analysis, Writing – original draft

Mahmuod Abubakar Bashir: Data curation, Methodology, Formal Analysis, Writing – original draft

Halliru Bilyaminu: Data curation, Methodology, Formal Analysis, Writing – original draft

Bello Rufai Wali: Data curation, Methodology, Formal Analysis, Writing – original draft

Conflicts of Interest

The Author(s) declares that there are no conflicts or competing interest regarding the publication of this paper.

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