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Umar Labaran Bashir
Department of Biological Sciences, Northwest University Kano, Nigeria

Aisha Sani Magaji
Department of Biological Sciences, Northwest University Kano, Nigeria

Ibrahim Isyaku Muhammad
[1] Department of Biological Sciences, Northwest University Kano, Nigeria
[2] Department of Botany, School of Bioengineering and Bioscience, Lovely Professional University, Phagwara, Punjab, India

Aisha Aliyu Lawal
Department of Biological Sciences, Northwest University Kano, Nigeria

Correspondence
Umar Labaran Bashir
Department of Biological Sciences, Northwest University Kano, Nigeria

Comparative neutraceutical potentials of *Tamarindus indica* and *Dialium guineense* fruits

Umar Labaran Bashir, Aisha Sani Magaji, Ibrahim Isyaku Muhammad and Aisha Aliyu Lawal

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Abstract
Tamarindus indica and *Dialium guineense* are indigenous African fruits trees which contain lots of neutraceutics essentials for their health promoting potentials. The present study investigates the nutritional compositions of *T. indica* and *D. guineense*. The study aimed to compare the proximate and mineral composition of these two fruits to evaluate their nutritional benefits. The research analyzed and compared the levels of proximate contents and essential minerals presents in *T. indica* and *D. guineense* fruits. The result revealed that *T. indica* had higher levels of crude fat of about 6.50±0.04, moisture content (26.57±0.03), and crude protein (2.28±0.007), compared to *D. guineense* which exhibit lower levels of the parameters crude fat (5.45±0.03), Moisture content (0.60±0.10), and crude protein (1.82±0.02), yet revealed no significant difference between the two fruits having a t-value of 0.0124, 0.0020 and 0.0135 respectively. While *D. guineense* had higher carbohydrate content that reads (88.68±0.01). Mineral analysis showed that *T. indica* generally had a higher mineral concentrations compared to *D. guineense*, such as in phosphorus (2196.45±25.70 and 2357.86±31.32), showing a significant difference of 0.0745, potassium (7177.20±71.29 and 5753.47±37.12), and calcium (4530.88±19.19 and 1153.68±6.80), which are vital minerals supporting human energy production and bone health, healthy blood pressure and nerve function and also strengthens bones and teeth respectively. Conversely, *D. guineense* exhibits higher copper and sodium levels. The study concluded that both fruits have significant nutritional benefits, with *T. indica* being a valuable source of fiber, protein, and healthy fats, and *D. guineense* being particularly well-suited for providing readily available energy. The study revealed the abundant nutraceutical potentials of the fruit as natural sources, and the genetic makeup and conservation of the fruit trees should be enhanced.

Keywords: Neutraceutics, Proximate compositions, *Tamarindus indica*, *Dialium guineense*

Introduction
Tamarindus indica L. belongs to a dicotyledonous family of large flowering plants; Fabaceae subfamily *Caesalpiniaceae*; which is composed of over 700 genera and spans over 19,000 species known to man (Maiti *et al.*, 2004; Lewis *et al.*, 2005) [16, 15]. It is native to West and sub-Saharan Africa, Asia, Central and South America (Teklehaimanot, 2008) [25]. It is an evergreen tree plant 30m high with a brownish-grey bark which produces a deep tap root, possessing a broad crosswise root system (Teklehaimanot, 2008) [25]. In certain parts of Africa, *Tamarindus indica* pulp is eaten or utilized as a key ingredient in chewing gum, fruit drinks, beverages and jams. Alternatively, it is combined with local millet porridge or bread and consumed as a delicacy (Ajayi *et al.*, 2006; El-siddig *et al.*, 2006) [5, 10]. This supports the tradition of consuming the fresh fruit pulp as a snack in the northern parts of Nigeria. Its ethno-medicinal uses includes being utilized as a laxative, expectorant, blood tonic, for treating bile disorders, as an antiscorbutic, as a component of cardiac and blood sugar medication. According to folklore, the fruit pulp is used to remedy swellings, sore throat, rheumatism, alcoholic intoxication and sunstroke (Komutarin *et al.*, 2004; El-Siddig *et al.*, 2006; Teklehaimanot, 2008) [14, 24, 25].

Dialium guineense commonly known as African black velvet tamarind, is a large tree found in many parts of Africa such as West Africa, Central African Republic and the Chad. The tree belongs to the family *Fabaceae-caesalpinioidaea*, it is 30 meters high, with a densely leafy crown, but often shrubby. The leaves are finely hairy, broadly elliptic, blunt at the apex, leathery and are a sunken midrib. Its flowers appear whitish and the branches are horizontally spread (Szolnok, 1985) [23]. Fruits are usually circular and flattened, black in colour with stalk 6mm long, a little collar is seen near the apex and a bristle shell encloses one or two seeds embedded in a dry, brownish edible pulp (Hong *et al*., 1996) [13].

It grows in dense forests in Africa along the southern edge of the Sahel. In Togo it is called atchethewh (Dressler, 2014) It grows in dense. *Dialium guineense* is a medicinal plant and can be found in West African countries such as Ghana where it is known as *Yoyi*, Sierra Leone where it is known as *black tombla*, Senegal, Guinea-Bissau and Nigeria where it is known as *Awin* or Igbaru in Yoruba, Icheku in Igbo and *Tsamiyar biri* in Hausa.

Despite the traditional use and growing interest in *Tamarindus indica* and *Dialium guineense* as potential sources of bioactive compounds, there is a lack of comprehensive studies on the neutraceutical potentials of their fruits, limiting our understanding of their unique properties and health benefits. This research project aims to fill this gap by conducting analysis of proximate and mineral composition of *Tamarindus indica* and *Dialium guineense*.

This study aim to compare the nutritional value, minerals compositions of the two indigenous African fruits trees with excellent neutraceutics.

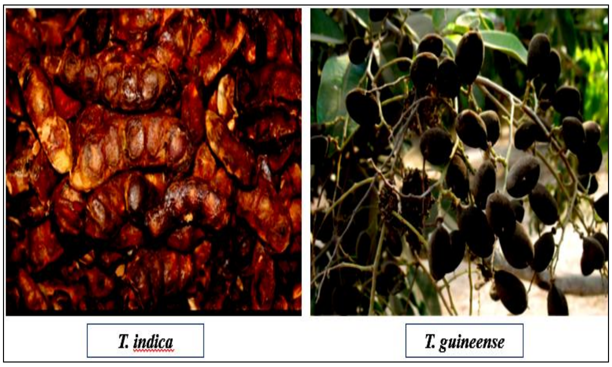

Fig 1: A figure showing *T. indica* and *T. guineense*

Materials and Methods

Chemicals and Equipment

All the chemical/reagents and standards used were of analytical grade and supplied from Sigma-Aldrich. The Equipment used are Fibertec 8000 (Auto fibre Analysis System), Carbolite, Kjeltec 8400 (Foss), Digestor, SR 210 Scrubber, Soxtec 8000 Extraction unit (Foss), Combustion calorimeter, Analytical Weighting Balance (OHAUS, PIONEER) and MP-AES (AGILENT 4210) Agilent Technologies.

Proximate Composition

Determination of Moisture

The percentage moisture of the fruits was determined using moisture analyzer (Ooi *et al*., 2012) [21] and the results were recorded.

Determination of Crude Fat

The measurement of fat content was conducted using Soxtec method previously described by Noureddini and Byun (2010) [18], with a SoxtecTM 8000 automated analyzer. Petroleum ether was used for the extraction, whereas the percentage of fat was obtained using the formula below;

$$\%\text{Fat} = \frac{Weight\text{extraction cup} + \text{residue} - Weight\text{extraction cup}}{Weight\ sampl} \times 100$$

Determination of Crude Protein

The nitrogen content in each sample was determined according to the method of (Ng *et al.* 2008; Hamisu *et al.*, 2023) [17, 11] using Kjeltec 8400 Auto Distillation Unit (FOSS Tecator Line), and the protein content was obtained using conversion factor of 6.25.

Determination of Ash Content

The method described by AOAC (2000) was used to measure the ash content of the fruit samples. The samples were incinerated in a furnace (CARBOLITE) at 550 °C, and the remaining inorganic material was cooled, weighed and the ash content was determined.

Determination of Crude Fibre

The method described by (Noureddini and Byun 2010; Usman *et al.*, 2020) [18, 25] was used to determine the crude fibre content of the fruit samples using a Fibretec 8000 auto fibre analysis system.

Determination of Carbohydrate and Caloric Value

The total carbohydrate content in the samples was calculated by difference method, while the caloric value was calculated by sum of the percentages of proteins and carbohydrates multiplied by a factor of 4 (kcal/g) and total lipids multiplied by a factor of 9 (kcal/g) Bashir *et al*., 2021) [7]

Determination of Mineral Composition

The mineral contents was estimated using Agilent Microwave Plasma Atomic Emission Spectrometer (MP-AES Model: AGILENT 4210).

Sample Preparation for Mineral analysis (Using Advanced Microwave Digestion System)

The fruit samples were prepared as programmed by the equipment; briefly: Two hundred milligram (200 mg) of samples were weighed and transferred into 90ml microwave digestion vessels. Ten millilitres (10 mL) mixture of 15.9 N trace metal grade Nitric acid, hydrogen peroxide and perchloric acid (7:2:1) was added to each vessel. After standing for one hour (1h), the samples were processed by microwave digestion system as follows: ramp temperature from ambient to 200˚C over 20 minutes, then hold at 200˚C for 20 minutes, after digesting, they were allowed to cool to approximately 50˚C or lower before handling. The digest was transferred to 50 ml volumetric flask, the solution volume was adjusted to 50 ml with deionised water and filtered for instrumental analysis (Bashir *et al.*, 2021) [7].

The sample was introduced through PVC peristatic pump tubing (white/white and blue/blue), and pass to cyclonic spray chamber and the oneNeb nebulizer. The Agilent MP Expert software was used to measure the intensities and automatically subtract the background signal from the analytical signal. A background spectrum from a blank solution was recorded, and the values was automatically subtracted from both standard and sample. The pressure of nebulizer was optimized using the software and position for each wavelength selected to maximize sensitivity was viewed, and a standard reference solution was used (Bashir *et al.*, 2021) [7].

Statistical Analysis

All determinations were carried out in triplicates, and data was expressed as mean±standard deviation (SD).

Results and Discussions

Results

Proximate Composition of the Fruits; *Tamarindus indica* and *Dialium guineense.*

The proximate composition analysis of *T. indica* and *D. guineense* revealed significant differences ($p < 0.05$) in crude fat, moisture, crude protein, and carbohydrates, with *T. indica* having higher values for crude fat, moisture, and crude protein while *D. guineense* had a significantly higher carbohydrate content. However, no significant differences ($p \geq 0.05$) were observed in ash and crude fiber contents.

Table 1: Proximate (%) Composition of the Fruits; *Tamarindus indica* and *Dialium guineense.*

Parameters Tested	*T. indica* fruit	*D. guineense* fruit	T. Values
Ash	2.70±0.02	1.20±0.12	0.0165
Crude fibre	31.14±0.02	2.25±0.02	0.4812
Crude fat	6.50±0.04	5.45±0.03	0.0124
Moisture	26.57±0.03	0.60±0.10	0.0020
Crude protein	2.28±0.007	1.82±0.02	0.0135
Carbohydrate	30.81±0.03	88.68±0.01	0.0002

All values were mean±standard deviation of triplicate determinations.

Mineral Analysis of the Fruits; *Tamarindus indica* and *Dialium guineense.*

The mineral composition of *T. indica* and *D. guineense* showed significant differences ($p < 0.05$) in the levels of selenium, zinc, calcium, iron, copper, potassium, magnesium, and sodium, with *T. indica* generally having higher concentrations except for copper and sodium, which were higher in *D. guineense*. Conversely, no significant differences ($p \geq 0.05$) were observed in the levels of phosphorus, nickel, and manganese. Cobalt was not detected in either samples.

Table 2: Mineral Composition of the Fruits; *Tamarindus indica* and *Dialium guineense*

Minerals	*Tamarindus indica* (mg/kg)	*Dialium guineense* (mg/kg)	T. Values
P	2196.45±25.70	2357.86±31.32	0.0745
Se	61.89±18.27	26.79±17.33	0.0365
Zn	14.69±0.50	11.14±0.20	0.0123
Ca	4530.88±19.19	1153.68±6.80	0.0011
Fe	77.74±0.12	82.97±0.90	0.0124
Cu	7.22±0.06	7.79±0.05	0.0465
Ni	2.38±0.40	2.47±0.03	0.1463
K	7177.20±71.29	5753.47±37.12	0.0091
Mg	940.36±7.74	302.86±6.55	0.0000
Mn	7.89±0.50	81.07±0.71	0.0017
Na	438.65±22.65	513.25±10.68	0.0904
Co	ND	ND	

All values were mean ± standard deviation of triplicate determinations.

Key: ND = Not detected.

Discussion

The proximate composition of *T. indica* and *D. guineense* showed distinct nutritional profiles. The ash content of *T. imdica* (2.70±0.02%) was significantly higher than that of *D. guineense* (1.20±0.12%), as indicated by a t-value of 0.0765, suggesting statistically no significant difference ($p \geq 0.05$). This result aligns with the findings of Oyeleke and Adeola (2022) [22], who reported ash content for *T. indica* ranging between 2.50-2.8-0%, though Okafor *et al.* (2023) [19] observed slightly lower levels (1.90-2.20%) due to differences in soil mineral availability. Similarly, the crude fiber content of *T. indica* (31.14±0.02%) was markedly higher than *D. guineense* (2.25±0.02%) supported by the t-value 0.481 which also indicates no significant difference. The findings conforms with that of Afolabi and Odu (2021) [4], who reported crude fiber levels of *T. indica* ranging between 30.00-32.00%, while Adesanya *et al*. (2023) [2] documented lower crude fiber levels in *D. guineense* (2.00-2.50%). Variations in crude fiber content (28.00-33.00%) observed by Adeola *et al*. (2023) [22] point to differences in fruit maturity and processing methods. Crude fat, an important energy source, was also higher in *T. indica* (6.50±0.04%) compared to *D. guineense* (5.45±0.03%). Moisture content, which affects fruit storage potential, was also found to be higher in *T. indica* (26.57±0.03%) compared to that of *D. guineense* (12.00-14.00%), in agreement with Bello *et al*. (2021) [7], who reported moisture content for *T. indica* as 25.00-27.00%. Crude protein content was as well significantly higher in *T. indica* (2.28±0.07%) than *D. guineense* (1.82±0.02%) as shown by a t-value of 0.01354. Okonkwo *et al.* reported similar protein levels for *T. indica* (2.00-2.50%) and *D. guineense* (1.70-1.90%). Conversely, carbohydrate content was significantly higher in *D. guineense* with a t-value 0.0002, indicating a strong statistical difference. This aligns with Adesanya *et al*. (2023) [2], who reported carbohydrate levels for *D. guineens e* ranging from 88.50-89.00% and *T. indica* between 30.00-31.50%. Discrepancies observed across studies, like the lower ash content reported by Okafor *et al*. (2023) [19] or variations in fiber content noted by Adeola *et al*. (2023) [22], may be due to environmental factors, fruit maturity, and post-harvest handling practices. The nutritional profiles of these fruits offer distinct advantages. *T. indica* stands out as a valuable source of fiber, protein, and healthy fats, suggesting its potential for contributing to dietry satiety and overall nutrient intake. On the other hand, *D. guineense*, with its high carbohydrate content, appears particularly well-suited for providing readily available energy.

The mineral composition analysis of *T. indica* and *D. guieense* revealed notable differences in several key minerals, each of which plays an essential role in nutrition and physiology. Selenium was significantly higher in *T. indica* (61.89±18.27 mg/kg) compared to *D. guineense* (26.19±17.33 mg/kg), with a t-value of 0.0364 ($p < 0.05$). Selenium is a crucial trace mineral that functions as a cofactor in antioxidant enzymes, such as glutathione peroxidase, helping to mitigate oxidative stress and improve immune function. The selenium levels found in *T. indica* in this study align with Adeyemi and Bello (2022) [3], who reported levels ranging from 60.00-62.00 mg/kg, but are slightly higher than those reported by Okafor et al. (2023) [19], who documented selenium levels between 50.00-55.00 mg/kg. Zinc content was also noticeably higher in *T. indica* (14.69±0.50 mg/kg) compared to *D. guineense* (11.14±0.20 mg/kg), with a t-value of 0.0123. Zinc is critical for enzymatic reactions, immune function, and wound healing (Afolabi and Odu, 2021) [4]. The zinc content in *T. indica* is within the range reported by Afolabi and Odu (2021) [4] (14.50-15.00 mg/kg), while the lower values in *D. guineense* are consistent with findings by Adesanya *et al.* (2023) [2] (11.00-11.50 mg/kg). The higher zinc levels in *T. indica* may enhance its nutritional and therapeutic value,

especially for populations at risk of zinc deficiency. Calcium were as well higher in *T. indica* (4530±19.19 mg/kg) compared to *D. guineense* (1153.68±6.80 mg/kg), with a t-value of 0.0111 ($p < 0.05$) indicating significant difference. Calcium is vital for bone health, muscle contraction, and nerve signaling (Bello *et al*., 2021) [7]. The calcium content in *T. indica* conforms with the findings reported by Bello *et al*. (2021) [7], who reported levels ranging from 4500.00-4550.00 mg/kg. Meanwhile, the calcium levels in *D. guineense* are slightly lower than those reported by Adeola and Adeleke (2023) [22], who documented levels between 1150.00-1200.00 mg/kg. Differences in calcium levels may be attributed to soil mineral availability or fruit maturity. Also, the level of iron concentration was higher in *T. indica* (77.74±0.12 mg/kg) compared to *D. guineense* (7.79±0.05 mg/kg). Iron serves in oxygen transport and energy metabolism, which makes it critical for preventing anemia. The iron levels in *T. indica* aligns with findings by Okwonkwo *et al*. (2023) [20], whose values were between (75.00-80.00 mg/kg). However, the iron content observed in *D. guineense* is lower than the range of 8.00-10.00 mg/kg documented by Adeola and Adeleke (2023) [22], potentially due to differences in soil iron availability. Copper and potassium contents were also higher in *T. indica* which are essential for red blood cell formation and maintaining electrolyte balance and muscle contraction respectively (Uche and Nnamdi, 2023) [26].
Conspicuously, phosphorus, nickel, and manganese showed no significant differences between the two fruits, as indicated by t-values greater than 0.05. Cobalt was not detected in both fruits, consistent with the findings of Uche and Nnamdi (2023) [26], who noted that cobalt is often absent in tropical fruits due to low soil concentrations.

Conclusion

The study concluded that *T. indica* and *D. guineense* offers distinct nutritional benefits with *T. indica* being superior in crude fat, protein, fiber, and essential minerals like calcium, potassium, magnesium, selenium and zinc, making it ideal for addressing micronutrient deficiencies and supporting bone health. Conversely, *D. guineense* is a potent source of carbohydrates, providing readily available energy, and contains slightly higher copper and sodium levels. Both fruits are valuable components of a balanced diet, with *T. indica* excelling in micronutrient provision and *D. guineense* serving as an energy-dense food source.

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