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Phytochemical Screening, Proximate Composition, and Mineral Analysis of Tropical Almond (*Terminalia catappa*) Seeds Collected from Gombe State, Nigeria

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Abstract

The growing demand for natural medicines and plant-derived nutrients has increased scholarly interest in botanical resources rich in bioactive constituents, minerals, phytochemicals, and other metabolites. *Terminalia catappa*, a member of the Combretaceae family commonly found in tropical and subtropical regions, is traditionally used for its antioxidant, anti-inflammatory, anticancer, and antidiarrheal properties. This study aimed to evaluate the phytochemical profile, proximate composition, and mineral content of *T. catappa* seed nuts. Standard analytical methods were employed for proximate analysis, while elemental content was determined using atomic absorption spectrophotometry and flame photometry. Phytochemical screening revealed the presence of saponins, steroids, phenols, and alkaloids, whereas tannins and flavonoids were absent. The proximate composition showed moisture content of 11.03%, ash content of 5.00%, crude fiber of 0.53%, crude protein of 8.28%, crude fat of 36.33%, and carbohydrates of 39.63%. Mineral analysis indicated notable concentrations of potassium at 1.1638 mg/L and calcium at 0.2046 mg/L, with sodium, manganese, zinc, iron, and copper detected in trace amounts. The study

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concludes that *T. catappa* seed nuts possess considerable nutritional and medicinal value, supporting their traditional applications and indicating their potential industrial use in food, pharmaceutical, and personal care products. These findings contribute to phytochemical and nutritional research by providing empirical evidence on the bioactive and compositional properties of *T. catappa* seeds.

Keywords: *Terminalia catappa*; Phytochemical Screening; Proximate Composition; Mineral Content; Plant-Based Nutrients

Introduction

Fruits and fruit-bearing nuts are consumed globally for their nutritional value and potential medicinal properties. Among such plants is *Terminalia catappa*, commonly known as tropical almond, a species belonging to the family Combretaceae. Traditionally, various parts of this tree have been used to treat ailments such as scabies, leprosy, stomachaches, and headaches (Anand et al., 2015). Beyond its ethnomedicinal applications, *T. catappa* also serves several non-food purposes, providing tannins, dyes, timber, fuelwood, and other resources of economic and pharmacological significance (Aigbokhan, 2015).

T. catappa is predominantly distributed across tropical and subtropical coastal regions. It is highly tolerant to environmental stress such as salt spray, high salinity in the root zone, and strong wind, making it ideal for shoreline ecosystems. The tree thrives in well-drained sandy soils and typically begins fruit production around three years of age. The ripened fruit is red in color, and its seed kernel—similar in taste to true almonds—is consumed in many parts of the world. This has led to common names such as Indian almond, sea almond, and wild almond (Barros et al., 2017; Raph et al., 2019; Bartocci et al., 2019).

Despite its wide traditional use and accessibility, the nutritional and chemical composition of *T. catappa* seeds remain underexplored in many parts of the world, including Nigeria. Particularly in Gombe State, there is limited scientific documentation regarding its proximate composition, mineral profile, and phytochemical constituents. Given that micronutrients such as calcium, iron, and magnesium are essential for normal physiological function and that their deficiency can lead to serious health problems, evaluating the nutritional and phytochemical potential of *T. catappa* seeds is essential. This study was therefore designed to assess the phytochemicals, proximate composition, and mineral

content of *Terminalia catappa* seeds, with the aim of contributing to the scientific understanding of this important but underutilized plant resource.

Materials and Methods

Study Area and Sample Collection

Mature fruits of *Terminalia catappa* were collected from Billiri Local Government Area, Gombe State, Nigeria. The area is situated between latitude 10.17°N and 11.10°E and longitude 10.283°E and 11.167°E, with an elevation typical of tropical savannah conditions. The collected samples were authenticated at the herbarium unit of the Botany Department, Gombe State University, where the plant was identified with specimen number 16.

Sample Preparation

The seeds were manually removed from the fruits, washed thoroughly, air-dried, roasted, and ground using a clean mortar and pestle. The powdered samples were stored in airtight containers for subsequent analyses.

Equipment and Reagents

Standard laboratory equipment and glassware were used, including beakers, conical flasks, Kjeldahl apparatus, Soxhlet extractor, spectrophotometer (Shimadzu), muffle furnace (Thermo Fisher), and atomic absorption spectrophotometer (Hitachi Model 10-170). All reagents used were of analytical grade and included sulfuric acid (H_2SO_4), hydrochloric acid (HCl), nitric acid (HNO_3), perchloric acid ($HClO_4$), sodium hydroxide (NaOH), copper sulfate ($CuSO_4$), and diethyl ether.

Phytochemical Screening

Qualitative phytochemical analysis was conducted following the methods described by Sofowora (2002). Specific tests were performed to detect tannins, steroids, flavonoids, saponins, phenols, and alkaloids. Each test involved weighing 0.5 g of the sample and reacting it with specific reagents:

Tannins: Boiled sample extract was treated with 0.1% ferric chloride; green or blue-black coloration indicated presence.

Steroids: Sample was treated with chloroform, acetic anhydride, and concentrated H_2SO_4; a bluish-red ring indicated steroids.

Flavonoids: Ethanolic extract was mixed with dilute ammonia and H_2SO_4; a yellow coloration indicated presence.

Saponins: Extract shaken with distilled water; persistent froth and formation of emulsion upon addition of olive oil confirmed saponins.

Phenols: Ferric chloride and gelatin solutions were used to detect phenolic compounds through precipitate formation.

Alkaloids: Acid-alcohol extracts were treated with ammonia and chloroform, then tested with Mayer's, Wagner's, and Hager's reagents for precipitate formation.

Proximate Composition Analysis

Proximate composition was determined using AOAC (2019) methods:

Moisture Content: 1 g of fresh sample was oven-dried at 60 °C for 24 hours. The process was repeated until a constant weight was obtained. Moisture was calculated as the percentage weight loss.

Ash Content: 1 g of dried sample was incinerated in a muffle furnace at 550 °C for 5 hours. After cooling, the residue was weighed to determine ash percentage.

Crude Protein: Determined via the Kjeldahl method. 1 g of the sample was digested with concentrated H_2SO_4 and a catalyst mixture (K_2SO_4 and $CuSO_4$). After digestion, ammonia was distilled into boric acid and titrated against 0.1 M H_2SO_4. Nitrogen percentage was calculated and multiplied by 6.25 to obtain crude protein content.

Crude Fat: 2 g of sample was digested with concentrated HCl in a boiling water bath, cooled, and extracted with ethanol and diethyl ether in a separating funnel. The ether layer was dried in a water bath and oven, then weighed to calculate fat content.

Crude Fiber: The defatted sample was sequentially treated with dilute acid and alkali to remove soluble materials. The residue was filtered, dried to constant weight, and the difference was used to calculate crude fiber percentage.

Carbohydrates: Calculated by difference after summing the percentages of moisture, ash, fat, protein, and fiber:

$$\text{Carbohydrate (\%)} = 100 - (\%\text{moisture} + \%\text{protein} + \%\text{fat} + \%\text{ash} + \%\text{fiber})$$

Energy Content: Estimated by multiplying crude protein and carbohydrate contents by 4 and crude fat by 9.

Mineral Content Determination

Wet digestion of the sample was performed using AOAC (2019) guidelines. Exactly 1 g of the powdered sample was mixed with 12 ml of concentrated HNO_3 and left overnight. Afterward, 4 ml of $HClO_4$ was added, and the mixture was heated in a digestion block with increasing temperature up to 250 °C until white fumes appeared, indicating completion. The digested material was diluted to 100 ml with distilled water and filtered.

Minerals such as calcium (Ca), potassium (K), sodium (Na), iron (Fe), magnesium (Mg), copper (Cu), manganese (Mn), and zinc (Zn) were quantified using Atomic Absorption Spectrophotometry (AAS). Each element was analyzed using a dedicated hollow cathode lamp specific to its wavelength. Readings were recorded in parts per million (ppm) and converted to mg/100 g using the formula:

$$MW = \frac{\text{Absorbance (ppm)} \times \text{Dilution factor} \times \text{Dry wt.}}{\text{Weight of sample (g)}}$$

Results

Phytochemical Screening

The qualitative phytochemical screening of *Terminalia catappa* (tropical almond) seeds revealed the presence of saponins, steroids, phenols, and alkaloids. However, tannins and flavonoids were not detected. These findings are consistent with prior studies reporting the presence of these compounds in *T. catappa* seeds and leaves (Divya et al., 2018; Mandloi et al., 2017; Chukwuma, 2015).These results are summarized in Table 1.

Table 1. Phytochemical constituents of Terminalia catappa seeds

Phytochemicals	Result
Saponins	+
Tannins	–
Steroids	+
Flavonoids	–
Phenols	+
Alkaloids	+

(+ = Present, – = Absent)

Proximate Composition

The proximate composition of *Terminalia catappa* seeds is presented in Table 2. Carbohydrate had the highest percentage (39.63%), followed by crude fat (36.33%), moisture content (11.03%), crude protein (8.28%), ash (5.00%), and crude fiber (0.53%). These values are within the ranges previously reported by Akpakpan and Akpabio (2016) and Atsu-Barku et al. (2016), who highlighted the nutritional richness of tropical almond seeds.

Table 2. Proximate composition of Terminalia catappa seeds

Parameter	Content (%)
Moisture	11.03 ± 0.25
Ash	5.00 ± 0.28
Crude Fat	36.33 ± 0.10
Crude Fiber	0.53 ± 0.18
Crude Protein	8.28 ± 0.35
Carbohydrate	39.63 ± 0.71

Values are expressed as mean ± standard deviation (n = 2).

Mineral Composition

The mineral composition of *Terminalia catappa* seeds is shown in Table 3. Potassium (1.1638 mg/L) was the most abundant mineral, followed by calcium (0.2046 mg/L), zinc (0.0745 mg/L), sodium (0.0375 mg/L), copper (0.0155 mg/L), iron (0.0123 mg/L), and manganese (0.0223 mg/L). These values are supported by findings from Barros et al. (2017) and Salvo et al. (1983), who similarly reported substantial potassium and calcium contents in *T. catappa*.

Table 3. Mineral content of Terminalia catappa seeds

Mineral	Concentration (mg/L)
Calcium (Ca)	0.2046 ± 0.0001
Potassium (K)	1.1638 ± 0.0006
Sodium (Na)	0.0375 ± 0.0002
Manganese (Mn)	0.0223 ± 0.0001
Zinc (Zn)	0.0745 ± 0.0001
Iron (Fe)	0.0123 ± 0.0002
Copper (Cu)	0.0155 ± 0.0001

Values are expressed as mean ± standard deviation (n = 2).

Discussion

Phytochemical Screening

The phytochemical analysis of *Terminalia catappa* seed revealed the presence of saponins, steroids, phenols, and alkaloids, while tannins and flavonoids were not detected (Divya et al., 2018; Mandloi et al., 2017). The presence of saponins indicates potential pharmacological applications, particularly in managing hyperlipidemia, microbial infections, and inflammatory conditions (Khan et al., 2014). Saponins are known for their cholesterol-lowering and immunomodulatory properties. Steroids, commonly found in medicinal plants, contribute anti-inflammatory, analgesic, and hormonal activities (Mandloi et al., 2017). Their presence supports the traditional use of *T. catappa* in folk medicine for managing inflammation and related disorders.

Phenolic compounds, indicated by the presence of phenols, are renowned for their antioxidant properties, which help combat oxidative stress and may have protective effects against chronic diseases (Divya et al., 2018). The detection of alkaloids further highlights the therapeutic potential of the seed, as alkaloids possess a wide range of biological activities, including antimicrobial, analgesic, and antimalarial effects (Sofowora, 2002).

The absence of tannins and flavonoids could be due to their possible degradation during sample processing or low inherent concentrations in the seed (Anand et al., 2015). However, their acidic nature may also influence their detectability during screening. Generally, the identified phytochemicals reinforce the medicinal relevance of *Terminalia catappa* and align with reports of its traditional use in herbal medicine.

Proximate Composition

The proximate analysis demonstrated that *Terminalia catappa* seeds are rich in carbohydrates (39.63%) and crude fat (36.33%), with a moderate amount of protein (8.28%). The high carbohydrate content suggests that the seeds can serve as a good source of dietary energy. Similarly, the substantial crude fat content positions the seed as a potential source of plant oil, contributing to its caloric value. This agrees with reports by Akpakpan and Akpabio (2016), who highlighted the seeds' potential as a food supplement.

The moderate protein content highlights its potential role in providing essential amino acids necessary for tissue repair and metabolic functions (Atsu-Barku et al., 2016).. However, the low crude fiber (0.53%) indicates that while the seeds may not significantly

contribute to fiber intake, their digestibility and energy value remain high. Low moisture content (11.03%) is advantageous for storage stability, reducing the risk of microbial spoilage and extending shelf life. This aligns with observations by Akpakpan and Akpabio (2016), who reported that low moisture favors prolonged storage by limiting microbial growth and enzymatic activity.

The ash content (5.00%) suggests a considerable presence of inorganic minerals, supporting the mineral composition findings. The overall proximate composition implies that *Terminalia catappa* seeds are nutritionally valuable, offering energy, essential fats, and proteins, which corroborates previous studies highlighting their food and nutritional relevance (Atsu-Barku et al., 2016; Akpakpan & Akpabio, 2016).

Mineral Composition

The mineral analysis revealed potassium (1.1638 mg/L) as the predominant mineral, aligning with the findings of Barros et al. (2017), who emphasized the high potassium content in *T. catappa* seeds and its role in maintaining fluid balance, nerve function, and muscle contraction. Calcium (0.2046 mg/L), an essential mineral for bone health, muscle contraction, and enzymatic processes, was also present in significant amounts. Its occurrence supports the seeds' use in bone health management (Gunasena, 2016). Zinc's role in immune function, wound healing, and enzymatic processes underscores the health benefits of consuming *Terminalia catappa* (WHO, cited in Mandloi et al., 2017).

Manganese and copper, though present in smaller amounts, are vital for bone formation, metabolism, and antioxidant defenses. Iron, despite its low concentration, is important for oxygen transport and cellular respiration. The measured mineral values, accompanied by low standard deviations, indicate reliable analytical methods and suggest that *Terminalia catappa* seeds could serve as a supplementary source of essential minerals. These findings are consistent with previous reports by Mandloi et al. (2017), who highlighted the nutritional and health-promoting potentials of nuts and seeds. Furthermore, the mineral profile aligns with WHO recommendations for essential micronutrients, suggesting *Terminalia catappa* may be beneficial as part of a balanced diet (Bartocci et al., 2019).

Conclusion

This study assessed the phytochemical composition, proximate analysis, and mineral content of *Terminalia catappa* (tropical almond) seeds collected from Gombe State, Nigeria. The findings confirmed the presence of key bioactive compounds — saponins, steroids, phenols, and alkaloids — which are known for their antioxidant, antimicrobial, anti-inflammatory, and pharmacological properties (Divya et al., 2018; Mandloi et al., 2017; Khan et al., 2014).

The proximate composition revealed that *T. catappa* seeds are rich in carbohydrates and crude fat, with moderate protein content, low moisture, and minimal crude fiber. These attributes suggest that the seeds could serve as a valuable source of energy and essential nutrients, with good storage stability (Akpakpan & Akpabio, 2016; Atsu-Barku et al., 2016).

The mineral analysis demonstrated significant levels of potassium, calcium, and zinc — minerals essential for nerve function, bone health, and immune support. The presence of iron, manganese, copper, and sodium, even in smaller quantities, highlights the seeds' contribution to micronutrient intake (Barros et al., 2017; Salvo et al., 1983; Bartocci et al., 2019).

In conclusion, the nutritional and phytochemical profile of *Terminalia catappa* seeds supports their traditional medicinal uses and points to their potential application in the food, pharmaceutical, and nutraceutical industries. Further research is recommended to explore their bioavailability, pharmacological properties, and potential for industrial processing and formulation.

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