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Nutraceutical Potential of *Jatropha tanjorensis* Stem: Comprehensive Nutritional Characterization and Heavy Metal Risk Assessment

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Abstract

Jatropha tanjorensis is a medicinal plant frequently consumed as a vegetable in Nigeria, yet the nutritional value of this plant's stems remains largely unknown. This study evaluated the proximate and mineral composition of Jatropha tanjorensis stem to assess its nutraceutical potential. Stems were collected, authenticated, dried, and pulverized. Proximate analysis was conducted using standard analytical methods, and Atomic Absorption Spectrophotometry (AAS) was used to quantify mineral elements. The stem contained high carbohydrate (43.93%) and crude fiber (20.90%) levels, indicating strong potential as an energy and dietary fiber source. Lipid content was appreciable (13.73%), with moderate ash (7.53%) and moisture (10.76%). Protein was relatively low (3.15%). Mineral analysis revealed exceptionally high calcium (1190.75 mg/100 g) and potassium (1003.1 mg/100 g), alongside appreciable magnesium (63.65 mg/100g). Trace elements included iron (58.83 mg/100 g), copper (27.62 mg/100g), and zinc (4.43 mg/100g). However, lead was detected at 15.70 mg/100 g, exceeding the WHO safety limits, while cadmium, nickel, and cobalt were below detection limits. Overall, the stem of Jatropha tanjorensis shows considerable nutraceutical potential due to its carbohydrate, fiber, and mineral content, particularly calcium and potassium. Nonetheless, the elevated lead concentration presents a considerable health hazard, highlighting the urgent need for safety assessments and possible detoxification methods before consumption.

Keywords: Dietary fibre; Heavy metals; *Jatropha tanjorensis*; Mineral composition; Nutraceutical evaluation; proximate composition.

Introduction

The urgent need for sustainable nutrition and functional foods has highlighted the importance of understudied plants with both nutritional and therapeutic potential. In developing countries, medicinal plants often serve as daily food and natural medicine, supporting nutrient intake and basic healthcare. These plants supply dietary fibre, minerals, and bioactive compounds vital for metabolism, immunity, and disease prevention. Accurately profiling their nutrition and Mineral composition is key for validating health benefits and ensuring dietary safety.

With over 170 documented species, the genus *Jatropha* (Euphorbiaceae) has attracted significant research interest for its ethnopharmacological value across tropical and subtropical regions[1]. Among these, *J. tanjorensis*, an interspecific hybrid that arose spontaneously from *J. curcas* and *J. gossypifolia*, is now commonly cultivated throughout Nigeria, where it is known by local names including 'Hospital too far' and 'Catholic vegetable'[2]. Used both as a leafy vegetable and in traditional medicine, the plant is commonly employed to manage health conditions including anaemia, diabetes, hypertension, malaria, and inflammation[2,3]. Phytochemical analyses have detected flavonoids, alkaloids, saponins, and glycosides in the leaves, along with nutrients that support their therapeutic efficacy[4,5], making them a valuable resource for functional food applications.

However, the stem of *Jatropha tanjorensis* remains largely unstudied, despite its use in traditional medicine for wound healing and the treatment of infections[3,5]. This gap is noteworthy because plant stems may have unique nutritional and mineral content valuable for nutraceutical development. Profiling the stem's proximate and mineral composition is essential for assessing its dietary potential and potential safety concerns, such as heavy metal contamination. Scientific data on the nutritional value of the stem is scarce, despite indications from traditional consumption that it may be beneficial. Growing interest in new nutraceutical sources requires targeted evaluation of the *Jatropha tanjorensis* stem for both nutrient content and possible toxic elements. Clarifying these attributes can inform safe dietary and medicinal use[4]. Given these research gaps, the present investigation aimed to achieve three primary objectives: i. To determine the proximate and mineral composition of *J. tanjorensis* stems, ii. To establish empirical

evidence regarding its nutritional value, and iii. To screen for potentially toxic elements that could compromise its safety as a food or medicinal material. To the best of our knowledge, this study provides one of the first comprehensive analyses of the stem's nutritional and mineral profile, as previous research on J. tanjorensis has predominantly focused on its leaves, with limited attention to the stem.



Figure-1: *Jatropha tanjorensis* Stem Image.

Methodology

Plant Material Procurement and Processing: J. tanjorensis stems were procured from Kubwa, located in the Bwari Area Council of the Federal Capital Territory, Abuja, Nigeria. Taxonomic identification was performed at the Herbarium of the Department of Plant Science and Biotechnology, Bayero University, Kano, where a reference specimen bearing the accession number BUKHAN0584 was retained for verification. The outer bark was carefully removed, and the fleshy inner stem tissue was sectioned into small fragments. These fragments underwent drying under shaded conditions for fourteen days, a process chosen to preserve thermally labile constituents and minimize degradation from ultraviolet radiation. The desiccated plant material was subsequently reduced to a homogenous powder using an electric grinder and kept in sealed containers under ambient conditions pending further analyses.

Proximate Analysis: Proximate composition was assessed using the method of Ibrahim et al.[6]. Moisture was determined by drying approximately 2g of sample in an oven at 105°C until a constant weight was reached. Ash content was obtained by incinerating samples in a muffle furnace at 550°C until a white residue formed. Crude lipid was extracted via Soxhlet apparatus using petroleum ether (boiling point 40–60°C) for 6 hours. Crude fiber was measured through sequential digestion of the defatted residue with acid and alkali, followed by ignition. The macro-Kjeldahl procedure was used to determine nitrogen content, and crude protein was calculated by multiplying nitrogen by 6.25. Total carbohydrate content was determined by difference. % Carbohydrate = 100 - (% Moisture + % Ash + % Lipid + % Protein + % Fiber)

Mineral Analysis: For mineral analysis, the method of Ndukaire et al.[7] was adopted. Briefly, 3.0g of the powdered stem material was digested in 20 mL of concentrated HNO_3 (65%, analytical grade) at 130°C until complete dissolution. The cooled digest was filtered through Whatman No. 42 paper and diluted to 100mL with ultrapure deionized water. Mineral quantification was performed using a Thermo Scientific ICE 3000 AAS equipped with appropriate hollow cathode lamps. The instrument was calibrated with certified multi-element standard solutions (Merck, Germany) prior to sample analysis. Elements determined included calcium (Ca), magnesium (Mg), potassium (K), iron (Fe), zinc (Zn), copper (Cu), lead (Pb), cadmium (Cd), cobalt (Co), and nickel (Ni). Triplicate measurements were taken for each sample, and results were expressed as mean ± standard deviation.

Results and Discussion

Proximate Composition: Figure-2 presents the proximate composition of *J. tanjorensis* stem; carbohydrates were the most abundant macronutrient (43.93%), indicating the stem's strong potential as an energy source. This was followed by a high crude fiber content (20.90%), suggesting utility as a roughage source. The stem also contained substantial lipids (13.73%) and a moderate ash content (7.53%), reflective of its total mineral matter. The moisture content was 10.76%, which is conducive to shelf stability, while the crude protein content was relatively low (3.15%).

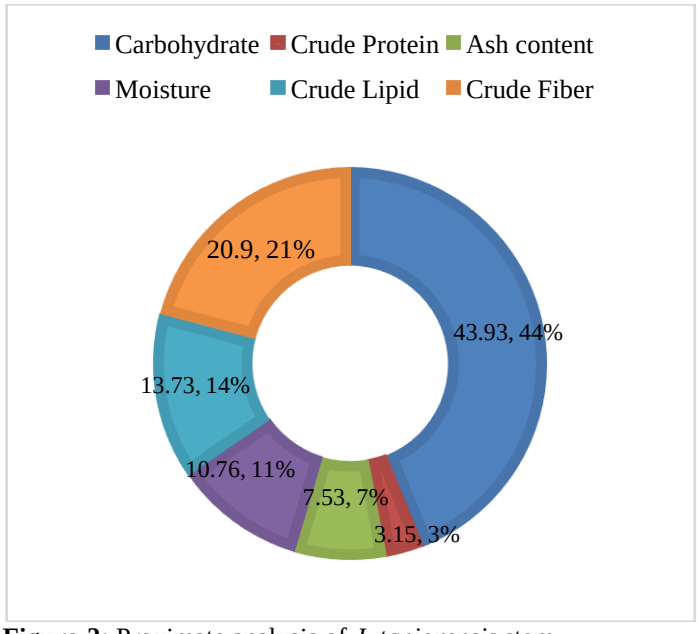


Figure-2: Proximate analysis of *J. tanjorensis* stem.

The proximate analysis of *J. tanjorensis* stems (Figure-2) demonstrates a nutritionally advantageous composition. Carbohydrates emerged as the predominant fraction (43.93%), positioning the stem as a viable energy substrate comparable to levels documented in the leaves by previous investigators[8,9].

As primary metabolic fuels, carbohydrates supply glucose for ATP generation and cerebral metabolism, reinforcing the stem's utility as an energy-dense dietary component. More notably, the crude fiber content (20.90%) substantially exceeds values reported for many conventional vegetables, representing a particularly significant attribute. This high fiber fraction offers multiple physiological benefits, including enhanced gastrointestinal motility, improved glycemic regulation, and reduced cardiovascular risk profiles[10]. The fiber content is especially relevant given the stem's traditional use in digestive health, suggesting its nutraceutical potential for metabolic health.

The lipid fraction (13.73%) warrants particular attention, as it surpasses values documented for several commonly consumed leafy vegetables. This elevated lipid content suggests the presence of both storage lipids and potentially bioactive fatty acid species, compounds essential for cellular membrane architecture, steroid hormone biosynthesis, and metabolic homeostasis[12]. The protein concentration (3.15%), while modest relative to leguminous sources, contributes to the overall amino acid pool required for tissue maintenance and enzymatic function. The ash content (7.53%) further corroborates the mineral richness observed in the mineral analysis, confirming the stem as a substantial source of inorganic nutrients.

Mineral Composition: The mineral composition revealed that the stem is a rich source of several essential elements, as detailed in Table-1. It was an exceptional source of macro-minerals, with very high concentrations of calcium (1190.75 mg/100 g) and potassium (1003.10 mg/100 g). Magnesium was present at a moderate level (63.65 mg/100 g). Among the trace elements, iron (58.83 mg/100 g) and copper (27.62 mg/100 g) were found in significant quantities, while zinc was present at a lower concentration (4.43 mg/100 g). A critical finding was the detection of lead at 15.70 mg/100 g, a level that exceeds permissible limits for dietary materials. Conversely, the toxic elements cadmium, cobalt, and nickel were below the instrument's detection limit (BDL).

KEY: BDL - Below Detectable Limit: The stem's macronutrient profile is further amplified by its exceptional mineral composition. The analysis (Table-1) revealed high calcium and potassium concentrations. Calcium is vital for bone formation, neuromuscular coordination, and blood clotting[13], while potassium regulates osmotic balance, nerve transmission, and heart rhythm, and helps counteract sodium's effect on blood pressure[14]. Magnesium enhances the nutritional profile, given its role in over 300 enzymatic reactions. Iron is significant for haemoglobin synthesis and combating iron-deficiency anaemia[15], while copper facilitates iron homeostasis and erythrocyte maturation. Zinc, though lower, contributes to immune function. These findings are consistent with mineral patterns reported in *Jatropha curcas*and other Euphorbiaceae species[4,3].

Table-1: Mineral composition of *Jatropha tanjorensis* stem (mg/100 g dry weight).

Element		Concentration (mg/100 g)	Interpretation
Macro-elements	Ca	1190.75±1.32	Very High
	K	1003.10±1.27	High
	Mg	63.65±1.18	Moderate
Trace Elements	Fe	58.83±2.03	Significant
	Cu	27.62±2.13	Moderate
	Zn	4.43±1.98	Low
Toxic Elements	Pb	15.70±1.36	High (Exceeds safety limits)
	Cd	BDL	Below Detectable Limit
	Co	BDL	Below Detectable Limit
	Ni	BDL	Below Detectable Limit

Results are expressed as mean ± standard deviation (n = 3).

A major safety concern is the elevated lead concentration, which exceeds the WHO permissible limit for medicinal plant materials (≤ 10 mg/kg)[16]. Chronic lead exposure is associated with neurological impairment, anaemia, and kidney dysfunction[17;18]. The contamination likely originates from environmental factors such as soil, irrigation water, or atmospheric deposition in the collection area. This finding underscores the need for environmental monitoring, detoxification strategies, and strict quality control before recommending the stem for dietary or pharmaceutical use. Encouragingly, cadmium, cobalt, and nickel were below detectable limits, reducing concerns about other toxic heavy metals[19].

Overall, the proximate and mineral composition of *Jatropha tanjorensis* stem suggests both nutritional and therapeutic potential. Its high carbohydrate and fiber content support energy provision and digestive health, while its mineral richness, particularly calcium, potassium, magnesium, and iron, positions it as a valuable source of essential micronutrients[20]. Collectively, these results support the promising utility of *J. tanjorensis* stems as a functional food ingredient, dietary supplement component, or herbal medicinal preparation. However, the presence of lead necessitates caution, and further toxicological studies are required to establish safe consumption levels and identify contamination sources[21].

Jatropha tanjorensis stem combines medicinal relevance with nutritional value, offering opportunities for nutraceutical development and sustainable health management in developing regions. Future research should focus on characterizing its lipid profile, assessing the bioavailability of its minerals, and developing detoxification strategies to mitigate heavy metal contamination, unlocking its full potential as a safe and functional dietary resource[22].

Conclusion

This investigation has established a comprehensive nutritional and Mineral profile of *J. tanjorensis* stems. The stem is characterized by a carbohydrate-dominated macronutrient composition (43.93%), substantial dietary fiber (20.90%), and noteworthy mineral density, particularly calcium (1190.75 mg/100g) and potassium (1003.10mg/100g). These attributes suggest that it could be developed into a functional food or nutraceutical ingredient. However, the lead concentration (15.70 mg/100g) exceeds WHO permissible limits, raising safety concerns that must be addressed prior to dietary application. This finding underscores the importance of identifying contamination sources and developing effective decontamination protocols. While the present data contribute to the understanding of *Jatropha* species as nutritional resources, additional research is needed to characterize the lipid fraction, evaluate mineral absorption efficiency, and establish processing conditions that ensure consumer safety.

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