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NUTRITIONAL COMPOSITION AND MINERAL PROFILE OF LOCUST BEAN CAKE (*PARKIA BIGLOBOSA*) AND ITS POTENTIAL ROLE IN ADDRESSING MALNUTRITION

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ABSTRACT

Malnutrition remains a serious public health problem across sub-Saharan Africa, particularly in Nigeria, where protein-energy malnutrition and micronutrient deficiencies contribute substantially to morbidity and mortality. This study evaluated the proximate composition and mineral profile of locust bean cake derived from Parkia biglobosa. Some samples were analyzed using standard analytical procedures, including the Kjeldahl method for protein determination, Soxhlet extraction for lipid analysis, gravimetric methods for crude fiber, and atomic absorption spectrophotometry for mineral quantification. Results indicated high crude protein (47.72%), fat (32.19%), and fiber (30.92%) contents. Essential minerals identified included calcium (0.83%), magnesium (0.70%), phosphorus (0.60%), potassium (0.76%), sodium (0.27%), iron (0.05%), copper (0.01%), and zinc (0.01%). The findings demonstrate that locust bean cake is a nutrient-dense food with substantial potential for improving dietary protein intake and micronutrient status. Modernized processing and enhanced product standardization may support its broader utilization in food security strategies.

KEYWORDS: *Parkia biglobosa*, locust bean cake, proximate composition, mineral analysis, malnutrition, food security.

1. INTRODUCTION

Malnutrition is a farm of under nutrition posing a risk to millions of individuals in sub-Saharan Africa particularly in Nigeria. It is caused by a lack of essential micronutrients and is

linked to several health and developmental challenges (Adeyeye, et al., 2023). Food fortification provides a cost-effective solution to hidden hunger. To ensure consumers receive the nutrition necessary for healthy and productive living, the Strengthening African Processors of Fortified Foods Project should supports African food companies in enhancing their capacity to produce and distribute fortified foods locally. (Durotoye, et al., 2023).

Malnutrition remains a major contributor to global disease burden, accounting for approximately 45% of deaths among children under five years (World Health Organization, 2021). In Nigeria, limited access to nutrient-dense foods exacerbates protein-energy malnutrition and micronutrient deficiencies (Chinenye, et al., 2025). Food-based approaches utilizing locally available plant resources are increasingly recognized as sustainable interventions.

Malnutrition in children can lead to delayed mental development and other health complications that limit their productivity, and these impacts can extend into adulthood. These effects can continue into adulthood, increasing risk of perpetuation, and prohibiting generations from leading healthy, productive lives. Although national programs supported by development partners have been introduced across sub-Saharan Africa since 2002 to promote staple food fortification, their impact has been limited due to challenges in meeting compliance standards. (Bell, et al., 2024).

The African locust bean tree (*Parkia biglobosa*) is a perennial leguminous species widely distributed across West Africa. Traditional healers in Africa utilize various parts of the locust bean tree for medicinal purposes. A survey of healers in Togo identified Parkia biglobosa as one of the most frequently cited plants for managing hypertension (Gbekley, et al., 2018). In Southwestern Nigeria, the tree was among the two plants recognized for their effective wound-healing properties, with a notable influence on dermal fibroblast proliferation. (Famojuro, et al., 2023). Findings from a related survey in Guinea on antimalarial use revealed a strong impact, particularly among low-income consumers, helping them break the cycle of malnutrition and lead healthier, more productive lives. (Odounharo, et al., 2022).

Its fermented seeds are processed into locust bean cake (commonly known as *iru* or *dawadawa*), which is traditionally used as a condiment. Previous studies have documented its high protein and mineral content (Animashahun, et al., 2024; Termote, et al., 2022). However, comprehensive evaluation of its proximate and mineral composition in cake form remains limited. This study aimed to determine the nutritional composition and mineral profile of locust bean cake and to evaluate its potential contribution to addressing malnutrition.

2.0 MATERIALS AND METHODS

2.1 Apparatus and Reagents

Weighing balance, Furnace, Crucible (porcelein), Filter paper, Heating mantle, Mortar and pestle, Nitric acid, Water, methanol, Ethyl acetate, n-hexane, Chloroform, Concentrated H_2SO_4, 40% NaOH, 2% H3BO3, Standard Hg solution (0.02m) Catalyst (combination of Na2SO4, Methyl red (indicator petroleum spirit, Acetone, Distilled water, hydrochloric acid (HCI), Ethanol, Potassium hydroxide (KOH).

2.2 Sample Collection

Some samples of locust beans cake were obtained from a Katsina LGA, Katsina State and taken to chemistry laboratory at Hassan Usman Katsina Polytechnic for identification.

2.3 Sample Pre-treatment

The samples of locust bean cake was pre-dried in the oven for 48hrs at 65^0c. The samples were milled using a mechanical milling machine. The sample of locust bean cake was placed in a container and stored. The prepared sample was preserved for nutritional composition.

2.4 Digestion of Samples

A 0.5 g of the sample was accurately weighed using an analytical balance and transferred into a clean digestion beaker. Subsequently, 7.5 mL of concentrated nitric acid (HNO_3) and 2.5 mL of concentrated hydrochloric acid (HCl) were added in a 3:1 ratio to form aqua regia. The mixture was heated on a temperature-controlled hot plate at approximately 120°C until near dryness was achieved. After cooling to room temperature, 20 mL of distilled water was added, and the solution was stirred thoroughly to ensure complete dissolution. The digest was filtered using whatman filter paper into a 50 mL volumetric flask and diluted to volume with distilled water prior to mineral analysis.

2.5 Preparation of standard solution

An aliquot (10 mL) of each standard stock solution—lead nitrate [$Pb(NO_3)_2$], cadmium nitrate [$Cd(NO_3)_2$], and chromium nitrate [$Cr(NO_3)_3$]—were accurately transferred into separate 100 mL volumetric flasks using calibrated pipettes. Each flask was diluted to the calibration mark with deionized water and inverted repeatedly to ensure complete homogenization. Working standard solutions were subsequently prepared from the 100 ppm stock solutions by pipetting appropriate volumes into calibrated volumetric flasks and diluting to volume with deionized water. All solutions were prepared fresh prior to instrumental analysis.

2.6 Determination of Crude Fat Content (Soxhlet Extraction Method)

A clean boiling flask was oven-dried at 105°C for 1 h, transferred to a desiccator, allowed to cool to room temperature, and weighed to obtain the initial flask weight (W_1). A Whatman extraction thimble was dried, cooled in a desiccator, and weighed. Approximately 2.0 g of the homogenized sample was accurately weighed into the labeled extraction thimble, and the combined weight was recorded (W_2).

The dried boiling flask was filled with petroleum ether (boiling range 40–60°C), and the Soxhlet extraction apparatus was assembled. The sample was extracted continuously for 8 h under reflux conditions to ensure complete lipid extraction.

After extraction, the solvent was recovered, and the boiling flask containing the extracted fat was dried in an oven at 105°C to constant weight. The flask was then transferred to a desiccator, allowed to cool to room temperature, and weighed (W_3).

The percentage crude fat content was calculated using the following formula:

$$\text{Crude Fat (\%)} = \frac{W3 - W1}{W2 - W1} \times 100$$

where: $W1$ = weight of empty boiling flask (g)

$W2$ = weight of flask plus sample before extraction (g)

$W3$ = weight of flask plus extracted fat after drying (g)

The procedure was performed according to the method described by Antony (2016).

2.7 Preparation of Digest for Heavy Metal Analysis

For mineral determination, the sample was digested using a nitric–hydrochloric acid mixture (aqua regia, 3:1 v/v HCl : HNO_3). The digestion mixture was heated at approximately 60°C under a fume hood until complete dissolution was achieved. After cooling, the digest was filtered through acid-washed Whatman filter paper into a 50 mL volumetric flask and diluted to volume with distilled water.

The prepared solution was analyzed for selected heavy metals, including lead (Pb), iron (Fe), copper (Cu), and calcium (Ca), using atomic absorption spectrophotometry (AAS) at the Umaru Musa Yar'adua University (UMYUK) Laboratory.

2.8 Determination of Crude Fiber Content

Crude fiber content was determined using the standard acid–alkali digestion method as described by Ameh (2015). Approximately 2.0 g of the homogenized sample was weighed into a 500 mL beaker and treated with 200 mL of 1.25% (w/v) sulfuric acid (H_2SO_4). The

mixture was heated and gently boiled for 30 min under controlled conditions, maintaining a constant volume by periodic addition of distilled water as needed.

The digest was filtered through muslin cloth followed by Whatman filter paper and washed thoroughly with hot distilled water until the filtrate was neutral. The residue was then transferred into a clean beaker containing 200 mL of 1.25% (w/v) sodium hydroxide (NaOH) solution and boiled for an additional 30 min.

Following alkaline digestion, the mixture was filtered and washed repeatedly with hot distilled water to remove residual alkali. The residue was then oven-dried at 105°C to constant weight and weighed (C_2). Subsequently, the dried residue was incinerated in a muffle furnace at 550°C for 3 h to obtain the ash content. The crucible was cooled in a desiccator and reweighed (C_3).

Crude fiber percentage was calculated using the following equation:

$$\text{Crude Fiber (\%)} = \frac{C2 - C3}{W} \times 100$$

where:

$C2$ = weight of dried residue before ashing (g)

$C3$ = weight of ash after incineration (g)

W = initial weight of sample (g)

2.9 Determination of Crude Protein (Kjeldahl Method)

Approximately 2.0 g of the homogenized sample was accurately weighed into a Kjeldahl digestion flask. A copper-based catalyst mixture was added, followed by 15 mL of concentrated sulfuric acid (H_2SO_4, 98%, analytical grade). The flask was placed under a fume hood and heated gradually until the solution became clear with a characteristic green coloration, indicating complete digestion of organic matter.

After digestion, the flask was allowed to cool to room temperature. The inner walls of the flask were rinsed with distilled water to ensure complete transfer of the digest and to remove any residual particles adhering to the neck of the flask. The digest was quantitatively transferred into a volumetric container and diluted with distilled water to a known volume.

The digested sample was then subjected to distillation and titration. The liberated ammonia was collected in a receiving flask containing boric acid solution and subsequently titrated against standardized 0.01 N hydrochloric acid (HCl). Nitrogen content was calculated based on the volume of acid consumed, and crude protein content was determined using a nitrogen-to-protein conversion factor of 6.25.

Calculation of Crude Protein Content: Nitrogen content obtained from the Kjeldahl analysis was used to calculate crude protein content. The percentage nitrogen was determined using the titration relationship:

$$\text{Nitrogen (\%)} = \frac{(Vs - Vb)xNx14.01}{W} \times 100$$

where:

Vs = volume of acid used for sample titration (mL)

Vb = volume of acid used for blank titration (mL)

N= normality of standard acid

14.01 = atomic weight of nitrogen

W = sample weight (g)

Crude protein content was calculated by multiplying the percentage nitrogen by the conventional conversion factor of 6.25:

Crude Protein (%) = Nitrogen (%) × 6.25

3.0 RESULTS

3.1 Proximate Composition

The proximate composition of locust beans cake is presented in Table 1.

Table 1: **Proximate Composition of Locust Bean Cake.**

Parameter	Mean (%)
Crude Protein	47.72
Crude Fat	32.19
Crude Fiber	30.92

Source: Field Experiments

The protein content (47.72%) indicates that locust bean cake is a highly concentrated plant protein source. Fat content (32.19%) suggests significant caloric contribution, while fiber content (30.92%) indicates potential digestive health benefits.

3.2 Mineral Composition

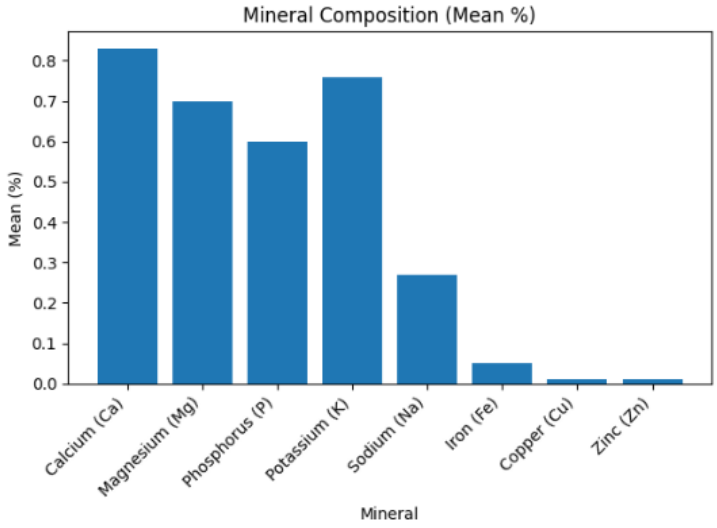

Figure 1: ***Mineral Composition of Locust Bean Cake.***

The mineral profile demonstrates the presence of essential macro- and microelements necessary for physiological functions.

4.0 DISCUSSION

The high crude protein content observed (47.72%) aligns with findings by Gernah et al. (2007), confirming the protein-rich nature of *Parkia biglobosa* seeds. The value exceeds many common legumes, suggesting that locust bean cake may serve as an affordable alternative to animal protein sources.

The lipid content (32.19%) contributes significantly to energy density, making it valuable in regions with caloric insufficiency. Moreover, dietary fats enhance absorption of fat-soluble vitamins and supply essential fatty acids.

The fiber content (30.92%) surpasses that of several conventional legumes (Ihekoronye & Ngoddy, 1985), suggesting potential roles in glycemic control and gastrointestinal health.

Mineral analysis revealed substantial calcium levels (0.83%), supporting bone health and neuromuscular function. Iron content (0.05%) may contribute to anemia prevention, particularly among vulnerable populations such as pregnant women and children (Ekum, 2013). The presence of magnesium, potassium, and phosphorus further enhances its nutritional profile.

Despite these benefits, traditional processing methods may limit large-scale utilization due to labor intensity and organoleptic characteristics (Odunfa, 1985). Technological improvements in fermentation and packaging may enhance market acceptability.

5.0 CONCLUSION

Locust bean cake derived from *Parkia biglobosa* is a nutrient-dense food rich in protein, fat, fiber, and essential minerals. Its nutritional composition suggests strong potential for mitigating protein-energy malnutrition and micronutrient deficiencies in resource-limited settings. Integration into food security programs and modernization of processing techniques could enhance its utilization and public health impact.

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