NUTRITIONAL COMPOSITION OF RAW UNDECORTICATED AND DECORTICATED *Adansonia digitata* (BAOBAB) SEED MEAL

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Abstract

Adansonia digitata, commonly known as the baobab tree, is a valuable resource in Nigeria due to its diverse uses in traditional medicine, cuisine, and animal feed. This study aimed to determine the proximate and phytochemical composition of raw undecorticated and decorticated Adansonia digitata seed meal (UADSM and DADSM). Proximate analysis was conducted using the procedure of AOAC (2005), while phytochemical screening was done using the method described by Makkar (2000). Results showed that DADSM had higher values of crude protein (27.66) compared to UADSM (20.98). Moisture content was 6.96% for DADSM and 8.79% for UADSM. The ether extract value of DADSM was higher than that of UADSM. Phytochemical analysis revealed higher concentrations of saponins, total phenolics, and alkaloids in DADSM, while higher concentrations of tannins, flavonoids, and terpenoids were recorded in UADSM. These findings suggest that Adansonia digitata seed meal could be a valuable alternative feed ingredient for livestock, and further studies are recommended to determine the bioavailability and potential health effects of the phytochemicals present in ADSM.

Keywords: *Adansonia digitata;* Undecorticated; Decorticated; Proximate; Phytochemical.

Introduction

Nigeria's vast botanical heritage provides a critical foundation for food security, economic livelihood, and traditional healthcare systems. The nation is endowed with a rich variety of indigenous trees, fruits, tubers, and vegetables that are not only of significant economic importance but also serve as vital reservoirs of essential nutrients necessary for human growth and disease prevention (Akiniyi & Waziri, 2011). Within this diverse agro-biodiversity, certain species stand out for their exceptional utility and cultural resonance. The baobab tree (*Adansonia digitata* L.), a majestic member of the Malvaceae family (Bremer et al., 2003), is arguably one of the most remarkable and iconic trees on the African continent. Known by various evocative names such as the monkey bread tree, the upside-down tree, or the bottle tree, the baobab is celebrated for its extraordinary longevity, with some specimens estimated to live for up to 6,000 years (Magaji, 2010). Ecologically, it is a keystone species of the dry savannahs, exhibiting remarkable resilience by thriving in the northern regions of Nigeria, where it endures high temperatures and prolonged drought conditions. This resilience translates into a reliable resource for communities in often harsh agro-ecological zones.

The value of the baobab is profoundly holistic, embodying the principle of zero waste in traditional use. Every component of the tree is utilised, forging a deep socio-economic and medicinal connection with local populations. The bark and roots are integral to traditional pharmacopoeia, used to treat a variety of ailments (Sidibe & Williams, 2002). The leaves are nutritionally and medicinally valuable; they are employed as a febrifuge and an immunological stimulant (De Caluwé et al., 2010) and are commonly dried, crushed, and used as a nutritious sauce or soup thickener. The popular soup 'Miyan kuka,' a staple in Northern Nigeria and parts of West Africa, is primarily made from these dried baobab leaves (Ogbaga et al., 2017). The fruit pulp is arguably the most widely recognised product, rich in vitamin C, calcium, and antioxidants. It is dissolved in water or milk to make a refreshing drink, used as a souring agent in sauces, or incorporated as a fermenting agent in local brewing (Sidibe & Williams, 2002).

Similarly, the seeds of the baobab fruit are a versatile but less-studied resource. Traditionally, they are consumed in diverse forms: the seeds can be fermented to create a flavouring for soups, roasted as a side dish or snack alternative to peanuts, or pressed to extract a valuable oil (Sidibe & Williams, 2002). The by-product of this oil extraction, the baobab seed cake, represents a significant but currently underutilised resource with potential for animal feed or further nutrient recovery (Osman, 2004). This extensive traditional usage underscores the seed's embedded value in local food systems. However, widespread and longstanding consumption does not automatically equate to comprehensive scientific understanding. There exists a critical paradox: while communities have utilised baobab seeds for generations, empirical data on their detailed nutritional and phytochemical composition remains surprisingly limited and fragmented. This gap is particularly pronounced within the specific geographical and climatic context of Nigeria.

The lack of detailed knowledge presents a substantial constraint. Without precise compositional data, it is difficult to fully quantify the seed's contribution to dietary intake of proteins, fats, minerals, and essential bioactive compounds. This limits efforts to formally promote its nutritional value, optimise its use in food formulations, or develop standards for its commercial processing and trade. Furthermore, the nutritional profile of plant seeds is not static; it is significantly influenced by extrinsic factors such as soil geochemistry, climate, tree provenance, and post-harvest handling. As Assogbadjo et al. (2012) demonstrated, the biochemical composition of baobab pulp, leaves, and seeds varies considerably across different soil types and geographical locations. This variability necessitates localised analysis, as findings from baobab populations in other parts of Africa cannot be directly extrapolated to Nigerian sources. Relying on generalised data risks overlooking unique nutritional advantages or potential deficiencies specific to locally harvested seeds.

A more nuanced gap exists in the differentiation between the whole seed (undecorticated) and the inner kernel (decorticated). The hard, outer seed coat constitutes a substantial portion of the whole seed's weight. Proximate and phytochemical analyses conducted on whole seeds yield an aggregate value that includes this largely fibrous, indigestible coat. For practical culinary and commercial applications, such as oil extraction, flour production, or direct consumption, the decorticated kernel is the primary product of interest. Therefore, understanding the compositional differences between the raw, undecorticated seed and the decorticated kernel is essential. This comparison can reveal the concentration of nutrients within the edible portion, inform processing efficiency (e.g., yield of oil or protein from the kernel), and provide insight into the nutritional value lost or retained in the seed cake by-product. Such a detailed breakdown is crucial for food scientists, nutritionists, and agro-processors seeking to add value to this indigenous resource.

Consequently, to address these interconnected knowledge gaps and generate actionable data for Nigeria's context, this study was undertaken. The overarching aim is to contribute to the scientific characterisation of Nigerian baobab seeds, providing a foundation for their enhanced utilisation and valorization. The specific objective is to determine and compare the proximate composition and the qualitative and quantitative phytochemical constituents of both raw, undecorticated and decorticated *Adansonia digitata* seeds. The proximate analysis will establish the fundamental nutritional framework, quantifying moisture, ash, crude protein, crude fat, crude fibre, and carbohydrate content. Concurrently, the phytochemical screening will identify and measure the presence of bioactive compounds such as alkaloids, flavonoids, tannins, saponins, and phenolic compounds, which are responsible for many of the seeds' medicinal properties and antioxidant potential. By elucidating these parameters, this research seeks to transform the baobab seed from a traditionally valued item into a precisely documented, modern nutritional asset, supporting efforts to improve food security, nutrition, and sustainable economic development in Nigeria

Statement of the Problem

The baobab tree (*Adansonia digitata* L.) is a vital indigenous species in Nigeria, with its seeds serving as a traditional food source, a potential ingredient for food processing, and a by-product for animal feed in the form of seed meal. Despite this established use and the broader recognition of the tree's nutritional value, there is a significant and problematic lack of precise, standardised scientific data on the fundamental nutritional composition of baobab seed meal. This gap is particularly acute when comparing the whole seed (undecorticated) with the edible inner kernel (decorticated).

Currently, the utilisation of baobab seeds is primarily guided by indigenous knowledge rather than empirical nutritional science. This presents several critical problems. First, the absence of detailed proximate composition data, including crude protein, fat, fibre, carbohydrate, ash, and moisture content, for both seed forms prevents an accurate assessment of their true dietary and economic value. Consequently, food scientists, nutritionists, and agro-processors cannot make informed decisions regarding the optimal integration of baobab seed meal into human food formulations or livestock feed rations to address protein-energy malnutrition or nutrient deficiencies.

Second, the hard, fibrous seed coat constitutes a substantial portion of the whole seed's mass. The specific nutritional contribution and antinutritional implications of this coat remain largely unquantified. Without a clear comparative analysis between the undecorticated and decorticated meal, it is impossible to determine the actual nutritional density of the edible kernel or to calculate the potential nutrient losses and fibre gains associated with using the whole seed. This ambiguity hampers efforts to develop efficient, value-adding processing protocols, as the benefits of the decortication process are not scientifically justified.

Third, the nutritional profile of plant materials is highly influenced by geographical location, soil type, and climatic conditions. Existing compositional studies on baobab seeds from other regions cannot be reliably extrapolated to the Nigerian context due to this known variability. This lack of localised data creates a dependency on non-specific information, which may lead to suboptimal or inaccurate applications in local food and agriculture systems.

Therefore, the core problem addressed by this study is the critical knowledge deficit concerning the specific proximate nutritional composition of raw, undecorticated versus decorticated baobab (*Adansonia digitata*) seed meal sourced from Nigeria. This deficit impedes the scientific valorisation, standardized processing, and optimal application of a readily available, drought-resistant indigenous resource, ultimately limiting its potential contribution to food and nutritional security in the region.

Research Questions

These two questions guided this study:

- **a.** How does the decortication of *Adansonia digitata* (baobab) seeds affect their proximate nutritional composition, specifically the concentrations of crude protein, fat, and fibre?
- **b.** What is the differential distribution of key phytochemicals between the undecorticated seed meal and the decorticated kernel of *Adansonia digitata*?

Materials and Methods

Preparation of *Adansonia digitata* seeds

Adansonia digitata seeds were collected in Ogbomosho, Oyo state. The fruit was harvested, and the seeds were manually separated from the pulp, washed in water to get rid of the pulp, after which the seeds were sundried. After drying, the seeds were hammer milled and samples taken to the laboratory for chemical analysis.

Laboratory analysis of *Adansonia digitata* seeds

The chemical analysis was carried out at the Central Research Laboratory, Tanke, Ilorin. The milled samples were analysed for proximate composition, qualitative and quantitative analysis. Proximate analysis was done using the procedure of AOAC (2005). The samples were screened for phytochemicals such as tannins, saponins, flavonoids, alkaloids, terpenoids, phytates, and phenolics. Test for total flavonoids was done using the Shinoda test, Alkaloids were confirmed by the Dragendroff's test, Borntrager's test was used for glycosides test, Froth formation test was used for saponin test, Wohler's test for Tannin presence and Salkowski's test for confirmation of the presence of steroidal and triterpenoids. All were carried out according to the methods described by Sofowora (1993), Kokate *et al*. (2006), and Ukwubile *et al* (2017)

Results and Discussion

The proximate composition of undecorticated and decorticated *Adansonia digitata* seed meal (ADSM) was determined (Table 1).

Research Question 1: How does the decortication of *Adansonia digitata* (baobab) seeds affect their proximate nutritional composition, specifically the concentrations of crude protein, fat, and fibre?

Table 1: Proximate composition of raw undecorticated and decorticated ADSM

Sample	Moisture Content (%)	Ash (%)	Ether Extract (%)	Crude Fibre (%)	Crude Protein (%)
UADSM	8.79	3.64	12.22	8.85	20.98
DADSM	6.96	5.39	17.53	3.09	27.66

Values are representative of the means of two independent analyses. UADSM: Undecorticated Adansonia digitata seed meal; DADSM: Decorticated Adansonia digitata seed meal.

The results indicate a distinct nutritional profile between the two samples, driven by the presence or absence of the fibrous seed coat. Decortication significantly increased the concentration of key nutrients, with decorticated ADSM (DADSM) exhibiting higher crude protein (27.66%) and ether extract (crude fat, 17.53%) compared to undecorticated ADSM (UADSM) at 20.98% and 12.22%, respectively. This aligns with the principle that decortication removes the dilutive seed coat, concentrating the nutrient-dense kernel. The crude protein values are consistent with previous Nigerian studies, which reported 20.4% for ADSM from Oyo State (Oladunjoye et al., 2014) and 28.85% for seeds from Katsina State (Saulawa et al., 2014). Conversely, UADSM showed a markedly higher crude fibre content (8.85% vs. 3.09% in DADSM), confirming the seed coat as a primary source of fibre. The ash content was also higher in DADSM (5.39%), suggesting a greater concentration of minerals within the kernel.

The moisture contents (UADSM: 8.79%, DADSM: 6.96%) fall within the 4.7-11.0 g/100g range compiled for baobab fruit pulp (Stadlmayr et al., 2013). The lower moisture in DADSM may reflect the reduced hygroscopicity of the kernel compared to the fibrous coat. The elevated ether extract (lipid) value in DADSM underscores its potential as a source of edible oil.

The qualitative and quantitative phytochemical composition of undecorticated and decorticated ADSM was also determined (Table 2).

Research Question 2: What is the differential distribution of key phytochemicals between the undecorticated seed meal and the decorticated kernel of *Adansonia?*

Table 2: Phytochemical analysis of raw, undecorticated, and decorticated ADSM

Parameters	UADSM	DADSM
Saponin (mg/kg)	1.83	4.18
Tannin (mg/kg)	4.23	5.19
Total Phenolics (mg/kg)	1.13	1.36
Steroids (µg/kg)	0.98	ND*
Flavonoids (mg/kg)	216.47	57.49
Terpenoids (µg/kg)	27.94	26.95
Alkaloids (mg/kg)	0.81	1.28

UADSM: Undecorticated Adansonia digitata seed meal; DADSM: Decorticated Adansonia digitata seed meal.

ND: Not Detected.

Decortication had a variable impact on phytochemical concentrations, revealing compartmentalisation within the seed. Higher concentrations of saponins, total phenolics, and alkaloids were found in DADSM. Notably, steroids (0.98 µg/kg) were detected only in UADSM. In contrast, UADSM retained significantly higher levels of flavonoids (216.47 mg/kg vs. 57.49 mg/kg in DADSM) and a slightly higher level of terpenoids. The presence of these compounds, including tannins and alkaloids, corroborates findings by Saulawa et al. (2014) for raw baobab seeds from Katsina State. Variations in specific concentrations can be attributed to genetic, environmental (soil, climate), and methodological factors.

The differential distribution of these bioactive compounds has important implications. The high flavonoid content in the seed coat (UADSM) suggests potent antioxidant activity associated with that fraction, while the concentrated saponins and alkaloids in the kernel (DADSM) may influence biological activity and taste. The presence of compounds like tannins and saponins indicates that, while ADSM holds promise as a source of beneficial antioxidants, its application in food and feed may require processing to mitigate potential antinutritional effects that could impair protein digestibility or mineral absorption.

The proximate composition of undecorticated and decorticated *Adansonia digitata* seed meal (ADSM) was determined (Table 1). Decorticated ADSM had higher values in some nutrients, like crude protein, compared to undecorticated ADSM. The moisture content of undecorticated ADSM was 8.79%, while that of decorticated ADSM was 6.96%. The ether extract value of undecorticated ADSM was 12.22%, while that of decorticated ADSM was 17.53%. The crude protein content of undecorticated ADSM was 20.98%, while that of decorticated ADSM was 27.66%. The results of this study showed that decorticated ADSM had higher values in some nutrients, like crude protein, compared to undecorticated ADSM.

This is consistent with previous studies that have reported higher nutrient content in decorticated ADSM. The crude protein values of 20.98% and 27.66% obtained for UADSM and DADSM are similar to that of Oladunjoye *et al.* (2014), who reported a value of 20.4% crude protein for ADSM collected within the vicinity of the Department of Forestry located within Old Oyo National Park in Oyo State of Nigeria, and the value of 27.66% for crude protein observed is similar to a value of 28.85% reported for raw A.digitata seed collected in Katsina State by Saulawa *et al.* (2014). The higher crude protein content of decorticated ADSM could be attributed to the removal of the seed coat during decortication, which contains lower amounts of protein compared to the endosperm. The higher crude fibre content of undecorticated ADSM could be due to the presence of the seed coat, which is rich in fibre. The moisture contents of 6.96% and 8.79% observed in this study are within the range of 4.7-11.0g/100g compiled for various literature on *Adansonia digitata* fruit pulp reported by Stadlmayr *et al.* (2013). However, variations in literature reports of moisture content could be because the fruit pulp reported was dried but hardly stated in the literature. The ether extract value of decorticated ADSM was higher than that of undecorticated ADSM. This could be because the seed coat of undecorticated ADSM contains more lipids compared to decorticated ADSM.

The qualitative and quantitative composition of phytochemicals present in undecorticated and decorticated ADSM was also determined (Table 2). Higher concentrations of saponins, total phenolics, and alkaloids were found in decorticated ADSM, while higher concentrations of tannins, flavonoids, and terpenoids were found in undecorticated ADSM. Undecorticated ADSM also contained steroids, which were not detected in decorticated ADSM. The saponin, tannin, total phenolics, steroids, flavonoids, terpenoids and alkaloids in UADSM content are similar to the report of Saulawa *et al.* (2014), who reported the presence of tannin, alkaloids, oxalate, phytic acid and trypsin inhibitor in raw *Adansonia digitata* seeds collected in Katsina state. Variations in the antinutritional factors present could be because of differences in fruit, soil and method of analysis. The presence of these phytochemicals in ADSM could have both positive and negative effects on human health.

Conclusion

The study concluded that undecorticated and decorticated ADSM has a moisture content of less than 10% and is rich in crude protein of above 20%, suggesting its use in livestock feed as a protein feedstuff. The qualitative and quantitative composition present in undecorticated and decorticated ADSM may limit its use as a dietary element in human and animal diets.

It is recommended that further research be carried out to explore different processing factors and methods to reduce the concentration and mitigate the effects of the phytochemicals in ADSM. When the antinutrients in ADSM is lowered, nutrient accessibility, acceptability, palatability, and usage in livestock feeds will be enhanced.

Recommendations

Based on the comparative results, the following concise recommendations are made:

1. Commercialise decorticated seed meal (DADSM) as a premium food ingredient due to its superior protein (27.66%) and fat (17.53%) content for nutritional fortification and oil extraction.
2. Utilise undecorticated meal (UADSM) as a functional fibre and antioxidant source for nutraceuticals or animal feed, leveraging its high fibre (8.85%) and flavonoid (216.47 mg/kg) content.

3. Establish separate quality standards and labelling for "Whole Seed Meal" (UADSM) and "Kernel Meal" (DADSM) to reflect their distinct nutritional profiles.

4. Investigate the health effects and optimal processing methods for the compartmentalised phytochemicals to maximise benefits and minimize antinutritional factors.

5. Develop value-added applications for the seed cake by-product from oil extraction to ensure a zero-waste economic model.

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