Evaluation of the Nutritional components of Plantain (*Musa paradisiaca* L.) fruit peels

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Abstract

Plantain is a staple crop widely consumed across tropical regions, with its peel often discarded as waste despite its rich nutritional potential. This study investigated the nutritional composition of plantain peels with the aim of evaluating their possible applications in food, feed, and industrial uses. Proximate, phytochemical and mineral analyses were carried using standard procedures. The results obtained revealed appreciable levels of carbohydrates (51.7%), crude fiber (29.20) and Crude protein (11.80%). Potassium, calcium, magnesium, iron and phytochemicals including tanins, terpenoids and saponins were observed. Fat soluble (Vit. A, D, E, K) and water soluble (Vit. B and C) vitamins were present. The findings suggest that plantain peels represent an underutilized resource with significant nutritional and functional value. Their incorporation into animal feed, dietary supplements, or as raw material in food processing could contribute to waste reduction and improved nutritional security. This highlights the importance of valorizing plantain peels as a sustainable alternative to conventional food and feed resources.

1.0 Introduction

Plantain (*Musa paradisiaca*), a member of the Musaceae family, is a staple food crop cultivated extensively in tropical and subtropical regions, including Sub-Saharan Africa, Southeast Asia, Central America, and South America. As a dietary cornerstone for millions, plantain contributes significantly to food security, providing essential carbohydrates, vitamins (vitamin A and C), and minerals (FAO, 2023).. However, while the fruit pulp is highly valued for its nutritional and culinary uses, the peel, constituting approximately 30–40% of the fruit's total weight, is predominantly discarded as waste, posing environmental and economic challenges (Bello *et al.,* 2024). Up to 1.2 million tons of plantain peels are generated annually in Nigeria alone (Udeh *et al.,* 2024). The improper disposal of these peels not only strains waste management systems but also leads to environmental degradation, as decomposing organic matter in landfills releases methane, a greenhouse gas with a global warming potential 25 times greater than carbon dioxide (Intergovernmental Panel on Climate Change, 2022). Recent advancements in sustainable agriculture and waste management have shifted attention toward the untapped potential of plantain peels applications (Hassan *et al.,* 2024) and applied topically to promote wound healing (Kumar, 2012).

The aim of this research was to explore the nutritional and non-nutritional components of plantain peels and their antioxidant properties improving the dietary acceptability of plantain-based products and reducing biological wastage of the exocarp.

2.0 Materials and Methods

2.1 Collection and preparation of plant materials

Plantain whose peels were used were collected from Okitipupa local market, Ondo state, and then identified at University of Ibadan Herbarium, Department of Botany Ibadan, with supplied voucher

number UIH-23614. The peels were washed, pretreated with cold water containing 0.5 % citric acid for 10 minutes, drained and sliced into small pieces. It was then dried within 6-7days. After that, the peel was then grounded in a blender and sieved through a sieving machine with mesh size 20 mm to get Nendran peel flour (NPF).

2.2 Proximate analysis of plantain peels

Determinations of the proximate compositions such as moisture content, Crude fibre contents, ash content, protein content (Micro-Kjeldahl method), fat (solvent extraction gravimetric method), Carbohydrate (James. 1995) and minerals (dry ash extraction procedure) by James [1995] were carried out as described by Chukwuka *et al.,* (2013). Versanate EDTA titrimetric extraction techniques used for calcium and magnesium, and Phosphorus content analysis followed the order described by James [1995]. Millner and Whiteside extraction procedures were adopted for Sodium and Potassium (Millner, 1981). Determination of Vitamins A, D and E were carried out as described by the Association of Official Analytical Chemists (A.O.A.C., 2005) while Vitamins B, C and K contents were determined as described by Laden (1999).

2.3 Determination of Phytochemical contents

Folin Denis Colometric analytical method according to Kirk and Sawyer (1999) reported by Chukwuka *et al.,* (2013) was adopted for Tanins determination. Determination of Saponin and Phlobatannins was done by the double solvent extraction gravimetric method (Harbome, 1973). Phenol was determined by using the method of AOAC (2005). Steroid was determined by the Analytical method used by Ejikeme *et al.* (2020). Flavonoid was determined using the method reported by Sofowara (2016) and Harborne (2018). Glycoside and alkaloids tests were conducted according to the method reported by Hikino *et al.* (2017). The procedure developed by Mônica *et al.* (2018) have been adopted for the quantification of total polyphenols

3.0 Results and Discussion

Table 1 showed the Proximate Composition (%) of plantain peels. The proximate analysis of plantain peels revealed a high carbohydrate content, significant dietary fiber, and moderate protein (11.80%), confirming their nutritional potential. The high carbohydrate content (51.7%) and crude fiber (29.20%) indicate that plantain peels are a potent energy source and a valuable source of dietary fiber, which supports digestive health and metabolic regulation (Oduro *et al.*, 2025). The low fat content (3.5%) makes them suitable for low-calorie food formulations, while the moderate protein content (11.80%) suggests potential for supplementing protein- deficient diets, particularly in resource-constrained settings (Bello *et al.*, 2024; Topping and Clifton, 2021).

Table 1: Proximate Composition (%) of Plantain Peel

Parameters	Concentration(%)
Ash	6.00
Moisture content	7.00
Crude fibre	29.20
Crude protein	11.80
Fat	3.50
Dry matter	92.20
Carbohydrate	31.70

Table 2: Vitamin Compositions of Plantain Peels

Vitamins	Values(mg/100g)
Vit. A	0.20
Vit. B	0.48
Vit. C	9.10
Vit. D	0.12
Vit. E	0.08
Vit. K	1.30

Table 2 showed the vitamin composition of plantain peels. The vitamin analysis showed that plantain peels contain significant levels of vitamins, particularly Vitamin C, which contributes to their antioxidant capacity. Vitamin C, along with polyphenols and flavonoids, contributes to the peels' ability to neutralize free radicals, which is crucial for preventing oxidative stress-related diseases such as cancer and cardiovascular disorders (Zhang *et al.*, 2024). The high vitamin C content (9.10 mg/100g) underscores the antioxidant potential of plantain peels, which can help mitigate oxidative stress and support immune function (Oduro *et al.*, 2025). The presence of B-complex vitamins (0.48 mg/100g) supports metabolic processes, while vitamins A, D, E, and K contribute to overall nutritional value, albeit in smaller quantities.

Table 3 shows the mineral composition of plantain peels. The mineral analysis revealed that plantain peels are rich in essential minerals, particularly potassium, and magnesium, which are critical for human and animal nutrition. The high potassium content supports cardiovascular health and blood pressure regulation, while calcium and magnesium contribute to bone health and metabolic functions (Adedayo *et al.*, 2023). The presence of the high potassium content (680.0 mg/100g), calcium (130.0 mg/100g), magnesium (61.0 mg/100g), iron (29.0 mg/100g) and zinc (2.3 mg/100g) which are higher than most literature reports for plantain pulp flour where K typically ranges 284-530 mg, Ca 3-12mg, Mg 17-29mg,

Fe 0-0.6 mg and Zn 0.08-0.4mg/100g(Anajekwu *et al*., 2020; Chinma *et al.,* 2021), highlights the potential of plantain peels to address mineral deficiencies in populations with limited dietary diversity. Elevated Ca (130mg/100g) and Fe (14mg/100g) align more closely with plantain bract flour reported by Adeolu and Enesi, (2013).

Table 4 shows the phytochemical composition of plantain peels. The phytochemical analysis confirmed the presence of various bioactive compounds with antioxidant properties. These compounds contribute to the peels' therapeutic potential and their ability to combat oxidative stress. The presence of polyphenols (8.85 mg of GAE/g), saponins (13.60 mg/100g), and glycosides (11.30 mg/100g) highlights the strong antioxidant capacity of plantain peels, which can neutralize free radicals and reduce oxidative stress-related diseases (Zhang *et al.*, 2024). All phytochemicals were within safe dietary limits: polyphenols at 885 mg/100g provide antioxidant benefits with no toxicity risk, while saponins 13.6 mg/100g, oxalates 2.34 mg/100g, and phytate 1.75 mg/100g are far below lethal/antinutritional thresholds and won't impair mineral absorption. The low oxalate and phytate levels also suggest the high Ca, Fe, Mg, and Zn reported will be bioavailable, supporting the flour's functional food potential.

The relatively low levels of anti-nutritional factors like oxalates (2.34 mg/100g) and phytates (1.75 mg/100g) suggest that preprocessing methods can further enhance nutrient bioavailability (Kumar *et al.*, 2020.

Table 3 showed the Mineral composition of plantain peel

Parameters	Values
Carbon	33.50
Total Nitrogen	1.89
Ca (mg/100g)	130.00
Mg (mg/100g)	61.00
K (mg/100g)	680.00
Na (mg/100g)	32.00
Mn (mg/100g)	6.00
Fe (mg/100g)	29.00
Cu (mg/100g)	1.20
Zn (mg/100g)	2.30
P (mg/100g)	28.00

Table 4: Phytochemical Composition of Plantain Peel

Parameters	Values
Tannin (mg/100g)	3.24
Saponins (mg/100g)	13.60
Terpenoids (mg/100g)	8.70
Oxalates (mg/100g)	2.34
Phytate (mg/100g)	1.75
Alkaloid (mg/100g)	3.12
Steroid (mg/100g)	2.64
Phylobotannins (mg/100g)	4.12
Glycosides (mg/100g)	11.30
Trypsin Inhibitor (ug/g)	8.70
Polyphenol (mg of GAE s/g)	8.85
Uronic (ug/g)	49.60

Conclusions

This study confirms that plantain peels are a rich source of nutritional and bioactive compounds, with significant potential for addressing food security, health, and environmental sustainability. These findings align with the United Nations' (2015) sustainable development goals, emphasizing resource efficiency and waste reduction. It is therefore recommended to promote awareness among farmers, consumers, and policymakers about the nutritional and economic potential of plantain peels to encourage their adoption in food systems and sustainable practices.

Declarations

4.2 Acknowledgments

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