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PROXIMATE COMPOSITIONS OF PLANTAIN AND BANANA PEELS: A POTENTIAL ADDITIVE TO ANIMAL FEED

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ABSTRACT

Plantain (Musa paradisiaca) and banana (Musa spp.) are widely cultivated tropical fruits that generate significant quantities of peels, often discarded as waste. These peels, constituting 30–45 % of fruit mass, represent a potential source of nutrients for livestock feed. This study evaluated the proximate composition of dried plantain and banana peels to assess their suitability as alternative feed ingredients. Samples were collected locally, washed, air-dried, and analyzed for moisture, crude fibre, crude protein, fat, ash, and carbohydrate content following standard AOAC methods. Results showed that plantain peels contained 72.19 % carbohydrates, 8.80 % crude fibre, 4.58 % protein, 3.12 % fat, 7.81 % ash, and 3.50 % moisture, while banana peels contained 70.35 % carbohydrates, 8.51 % crude fibre, 7.47 % protein, 2.01 % fat, 6.66 % ash, and 5.00 % moisture. Statistical comparison using independent t-tests indicated significant differences in all parameters ($p < 0.05$). Plantain peels were richer in carbohydrates, fibre, fat, and minerals, whereas banana peels contained higher protein and moisture. These findings suggest that both peel types can serve as cost-effective, locally available feed supplements, with potential to reduce dependency on conventional feedstuffs, enhance nutrient intake, and mitigate agro-waste disposal issues. Inclusion in livestock diets should consider balancing energy, protein, and mineral content to optimize animal performance.

Keywords: Plantain Peel, Banana Peel, Proximate composition, Animal feed, Agro-wast.

Introduction

Plantain (*Musa paradisiaca*) and banana (*Musa spp.*) are perennial herbaceous plants cultivated widely in tropical and subtropical regions. They serve as staple foods for millions of people and are valued for their carbohydrate, vitamin, and mineral content (Bains, 2001; Debabandya, Sbyasachi, & Namarata, 2010). These plants produce large quantities of by-products, particularly peels, which account for 30–45 % of the fruit mass and are often discarded as waste (Alkarkhi *et al.* 2010; Mohapatra *et al.,* 2010). The improper disposal of peels contributes to environmental pollution and waste management challenges, while underutilizing a nutritionally valuable resource (Udo *et al.,* 2021).

The peels of plantain and banana are rich in carbohydrates, crude fibre, residual protein, and minerals (Tsado *et al.,* 2021). Dietary fibre from these peels supports gut health, promotes digestion, and improves nutrient absorption in livestock (Munguti *et al.,* 2018). Moderate protein content complements other feed ingredients to support tissue growth, enzyme synthesis, and overall animal performance (Patra, 2014). The mineral fraction, reflected in ash content, provides

essential nutrients such as calcium, magnesium, potassium, and phosphorus, which are crucial for bone development and physiological functions (Ighodaro, 2014).

Conventional feed ingredients such as maize and soybean are becoming increasingly expensive and less accessible, particularly in developing countries (Onwuka, Onyemachi, & David-Chukwu, 2015). Therefore, there is a pressing need to identify alternative, locally available feed resources. Plantain and banana peels represent a sustainable option that can reduce feed cost while enhancing nutrient intake in livestock diets (Arogbodo *et al.,* 2021). Each proximate component plays a vital role in animal nutrition. Protein is essential for growth, tissue repair, and enzyme synthesis, while carbohydrates serve as the primary energy source (Tsado *et al.,* 2021). Fibre contributes to proper gut motility and fermentation in ruminants and non-ruminants, and fat provides concentrated energy and aids in vitamin absorption (Patra, 2014). Minerals, reflected in ash content, support skeletal development, metabolic processes, and electrolyte balance (Ighodaro, 2014). Low moisture content in dried peel powders enhances storage stability by reducing microbial growth and spoilage (Hassan *et al.,* 2019).

Agro-waste utilization addresses both environmental and economic challenges. Plantain and banana peels, often discarded in urban and rural settings, can be transformed into value-added feed ingredients, thereby reducing waste and mitigating environmental pollution (Onwuka *et al.,*2015; Debabandya et al., 2010). Inclusion of these peels in feed formulations reduces dependency on conventional, high-cost feedstuffs such as maize and soybean (Patra, 2014; Udo *et al.,* 2021). Moreover, it aligns with principles of sustainable agriculture and circular bioeconomy by promoting resource efficiency and reducing production costs (Montiel*et al.,*2019).

Methods and Materials

Sample Collection and Preparation

Plantain peels were collected from roasters at Federal Polytechnic, Oko environs, and along Oko–Ekwulobia road. Banana peels were obtained from sellers at Total Mini Market, Oko, Orumba North LGA, Anambra State. Peels were washed, drained, air-dried for 15 days, and ground manually using a Victoria grinding machine.

Proximate Analysis

The proximate analysis of the two dried peel samples were done using the methods of AOAC, 2016. The following parameters were determined.

Moisture Content

Moisture content was determined on a 2g sample of each peel by oven drying method and percentage moisture content calculated using the formula:

$$\%\, moisture = \frac{w_1 - w_2}{weight\ of\ sample} \times 100$$

Where;
w_1 = Initial weight of crucible + sample
w_2 = Final weight of crucible + sample

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Ash Content

Ash content was determined by the incineration method (Patra, 2014). Two (2g) of each sample were placed in a muffle furnace maintained at 550℃ for 6 – 8 hours. The appearance of gray white ash indicated complete oxidation of all organic matter in the sample. Percentage ash was calculated using the formula:

$$\%\ ash = \frac{difference\ in\ weight\ of\ ash\ (w_3 - w_1)}{weight\ of\ sample} \times 100$$

Protein Content

Crude protein was determined by the Kjeldahl method, using 2g of each sample and the percentage crude protein calculated with the formula (% total Nitrogen × 6.25) based on the fact that most proteins contain 16% nitrogen using the Kjeldahl method.

Crude Fibre Content

The crude fibre was obtained by digesting 2g of each sample with H_2SO_4 and NaOH, incinerating the residue in a muffle furnace maintained at 550℃ for 6 – 8 hours. Percentage crude fibre calculated using the formula:

$$\%\ crude\ fibre = \frac{loss\ in\ weight\ after\ incineration}{2g} \times 100$$

Crude Lipid/Fat

Crude lipid/fat was determined by ether extract method (Bains, 2001), using Soxhlet apparatus. An exhaustive extraction of 10g of each sample in a Soxhlet apparatus was done and petroleum ether was used as solvent.

Percentage crude lipid calculated with the formula:

$$\%\ crude\ lipid = \frac{weight\ of\ ether}{weight\ of\ the\ sample} \times 100$$

Carbohydrate Content

Carbohydrate content was determined by the deduction method. The percentage carbohydrate content was done by calculation of the difference of the summation of all the results of other proximate parameters.

$$\%\ carbohydrate = 100\ -\ \%(protein + fat + moisture + ash + crude\ fibre)$$

The experiment was replicated three times for the samples (Pico, 2020).

Results

The results of the proximate composition of plantain and banana peels are shown in Table 4.1.

Table 4.1: Proximate Composition of Plantain and Banana Peels

Parameters	Plantain Peels (%)	Banana Peels (%)
Crude fibre	8.80 ± 0.14	8.51 ± 0.01
Fat	3.12 ± 0.28	2.01 ± 0.02
Moisture	3.50 ± 0.43	5.00 ± 0.25
Ash	7.81 ± 0.51	6.66 ± 0.113
Protein	4.58 ± 0.12	7.47 ± 0.01
Carbohydrate	72.19 ± 0.21	70.35 ± 0.30

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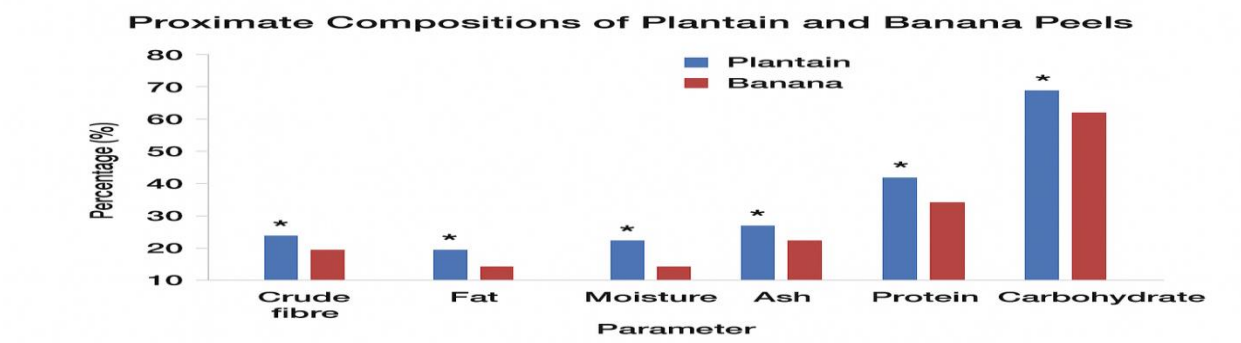

Comparison of Proximate Composition of Plantain and Banana Peels

Parameters	N	Mean	SD	t-cal	t-crit	p-value	Decision
Crude Fibre	3	0.29	0.081	3.58	2.776	0.025	Reject H_0
Fat	3	1.11	0.162	6.85	2.776	0.005	Reject H_0
Moisture	3	-1.50	0.287	-5.23	2.776	0.01	Reject H_0
Ash	3	1.15	0.302	3.81	2.776	0.02	Reject H_0
Protein	3	-2.89	0.0695	-41.58	2.776	0.001	Reject H_0
Carbohydrate	3	1.84	0.211	8.72	2.776	0.005	Reject H_0

Discussion

The proximate composition analysis of plantain and banana peels (Table 4.1) revealed notable differences across all measured parameters, suggesting that these agro-wastes possess distinct nutritional profiles suitable for animal feed formulation. Carbohydrates were the predominant macronutrient in both peels, with plantain peels containing 72.19 % and banana peels 70.35 %. This high carbohydrate content indicates that both peels could serve as valuable energy sources in livestock diets, supporting metabolic activities and growth (Tsado *et al.*, 2021). The difference in carbohydrate content was statistically significant (t-cal = 8.72; p = 0.005), demonstrating that plantain peels could provide slightly more energy than banana peels.

Crude fibre content was relatively similar, with plantain peels at 8.80 % and banana peels at 8.51 %. Fibre plays a critical role in maintaining gut health, improving digestion, and enhancing microbial fermentation in ruminants (Munguti *et al.*, 2018; Ejigui *et al.,* 2019). The significant t-test result (t-cal = 3.58; p = 0.025) confirms a measurable difference, implying that plantain peels may provide marginally better support for digestive processes.

Fat content differed significantly between the two peel types, with plantain peels containing 3.12 % and banana peels 2.01 % (t-cal = 6.85; p = 0.005). Although low, the fat fraction is important for supplying energy and facilitating the absorption of fat-soluble vitamins, which are critical for

metabolic health (Patra, 2014). Moisture content was higher in banana peels (5.00 %) than in plantain peels (3.50 %), suggesting that plantain peels may have greater storage stability and lower susceptibility to microbial spoilage (Hassan *et al.,* 2019). The significant difference in moisture (t-cal = -5.23; p = 0.01) indicates that peel type must be considered when planning storage and feed processing.

Ash content, representing total mineral composition, was higher in plantain peels (7.81 %) compared to banana peels (6.66 %), and this difference was significant (t-cal = 3.81; p = 0.02). This suggests that plantain peels may serve as a richer source of essential minerals such as calcium, potassium, and magnesium, which are vital for skeletal development, enzymatic activity, and overall animal health (Ighodaro, 2014). Protein content was significantly higher in banana peels (7.47 %) than in plantain peels (4.58 %) (t-cal = -41.58; p = 0.001), highlighting that banana peels may contribute more body-building nutrients. However, the overall protein content is moderate and may require supplementation when formulating complete diets.

The observed variability in nutrient composition may result from differences in ripeness, cultivar, and post-harvest processing (Arogbodo *et al.,* 2021). Anti-nutritional factors such as tannins, oxalates, and phytates may reduce nutrient bioavailability. However, these can be mitigated through processing techniques like fermentation, boiling, or blanching, which enhance digestibility and nutrient uptake (Montiel *et al*., 2019).

Overall, the proximate composition and statistical analysis indicate that both plantain and banana peels are suitable as partial substitutes for conventional feed ingredients. Their inclusion can improve nutrient intake, reduce feed costs, and minimize environmental waste associated with peel disposal (Onwuka *et al.*, 2015; Udo *et al.*, 2021). Careful feed formulation is necessary to balance energy, protein, and mineral content, particularly if peels are used in substantial quantities. Future research should investigate optimal inclusion rates, growth performance, and health effects in livestock to fully exploit the nutritional potential of these agro-wastes.

Conclusion and Recommendations

Plantain and banana peels have substantial nutritional value for inclusion in animal feed, offering carbohydrates, fibre, protein, and minerals. Proper processing, blending with other feed ingredients, and consideration of anti-nutritional factors can enhance their utility. Adoption of these agro-wastes as feed additives can reduce production costs, improve livestock performance, and contribute to sustainable waste management. Further research should focus on digestibility studies, optimal inclusion levels, and performance trials in livestock systems.

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