Journal of Agriculture and Agricultural Technology
(JAAT)
Journal of Agriculture and Agricultural Technology 12(1), 2023

Original Research Paper

EVALUATION OF THE NUTRITIVE QUALITIES OF RIPE AND UNRIPE PLANTAIN PEELS AS A POTENTIAL FEED INGREDIENT

Alabi Olayinka Olubunmi[1], Olajide Olasunkanmi Peter[1,2], Dasaolu Oluwatomiwa Solomon[1], Ologbosere Yemi Deborah[1,3]

[1]Animal Science Program, College of Agricultural Sciences, Landmark University

[2]Research Laboratory 1, College of Agricultural Sciences, Landmark University

[3]Teaching and Research Farm, Landmark University

Corresponding Author email: olajide.olasunkanmi@lmu.edu.ng **GSM:** +2347061507673

ABSTRACT

The study examined the nutritional properties of plantain peels subjected to different processing methods which were air-drying, sun-drying, and fermentation. Each method was replicated thrice. Experimental samples were subjected to proximate analysis, phytochemical evaluation, and functional properties determination. Data collected were compared using analysis of variance and significant differences between the means were determined using Duncan's Multiple Range Test. The results of the proximate analysis showed no significant difference between the treatments for moisture content. Ripe sun-dried plantain peels gave the highest crude protein value (9.62 %), Ripe air-dried plantain peels gave the highest lipid content (10.33 %), Unripe fermented plantain peels had a lower crude fibre (4.28 %), Ripe air-dried plantain peels gave the highest moisture content (10.00 %). Unripe air-dried plantain peels had the highest NFE (63.39 %). The result of the phytochemical evaluation disclosed the presence of saponin, alkaloids, and flavonoids. Unripe fermented plantain peels had the least saponin (0.70 %) and flavonoid content (0.08 %). The bulk density values of the ripe and unripe plantain peels reduced from air-dried to sundried, and fermented with the sun-dried sample, they were in the range of 0.34 -0.53 g/cm3. Unripe plantain peels subjected to air drying retained the highest water absorption capacity of 0.51 g/g while *unripe plantain peels subjected to fermentation and sun drying had the least water absorption capacity of 0.37 g/g. Fermentation with the sun-drying process had better results for phytochemical and functional evaluation. Hence, fermented sun-dried unripe plantain peels are recommended as a potential feed ingredient for animals.*

Keywords: Alternative feed ingredient, functional properties, plantain peels, phytochemical evaluation, proximate analysis.

INTRODUCTION

Plantain peels, like many other fruit and vegetable peels, offer a series of nutrients and functional properties that can benefit animal alimentation (Oduje *et al.,* 2015). The utilization of fruit debris and agricultural waste provides alternative nutritious livestock dietary supplements. It has been shown that several important bioactive phytochemicals are present in them, required for long-term livestock development and healing growth (Achilonu *et al*., 2018). In developing countries, a significant challenge in livestock production is a clear cost rise, scarcity, and sparse availability of major feeding ingredients as well as the existing competition between humans and animals for these ingredients (Arogbodo *et al.*, 2021). Due to this fact, the profitability that goes to the farmer is significantly reduced since feed costs well over 70% of the entire cost of production (Abdulrahman *et al.,* 2022; Agama-Acevedo *et al.,* 2016). For these to be realized, some leftovers from farming may be utilized in feed composition. Plantain peels are a significant component of the list of agro-industrial by-products (Galani, 2019). The level of carbohydrates, protein, fibre, fat, ash, and moisture in the peel imply that they are capable of addressing those mentioned issues. This is because they are widely available and reasonably priced across the nation (Ighere, 2019; Ndarubu *et al*., 2021). Plantain peels are commonly found across most parts of Nigeria in large quantities but have been fully utilized as a source of feed ingredient, but rather regarded as a waste material (Kadirvel and Ramalakshmi, 2021). This gap is owing to limited information on its nutritive properties, hence the purpose for which this research was carried out (Etim *et al.,* 2018; Usman *et al.,* 2018). To investigate the proximate composition of raw, air-dried, sun-dried, and fermented ripe and unripe plantain peels. of plantain peels into valuable products as a good source of carotenoids, phenolics, and biogenic amines as examples of bioactive substances. (Mohd Zaini *et al.,* 2022; Zhang *et al.,* 2020). Hence, this research focused on determining the nutritive quality of plantain peels using different processing methods which will enable its usage as an alternative livestock feed ingredient.

MATERIALS AND METHODS

Experimental Location

The study was conducted accordingly at the Feed-Processing Unit of the Teaching and Research Farm of Landmark University, Kwara State, Nigeria. Kwara is located between latitude 8° 32 1 North and longitude 4°35 (Elemile *et al.,* 2019).

Plantain Peels Collection and Preparation

Healthy plantain fruits (unripe and ripe) exploited for this study were obtained from peels collected from several plantain vendors in Omu-Aran, Irepodun LGA of Kwara State. Collected plantain peels were subjected to different processing methods and each method was replicated thrice as shown in Table 1.

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Table 1: Processing method and allotment of treatment samples

Plantain Peels	Treatment Sample	Processing Method
Ripe	T1	Air-dried
	T2	Sun-dried
	T3	Fermented for 3 days + Sun-dried
Unripe	T4	Air-dried
	T5	Sun-dried
	T6	Fermented for 3 days + Sun-dried

Processing and Treatment of Samples

The Fresh peels of unripe and ripe *Musa paradisiaca* were properly washed with distilled water and subsequently processed by peeling with a keen sterile knife and the pulp was carefully removed; then collected, separated, and cut into smaller pieces. They were further cleaned using distilled water to rid them of any contaminants and then kept at room temperature after which they were separated for the air-drying, sun-drying, and fermentation. The plantain peels were sun-dried and air-dried in batches for 7 days to remove moisture. After sun and air drying separately, the dried-out unripe and ripe plantain peels were pulverized utilizing a hand grinder, and the crushed plantain peels were stored at room temperature in sealed bags. Furthermore, the third set of peels was soaked in water under anaerobic conditions for three days after which they were oven-dried and then ground using a hand grinder. The powder form of the peels was stored in separate labelled air-tight plastic bags under dry conditions until use

Proximate Analysis of Plantain Peels

The moisture content, ash content, crude fibre content, ether extract, and crude protein of plantain peels were all determined using the proximate examination. The proximate composition of the peels was appraised using a standard procedure at Landmark University's Animal Science Laboratory, according to the protocols published by the Association of Official Analytical Chemists (AOAC, 2005).

Phytochemical screening (Quantitative analysis)

Quantitative determination of the air-dried, sun-dried, fermented oven-dried, ripe, and unripe crushed plantain peel specimens for flavonoid, saponin, alkaloids, and phenol showed positive results and, hence were determined quantitatively.

Determination of Total Phenol: The full phenol content was determined as designated by Oluba *et al.* (2021). In brief, the extracts were oxidized with 2.5 ml of 10 % Folin-Ciocalteau's reagent (v/v) and neutralized with 2.0 mL of 7.5 % sodium carbonate. The rejoinder mixture was incubated for 40 minutes at 45 °C, and the absorbance was measured in a spectrophotometer at 765 nm. Subsequently, the entire phenol content was assayed as gallic acid equivalent.

Determination of Alkaloid: The alkaloid content of plantain powdered material was determined using the method of Ojinnaka *et al.* (2017) with minor changes. In a 250 mL conical flask, 5 g of each sample was weighed and 200 mL ethanol in 10 % acetic acid was added. The resulting mixture was wrapped in foil and left at room temperature for 120 minutes. Following that, the mixture was placed in a 50 °C water bath and permitted to evaporate until the entire volume was abridged to one-quarter of its original level. A few droplets of concentrated ammonia solution were added, and the mixture was allowed to settle. The precipitate was removed using Whatman filter paper (number 6) and oven-dried to a certain weight at 45°C. The alkaloid content was calculated in percentage as:

$$\% \, Alkaloid = \frac{(\alpha)-(\beta)}{\infty} x \; 100, \text{ where;}$$

α=weight of filter paper + residue

β=weight of filter paper

∞=*weight of sample*

Flavonoid determination: The content of both extracts was determined using a tad-modified method described by Oleszek *et al.* (2023). In brief, 0.5 ml of properly diluted material was combined with 0.5 ml methanol, 50% AlCl3, 50% potassium acetate, and 1.4 ml water and incubated at room temperature for 30 minutes. The absorbance of the reaction mixture was then measured at 415nm, and the overall flavonoid content was computed.

Functional Properties of Plantain Peels

Bulk density: The method that was employed was described by Oluba *et al.* (2021). By weighing plantain peel samples (50g) into a 100ml graduated cylinder, beating the bottom ten times on the palm, and articulating the resulting volume in grams per milliliter, the bulk density of the samples was determined.

Swelling power: The procedure used by Alabi *et al.* (2023) was utilized for this analysis. After getting the specific gravity, each plantain peel sample was then given 30 ml of distilled water, and the cylinder was swirled and left to stand for 60 minutes even though the volume change (swelling) was noted every 15 minutes.

Water absorption capacity determination: The technique developed by Ojinnaka *et al*. (2017) was used to calculate water absorption capacity. Each treatment's one-gram sample of plantain peels was weighed separately (as well as with the spotless, dry centrifuge conduit it was placed in). Peels and up to 10ml of distilled water were combined to create the dispersion. It was at that moment centrifuged for 15 minutes at 3500 rpm. The tube's contents were reweighed as grams of water absorbed per gram of material after the supernatant was removed. The rise in mass was due to the plantain peel sample's ability to absorb water.

Data Analysis

The data collected from all the analyses were subjected to analysis of variance (ANOVA), according to GenStat release Version 10, 2013. The means were separated using Duncan's Multiples Range Test.

RESULTS AND DISCUSSION

RESULTS

The proximate composition of variously processed plantain peels is shown in Table 2. The results of the plantain peel samples' proximal (%) composition are expressed as a means of triplicate. Parameters evaluated include - crude protein, crude fibre, ash, moisture, and nitrogen-free extracts as present in the proximate composition of plantain peels. There was a significant difference ($p<0.05$) between the ripe and unripe plantain peels. The proximate composition of RAP, RSP, RFP, UAP, USP, and UFP are shown in Table 1. From the results, moisture, crude fibre, and crude fat were not significantly ($p<0.05$) different while crude protein, ash, and nitrogen-free extract were significantly ($p<0.05$) different. The outcomes from the proximate analysis showed that there was not any significant difference ($p<0.05$) between the treatments for moisture content. RAP had a higher moisture (9.83 %), than RSP (8.33 %) and RFP 7.83 %. Similarly, UFP (8.17 %) had the lowest moisture compared to USP (9.50 %) and UAP (10.00 %).

Table 2: **Proximate composition of air-dried, sun-dried and fermented; ripe and unripe peels**

Parameters (%)	RAP	RSP	RFP	UAP	USP	UFP	SEM	P. val.
CP	8.82^{ab}	9.62^{a}	8.63^{ab}	7.08^{c}	6.76^{c}	8.32^{b}	0.33	<.001
CF	4.00^{c}	7.36^{b}	4.91^{c}	8.86^{a}	4.58^{c}	4.28^{c}	0.43	<.001
Ash	9.00^{ab}	7.33^{bc}	7.00^{c}	9.67^{a}	9.00^{ab}	8.33^{b}	0.29	<.001
M	9.83^{a}	8.33^{b}	7.83^{c}	10.00^{a}	9.50^{ab}	8.17^{b}	0.27	<.001
EE	10.33^{a}	8.33^{b}	8.50^{b}	6.83^{c}	7.33^{bc}	7.50^{b}	0.25	<.001
NFE	58.01^{b}	59.02^{b}	63.13^{a}	57.56^{b}	62.83^{a}	63.39^{a}	0.73	<.001

CP: crude protein, CF: crude fibre, M: moisture, EE: Ether extract, NFE: nitrogen-free extract). RAP: ripe air-dried plantain peel samples, RSP: ripe sun-dried plantain peel samples, RFP: ripe fermented plantain peel samples, UAP: unripe air-dried plantain peel sample, USP: unripe sun-dried plantain peel samples, UFP: unripe fermented plantain peel sample.

The qualitative phytochemicals of plantain peels are shown in Table 3. The results showed that tannin and phlorotannin were absent in the air-dried, sundried, and fermented ripe and unripe plantain peel samples. Alkaloids, flavonoids, phenols, and saponin, were detected.

Table 3: Qualitative phytochemical screening of plantain peels

Parameters	RAP	RSP	RFP	UAP	USP	UFP
Phytochemical elements						
Alkaloid	+	+	+	+	+	+
Flavonoid	+	+	+	+	+	+
Phenols	+	+	+	+	+	+
Phlobatannin	-	-	-	-	-	-
Saponin	+	+	+	+	+	+
Tannin	-	-	-	-	-	-

RAP: ripe air-dried plantain peel samples, RSP: ripe sun-dried plantain peel samples, RFP: ripe fermented plantain peel samples, UAP: unripe air-dried plantain peel sample, USP: unripe sun-dried plantain peel samples, UFP: unripe fermented plantain peel sample.

Table 4 shows the value of saponin, phenols, flavonoids, and alkaloids in RAP RSP RFP UAP USP. and the phenolic values in UFP. AP, RSP, RFP, UAP, USP, and UFP were significantly ($p<0.05$) but were not significantly ($p>0.05$) different in flavonoid and saponin. The UAP (0.855) showed the highest alkaloid level, while the USP (0.773) had the lowest value. The UAP and UFP showed significant alkaloid levels, while RAP, RSP, RFP, and URP were not significantly ($p>0.05$) different. The UAP 0.612 of flavonoid was the highest, while the lowest flavonoid was UFP (0.0779). The UAP had the highest saponin of 0.920, while UFP 0.704 had the least.

Table 4: **Phytochemical quantitative screening of plantain peels**

Parameters (%)	RP			UP			SEM	P-value
	RAP	RSP	RFP	UAP	USP	UFP		
Alkaloid	0.74	0.77	0.80	1.15^{a}	1.11	1.14^{a}	0.66	<. 001
Flavonoid	0.33	0.23	0.29	0.61	0.11	0.08	0.00	<.001
Saponin	0.29	0.29	0.29	0.77	0.76	0.70	0.04	<. 001
Phenolics	0.23^{ab}	0.27^{a}	0.19^{b}	0.20^{b}	0.21^{b}	0.24^{ab}	0.01	0.024

RAP: ripe air-dried plantain peel samples, RSP: ripe sun-dried plantain peel samples, RFP: ripe fermented plantain peel samples, UAP: unripe air-dried plantain peel sample, USP: unripe sun-dried plantain peel samples, UFP: unripe fermented plantain peel sample. RP: ripe plantain peels, UP: unripe plantain peels.

The functional properties of plantain peels sample and unripe plantain peels exposed to different processing methods are shown in Table 5. The Table displays the data for bulk density, swelling power, and water absorption capacity of plantain peel samples. There was a significant ($p<0.05$) difference in the bulk density of the three differently processed plantain peels. The lowest value of

UFP, 0.3467g/cm3, and the highest value of UAP 0.5133 g/cm3, occurred in the unripe plantain sample. The plantain peels were in the range of 0.34 -0.53 g/cm3. In unripe plantain peels, bulk density increased from UFP (0.3467) to USP (0.3867) to UAP (0.513). The same trend occurred in ripe plantain peels where bulk density increased from RFP (0.3733) to RSP (0.4167) to RAP (0.4167). However, unripe plantain peel samples (UFP-0.3467g/cm3; USP-0.3867) had lower bulk density than ripe plantain peel samples (RFP-0.3733, RSP-0.4167) in ripe plantain except in air-dried process.

Table 5: **Functional properties of plantain peels**

TRT	RAP	RSP	RFP	UAP	USP	UFP	SEM	P value
BD	0.4167^{a}	0.4167^{a}	0.3733^{b}	0.5133	0.3867^{b}	0.3467	0.00577	<0.01
SP	50.0^{a}	50.8^{a}	50.0^{a}	29.2^{b}	29.2^{b}	54.2^{a}	2.97	<0.01
WAC	0.467^{ab}	0.460^{ab}	0.400^{bc}	0.407^{bc}	0.507^{a}	0.370^{c}	0.0269	0.032

BD: bulk density, SP: swelling power, WAC: water absorption capacity, RAP: ripe air-dried plantain peel samples, RSP: ripe sun-dried plantain peel samples, RFP: ripe fermented plantain peel samples, UAP: unripe air-dried plantain peel sample, USP: unripe sun-dried plantain peel samples, UFP: unripe fermented plantain peel sample.

DISCUSSION

The results from proximate analysis showed that there was no significant difference (p<0.05) between the treatments for moisture content. In feed analysis, the moisture content is affected by the method of processing. As a crucial parameter, it influences the shelf-life or how long a feed will last when stored (Oduje *et al.*, 2015). The moisture content of unripe plantain peels that were air-dried had the highest value (10.00 %), followed by ripe plantain peels which were air-dried (9.83 %); while the lowest percentage of moisture as reported in Table 2 was ripe plantain peels, fermented for three days and sundried (7.83 %). The moisture contents of the air-dried, sun-dried, and fermented sun-dried ripe peels sample being higher than the unripe air-dried, sun-dried, and fermented sun-dried ripe peels sample coincides with the findings of Adamu *et al.* (2017). From the result obtained, fermented sundried ripe plantain peels will last longer when stored while air-dried unripe plantain peels have the shortest time of storage. The high level of moisture gained in the RAP and UAP may perhaps be caused by moistness absorbed from the atmosphere during the air-drying procedure, while the RSP and RFP moisture reduction was from the sun-drying process (Adamu *et al.,* 2017). However, RAP moisture is higher than UAP may be owed to the moisture gained from the ripening course and from general microbial activities as the fruit ripens (Shadrach *et al.,* 2020).

The ash content is a portion of the mineral content (Oduje *et al.,* 2015; Matthew *et al.*, 2020). The percentage of ash in this study is similar to results recorded by (Oduje *et al.*, 2015) with 17.24 % in ripe plantain peels and 13.33 % in unripe plantain peels; where unripe plantain peels had a higher value than ripe plantain peels. From the table, air-dried unripe plantain peels, UAP (9.67 %) had the highest ash content, similar to (Oduje *et al.,* 2015) findings. The plantain peel with the least ash was recorded in RFP (7.00 %) similar to Shadrach *et al.* (2020) findings where the plantain peels with the least ash were recorded in ripe plantain peels (10.35 %). The percentage ash in unripe plantain peel decreased to ripe plantain peel over the same processing method: UAP (9.67 %)>RAP (9.00); USP (9.00 %)>RSP (7.33); UFP (8.17 %)>RFP (7.00 %). Sun-drying reduces the inorganic content of the unripe plantain peels (UAP 9.7 %, USP 9.83 %, and UFP 8.83 %) which is similar in ripe plantain peels RAP (9.67 %), RSP (8.73 %), and RFP (7.83 %) as revealed in Table 2. The plantain peel treatment with the peak quantity of minerals is UAP (9.7 %). Oduje *et al.* (2015) observed that minerals are higher in air-dried, unripe plantain peels.

The result for ether extracts obtained from plantain peels in this study exhibited that there is a significant ($p<0.05$) difference between the treatments. RAP (10.33 %) showed the highest ether extract percent, while UAP (6.83 %) showed the least ether extract composition similar to Shadrach *et al.* (2020) who recorded 11.33 % in air-dried plantain peels. The ether extract composition increased significantly with an increase in ripeness as the value of RAP (10.33 %) is higher than the UAP value (9.33 %), RSP (8.50 %) than USP (8.50 %), and RFP (11.83 %) compared to UFP (10.5 %). Also, the EE values of the plantain peels decreased with the processing method: the highest was ripe plantain peels, (RP), then in unripe plantain peels (UP).

According to Shadrach *et al.* (2020), the crude fibre in air-dried ripe plantain peels is less than in air-dried unripe plantain peels (RAP-8.78 UAP-12.58). Similarly, from Table 2, UAP (8.86 %) showed the highest crude fibre compared to RAP (4.00 %), the least fibre-containing plantain peel.

UAP and RSP showed significantly high levels of crude fibre while RAP, RFP, USP, and UFP showed no significantly high level of crude. Although crude fibre is quickly digested by monogastric animals, the appropriate functioning of the intestinal tract of ruminant animals is dependent on the presence of sufficient fibre (Egbuna and Ifemeje, 2015; Oduje *et al.*, 2015). RSP (9.62 %) shows the highest level of CP as recorded in Table 2 while USP (6.76 %) showed the least crude protein. Generally, crude protein was higher in air-dried, sun-dried, and fermented sun-dried ripe plantain peels samples than in air-dried, sun-dried and fermented sun-dried unripe plantain peels. These levels of CP in ripe and unripe plantain peels agree with Oduje *et al.* (2015), with air-dried unripe plantain peels having 7.89 % and air-dried ripe plantain peels 5.72 %. The UFP (63.39 %) showed the highest nitrogen-free extract to UAP (57.56). NFE represents the soluble carbohydrate level in the peels UFP (63.39) was significantly ($p<0.05$) higher than both the RAP and RSP, (58.01 and 59.02, respectively). The difference in CP with Shadrach *et al.* (2020) (UAP-6.13) may be a result of environmental factors on the plantain peels as well as the differences in processing methods used for this study. This could also indicate an upsurge in the amount of carbohydrates in the pulp. It's also probable that a drop in protein in the plantain peels lead to an increase in carbohydrate.

Plant food, leaves, and other portions of plants contain natural bioactive compounds called phytochemicals. These compounds work in conjunction with nutrients and dietary fibre to protect other substances. (Egbuna and Ifemeje, 2015). Phytochemicals are unpalatable plant compounds with defense or disease-preventing capabilities. (Shadrach *et al.,* 2020). The plantain peels' phytochemical content raises the possibility of using them as nutritious animal feed (Egbuna and Ifemeje, 2015; Veer, 2021). The concentration of alkaloid content decreased from RP to UP. The occurrence of alkaloid in RP is in the order RSP>RFP>RAP (values in that order) while in UP is in the order UAP>UFP<USP (values in that order). In air-dried ripe plantain and unripe plantain, RAP had a lesser value of alkaloid, this may infer that ripeness is inversely proportional to alkaloid content in plantain peels. The same trend was also observed in RFP (0.800) and UFP (0.855) respectively. However, the USP (0.773) was higher than the RSP (0.8325). Alkaloids are naturally occurring toxic amines produced by plants as a defense mechanism for protection (Taylor and Hefle, 2017). The result of the analysis showed that air drying is best for processing ripe plantain peels and sun-drying for unripe plantain peels.

Flavonoid content in UFP and USP is lower than in RFP and RSP respectively. This may be because the age of the plant part is directly proportional to its phytochemical content. Conversely, USP (0.6123) is higher than RAP (0.3307). The result of the flavonoid screening shows that RSP and UFP are the best-processed peels among ripe and unripe plantain peels for use in animal feed. Flavonoids are non-nutritive plant chemicals with disease-preventive properties, hence their presence in RSP and UFP suggests possible applications as animal feed (Egbuna *et al.,* 2019). According to Khan *et al.* (2018), saponins are phytochemicals that show anti-biotic properties in plantain peels. From the result obtained in this study, the inclusion of UFP (0.7040), being the least containing saponin UP, in feed ingredient is suitable (Dong *et al.,* 2020)

The presence of phenolic chemicals, including monomeric flavan-3-loss, polymerized prodelphinidins, glycosides, and B-type procyanidin dimers, as described by Rebello *et al*. (2014) in RP is in the order RSP>RFP>RAP while in UP is in the order UAP>UFP<USP. In air-dried ripe plantain and unripe plantain, RAP (0.2267) and UAP (0.2040) have lesser values of phenols. This may infer that ripeness is inversely proportional to total phenolic content in plantain peels. The same was also observed in RFP (0.800) and UFP (0.855) respectively. However, the USP (0.773) was lower than the RSP (0.8325). From the results obtained in this analysis, RFP (0.193) has the least phenolic value among all the samples, hence best for processed plantain peels when considering phenolic content.

Table 5 shows findings for bulk density, specific gravity, swelling power, and water absorption capacity of plantain peel samples**.** This implies that the processing method of both ripe and unripe plantain peels influences its bulkiness; which is a key factor for feed selection in animal nutrition. The bulk density values of the ripe and unripe plantain peels reduced from air-dried to sundried, and fermented with the sun-dried sample, they were in the range of 0.34 -0.53 g/cm3. In unripe plantain peels, bulk density increased from UFP (0.3467) to USP (0.3867) to UAP (0.513). The same trend occurred in ripe plantain peels where bulk density increased from RFP (0.3733) to RSP (0.4167) to RAP (0.4167). However, unripe plantain peel samples (UFP-0.3467; USP-0.3867) have lower bulk density than ripe plantain peel samples (RFP-0.3733 USP-0.4167) in ripe plantain except in air-dried process. Bulk density makes known the relational volume of packaging material required. (Ojinnaka *et al.,* 2017). Therefore, UFP has the lowest volume required for storage, processing, or transport.

A higher WAC is relevant in certifying that feed ingredients hold good texture which influences palatability (Oluba *et al.,* 2021). The water absorption capacity (WAC) of the plantain peels decreased using increasing processing methods as shown in Table 4. Unripe plantain peels subjected to air drying retained the highest water absorption capacity of 0.507 while unripe plantain peels subjected to fermentation and sun drying had the least water absorption capacity of 0.37.

CONCLUSION

The study showed that nutrients that are essential for animal feed could be potentially derived from sun-dried, fermented, and air-dried unripe and ripe plantain peels. Despite the processing approach, all peel samples exhibited possibilities as animal feed. It is recommended that plantain peels be studied for further processing methods to enhance their use as a feed ingredient. Further studies should be carried out on the medicinal qualities of processed plantain peels to know their application in animal health. Processed plantain peels functional properties make it a good additive in animal feed formulation. Therefore, it is recommended that feeding trials should be carried out to evaluate its potential as an alternative animal feed ingredient source.

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