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Nutritional and Phytochemical Potentials of Banana (*Musa sapientum* L.) and Plantain (*Musa paradisiaca L.)* Peels Generated from Elebele, Bayelsa State

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ABSTRACT

This research was conducted to evaluate the phytochemical, mineral, and proximate compositions of ground powder obtained from peels of banana and plantain waste, produced in Elebele in Ogbia, Bayelsa State. Banana and plantain peels were collected from a waste bin in Elebele. Dried ground plant materials from the peels were used to determine the nutritional and phytochemical constituents. Triplicate results were used to determine the mean and standard error from the data obtained from the analysis. Values obtained showed that banana peels (BP) and plantain peels (PP) contain significantly higher levels of potassium (1420.92 mg/100 g - BP and 730 mg/100g- PP), moderate calcium (46.07 mg/100 g- BP and 40.33 mg/100g- PP), and magnesium (23.20 BP/16.61 mg/100 g PP). However, lower values were recorded for sodium, copper, manganese, and zinc. Proximate values showed a high content of carbohydrates (63.34mg/100 g _ BP and 54.01 mg/100g PP). A moderate level of moisture content (16.10 mg/100 g _ BP, 14.46 mg/100g_ PP) was observed, while crude ash, protein, fiber, and fat content were relatively low. Results for phytochemical analysis revealed a high content of oxalates (26.43 mg/100g _BP and 20.56 mg/100 g- PP), while there was the presence of saponins, tannins, phytates, flavonoids, and alkaloids. The results in this study revealed that peels from banana and plantain are a good source of minerals, nutrients, and secondary metabolites which can be converted to useful products in medicine, animal feeds, and functional food products for human nutrition.

Keywords: Banana peels, Plantain peels, Phytochemical, Waste, Mineral composition, Proximate analysis.

INTRODUCTION

The problem of waste management and spoilage of produced food resources has resulted in uncertainty of food security in the World. Maintaining a sustainable environment for future generations with green technology is imperative, mostly due to modernization, industrialization, and the fast-growing population. Converting Waste materials through resource recovery into organic fertilizer has been a long-standing practice in Somalia (Sahoo & Lenka, 2024). Farm application is a conventional waste management practice to eliminate the cost of disposal and generate economic value from the use of the waste materials (Sim & Wu, 2010). Waste from Banana and plantain peels is biodegradable. Banana peels, which constitute one-third of the total fruit weight are disposed due to a dearth of knowledge about their usage. Their waste contributes to current environmental issues. Literature revealed that Banana peels contain approximately 50% nutrients and natural bioactive compounds like polyphenols, carotenoids, and dietary fiber which are therapeutic and help in preventing cardiovascular diseases and cancer (Ahmed *et al*., 2021).

Banana peels have been utilized in the food industry, including bakery, culinary and meat products due to their nutritional constituents. (Zou *et al.,* 2022). Plantain and banana peels are excellent sources of macro and micro elements that needs to be recycled naturally to mitigate environmental waste thus creating a balance between economic development and environmental protection (Menon *et al*., 2012). Current sustainable approaches, like green synthesis can utilization peels from banana and plantain peels into functional products (Eddy & Udoh, 2006). Production of plantain play a significant role in income generation for large-scale and small farm holders in Nigeria (FAO, 2001). African indigenous trees have been used in the past decades for culinary, nutritional

and therapeutic purposes. They are prospect for income generation if their potentials are maximized (Stadlmayr *et al*., 2013; Otori & Mann 2014; Hyacinthe *et al.,* 2015). Latest research also reveals that Banana and plantain peel are a rich source of potassium and thus can be use in the production of potash (Eddy & Ebenso, 2008; Eddy *et al*., 2008; Taiwo *et al.,* 2008; Babavemi *et al.,* 2011; Hassan *et al*., 2018). Despite the current trend, there is limited scientific evidence to validate the nutritional and therapeutic component of many native trees and waste produce which has led to inadequate documentation in their role in sustainable development strategies for poverty alleviation (Schreckenberg *et al.,* 2006; Ngome *et al.,* 2017). As a result, the economic value of most organic waste products is underestimated and underutilized. It is necessary to evaluate the nutritional constituents of agricultural waste to determine their usefulness and convert waste into sustainable products. Research evidence will provide necessary information to facilitate the selection of organic waste products for economic growth and foster environmental protection. Soil Fertilization with plantain and banana waste residue serves as a cheap source of manure, thereby reducing the use of chemical fertilizers (Hussain, 2000; Akhigbe *et al*., 2024).

Epidemiological studies have revealed that bioactive phytochemicals play a significant role in preventing and managing several diseases like cancer, diabetes, Alzheimer's disease and other cardiovascular diseases. Nutrition science has advanced from conventional concepts of avoiding nutritional deficiencies to a contemporary concept of "positive nutrition". Food products known as functional foods are being produced to incorporate such beneficial components for the desired health benefits. Hence, new research is geared towards the identification of bioactive compounds in food materials that have the potential benefit in medicinal, physiological, and psychological wellbeing for nourishing individuals at all levels (Kumar & Krishnan, 2017). The conversion of Banana and plantain waste to useful products has made it vital for more research to provide information on their nutritional and phytochemical constituent to determine their actual nutritional benefit, health, and other medicinal importance. Hence, the aim of this study is to evaluate the Nutritional and phytochemical components of banana and plantain peels generated from Elebele, Bayelsa State.

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MATERIALS AND METHODS

The following equipment/apparatus were used for this study: Atomic absorption spectrophotometer (AAS), Spectrophotometer, weighing balances, extraction bowls, measuring cylinders, volumetric flasks, pipette, orbital shaker, water bath, filter papers, and drying oven. The following reagents/chemicals were also used: Acetic acid, ammonium hydroxide, absolute ethanol, distilled water, Na_2CO_3 solution, Folin-Denis reagent, aqueous methanol, diethyl ether, aqueous sodium chloride, ether. n-butanol, H_2SO_4, sodium hypochlorite (hypo).

Study Area;
This study was carried out in Federal University Otuoke, Bayelsa State, which is located at coordinates of 4°42'23.418"N6°19'44.472"E.

Sample Collection and Identification: Banana and plantain peels were collected from domestic waste bins in Elebele, Ogbia Local Government Area of Bayelsa State. They were stored in an airtight container and taken to the Laboratory at Federal University, Otuoke for Identification.

Identification of Plant Materials; Plant samples were identified by a Taxonomic expert in the Department of Biology, Federal University Otuoke, Bayelsa State.

Sample preparation: The plant materials were washed and shadow-dried for two weeks.

Analysis of Mineral elements from peels of banana and plantain.
Collected plant materials were first shadow-dried separately for two weeks and macerated into small pieces. They were then oven-dried at 100^0C for 4 hours. They were crushed and ground to powder, then 2 grams each of the powders were weighed into Porcelain crucibles and placed in a muffle furnace, and the furnace was set at 450^0C to ash. The ashing was done for 6 hours. The resulting ash was acid-digested in 15ml of concentrated HNO_3 (Trioxonitric acid) on a hot plate. 20ml of distilled water was then added to the crucible to dilute the acid in the crucible. The mixture

was then filtered into a 100 mL volumetric flask and made up to the mark with distilled water. All the samples were then ready for AAS analysis. The AAS machine was then set-up and the various elements were analyzed at the specific wavelengths, lamps, currents, and gas mixtures.

Phytochemical analysis of Banana and plantain peels

Tannin content was determined by method of Pearson (1976) while the method of Bohn and Kocipal-Abyazan (1994) was adopted to evaluate the flavonoids content. The saponin constituent was determined by procedures of Obadoni and Onyeka (2001). Determination of alkaloid were obtained using the method described by Harbone (1973) and the composition of oxalates was obtained by titration method while the method of Wheeler and Ferrel *et.al.* (1971) was used to determine the phytates constituent.

Determination of Proximate analysis: Moisture, ash, crude protein, crude lipid, crude fiber contents were determined using the method of A.O.A.C. (2006).

Statistical Analysis

Data are presented as mean ± standard error (SE) from three replicates. Biostatistical analysis was performed using SPSS version 24. A one-way Analysis of Variance (ANOVA) was used to determine the varied nutritional and phytochemical potentials of banana and plantain peels obtained from Elebele, Bayelsa State. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The content of mineral elements in plantain and banana peels as presented in Table 1 showed high content of calcium, potassium and moderate values for magnesium. Banana peels contain relatively higher amount of the mineral elements when compared to peels from plantain.

Table 1: Mineral elements in Banana and plantain peels generated in Elebele, Bayelsa State

Mineral elements	Banana peels (mg/100g)	Plantain peels (mg/100g)
Magnesium	23.20±0.60	16.61±0.35
Calcium	46.07±0.47	40.33±0.59
Potassium	1420.92±0.61	730.03±0.78
Sodium	8.32±0.83	12.05±0.20
Copper	0.08±0.04	0.09±0.03
Zinc	0.59±0.02	0.47±0.07
Manganese	0.45±0.04	0.37±0.02
Iron	0.04±0.02	0.03±0.03

Mean ± standard error from 3 replicates

The result obtained for proximate constituent of Banana and plantain peels generated in Elebele as presented in Table 2 revealed high carbohydrates content while values obtained from analysis of moisture, fiber, crude protein, crude lipid and ash content were relatively low.

Table 2: Proximate composition in Banana and plantain peels generated in Elebele, Bayelsa State

Proximate parameters	Banana peels(mg/100g)	Plantain peels(mg/100g)
Moisture	16.10±0.68	14.46±0.32
Crude protein	0.45±0.36	0.42±0.25
Crude fiber	7.70±0.95	19.21±0.10
Crude fat	5.06±0.57	5.40±0.45
Crude ash	8.33±0.25	6.50±0.36
Carbohydrate	62.36±0.46	54.01±0.23

Mean ± standard error from 3 replicates

The composition of phytochemical contents from peels of Banana and plantain obtained from Elebele are presented in table 3 showing moderate levels of oxalates. Values for saponins, tannins, flavonoid, alkaloids and phytates were observed to be relatively low.

Table 3: Phytochemical contents in Banana and plantain peels generated in Elebele, Bayelsa State

Phytochemicals analyzed	Banana peels(mg/100g)	Plantain peels(mg/100g)
Saponins	4.90±0.37	1.38±0.50
Tannins	2.72±0.29	3.03±0.45
Alkaloids	0.80±0.27	0.69±0.57
Phytates	2.71±0.14	2.06±0.25
Oxalates	26.43±0.35	20.56±0.18
Flavonoids	0.12±0.02	0.15±0.03

Mean ± standard error from 3 replicates

DISCUSSION

The values obtained for mineral element constituent in ground peels of banana and plantain are presented in Table 1. The progressive high content of potassium, calcium and magnesium suggest their excellent nutritional value; hence can be incorporated into foods (Sahoo & Lenka, 2024). Potassium is a cellular cation that maintains intracellular osmotic pressure and also a vital element that facilitates body hemostasis which is vital for co-regulating ATP (Anhwange *et al.,* 2004).The high potassium values obtain in this study of 1420mg/100g for banana peels and 730mg/100g for plantain peels is in agreement with the report of Filiz (2015) and the work of Kumar *et al*. (2019) who reported high values of 1492.54 mg/kg and 618.4 mg/100g in Banana peel powder. Similarly, Jumare *et al*. (2022) also reported a high value of PP with a value of 2633.33 mg/kg. Calcium is a structural element for dental health and strong bones. It aids nerves transmission of impulse and facilitates muscle contraction (Alais & Linden, 1991). The relative calcium content of 46.00 mg/100 g for BP and 40 mg/100 g for PP is in conformity with the research of Ali (2022) who reported a moderate value of 80 mg/100g for BP and disagrees with the work of Jumare *et al.* (2022) who reported a low value 0.28 mg/kg. This variation may be due to difference in soils and fertilizers used in cultivation of plantain. The findings of a moderate content of magnesium in BP of 23.20mg/100 g and PP of 16.61mg/100 g does not correspond with the low values 0.47 mg/100 g _ BP and 0.58 mg/100 g for PP as reported by Jumare *et al.* (2022).

Lower levels of copper, sodium, zinc, manganese and iron were observed in this experiment, the sodium level of 24.30 mg/100 g by earlier report of Anhwange *et al.* (2009) in BP contradicts the value of 8.2 mg/100g obtained in this study. Iron is an essential component in the body which Facilitates hemoglobin synthesis (Alais & Linden, 1991). Pasha (2022) reported zero content of copper, manganese while the low values observed by Ali (2022) of 0.6mg/100mg copper and 5.29 manganese in BP is in conformity with the results obtained in this study. Similar reports in the review of Jumare *et al.* (2022) also recorded low value of 0.58mg/kg in BP. The low zinc content of 0.59 mg/100 g in BP and 0.47 mg/100g in PP contradicts the high quantity of 37.11mg/100g in the research of Ali (2022). The low level of manganese of0.45 mg/100 g _ BP and 0.37 mg/100 g _ PP is further consolidated by the low values of 5. 29 mg/100 g reported by Ali (2022).

The nutritional quality of banana peels may depend on the cultivar and stage of development. The starch content in Plantain peels is about 40% which transform to sugars when it is ripe while banana peels can contain about 30% when ripe (Jumare *et al*. 2022). Proximate values reveal a high carbohydrate content of 62.36 mg/100 g _BP and 54.01 mg/100 g for PP. The result of Khatun *et al.* (2021) with a carbohydrate value of 54.01 mg/100 g in BP further validates the findings in this report. The moisture content of 16.10mg/100 mg in BP and 14.46 mg/100 g in PP agrees with the finding of Filiz (2015) who recorded a moisture content of 11.6mg/100g.The result for crude proteins observed in this study of 0.45 mg/100 g BP and 0.42 mg/100 gin PP disagree with the evidence of Safi (2022) who recorded protein value of zero for BP while Essien *et al.* (2005) recorded 7.8 mg/ 100 g. Crude fiber measures the cellulose and lignin components in plant material (Zakpaa *et al,* 2009). The crude fiber content of 7.70 mg/100g in BP and 19.21 mg/100g in PP is comparable with 18.47% reported in the bract of plantain by Adeolu and Enesi (2013). The crude fat content of 5.06mg/100g _BP and 5.40mg/100g _ PP were relatively low and comparable with the values obtained from report of Hassan *et al*. (2018) who recorded 5.95 mg/100 g for BP. Fats contribute to food flavors and contain essential fatty acids for metabolic processes (Mann & Skeaff, 2002).

Banana and plantain peels extracts can be incorporated into animal feeds for enhance energy due to their fat content (Okareh *et al.,* 2015). The crude protein content of 0.45 mg/100 g_ BP and 0.42 mg/100 g _PP observed in this study does not correspond with the findings of Essien *et al.* (2005) who recorded higher value of crude protein contents of 7.8 mg/100 gin BP. Phytochemical fingerprints of different plants species revealed vital chemical compounds, especially secondary metabolites which have application in medicine for treating diseases and promoting health in natural ways. Many phytochemicals are yet to be discovered while new sources of secondary metabolites are being discovered and developed (Kumar and Krishnan, 2017). The presence of flavonoids, tannins, saponins, phytates, oxalates and alkaloids are validated by the qualitative results of Onoja and Emurotu (2017) who recorded their presence in both ripe and unripe peels of banana and plantain grown in Anyigba in Kogi State. Kibria *et al.* (2019) also reported the presence of alkaloids, saponins, tannins, glycosides and flavonoids in plantain and banana peels.

CONCLUSION AND RECOMMENDATIONS

The data generated in this study reveals that Banana and plantain peels contain essential nutrients and phytochemical components that can be explored and applied in medicine and as food additives due to presence of important secondary metabolites. Waste generated from popular plantain sellers in Bayelsa State and environs normally referred to 'bole' can be converted to functional products like animal feeds to create a balance between economic development and poverty eradication for a healthy and sustainable environment. More scientific research is required on the quantitative component of vital secondary metabolites in banana and plantain peels and how they can be extracted to functional healthy products which can be mainstreamed into animal and human food for sufficient nutritional value.

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