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Nutrient and Heavy Metal Composition of Plantain (*Musa paradisiaca*) and Banana (*Musa paradisiaca*) Peels

Okorie DO[1]*, Eleazu CO[2] and Nwosu P[2]

[1]*Michael Okpara University of Agriculture, Umudike, Nigeria*
[2]*National Root Crops Research Institute, Umudike, Nigeria*

Abstract

The total protein, calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), phosphorous (P), zinc (Zn), copper (Cu) and lead (Pb) composition of the peels of unripe plantain, ripe plantain, unripe banana and ripe banana were investigated using standard techniques. All the peel samples studied contained considerable amounts of Ca, Mg, K, Na, P, Zn, Cu, and protein while the amount of Pb in all the peel samples were quite low to cause any deleterious effects. The study showed the nutritional relevance of the peels of these plants.

Keywords: Minerals; Nutrients; Peels; Wastes

Introduction

A major problem experienced by agro-based industries in developing countries is the management of wastes. Agro wastes or plant biomasses in Nigeria are mostly subjected to open air burning with its attendant environmental implications [1]. Inefficient and improper disposal of solid wastes creates serious hazards to public health, including pollution of air and water resources and increases in rodent and insect vectors of disease, creates public nuisances as well as interfere with community life and development [2]. The failure or inability to salvage and re-use such materials economically results in unnecessary waste and depletion of natural resources [2]. To date, emphasis is on biological conversion of plant wastes, especially agricultural wastes into value added products.

In Nigeria and many other parts of Africa, plantain (*Musa paradisiaca*) serves as a major staple food [3]. Plantains can be consumed in the unripe, fairly ripe, ripe and overripe stages.

Banana is one of the most popular fruits in the world. A member of the genus *Musa* (part of the family *Musaceae*), it is considered to be derived from the wild species *Musa acuminata* and *Musa balbisiana* [4]. Bananas are rich sources of carbohydrates and potassium while they are low in protein [5].

The major wastes of plantain and banana processing in Nigeria are their peels (generated as a result of mechanical removal of the two outer coverings of plantain and banana pulps subsequent to their processing). The peels account for 40% of the total weight of fresh bananas or plantains and these peels are currently either used as fertilizer or discarded in many countries [6].

Various parts of plantain and banana have been studied for various uses: alcohol production from ripe fruit, medicinal use for treatment of gastric ulcer, and the pseudo-stem as a source of fibre. There is a large consumption rate of these crops in Nigeria, either as 'dodo' (fried ripe fruit), 'dodo Ikire' (from over-ripped fruit), chips (fried unripe fruit), or processed to produce plantain flour and local beer [1]. In all these stated uses, there is little or no account of reuse or recycling of the waste peels, except for some insignificant use as animal feed [1].

In a bid to encourage the bioconversion of the peels of these crops into useful products, this study was set up to investigate the mineral and heavy metal composition of the peels of unripe plantain, ripe plantain, unripe banana and ripe banana.

Materials and Methods

The plantain and banana samples (unripe and ripe) used for this study were bought from Umuahia main market, Abia State, Nigeria in 2014. The samples were washed, peeled and cut into pieces (1 cm^2).

Sample treatments

Some quantities (about 500 g) of each portion were collected and grouped as follows:

Group 1: Unripe plantain peels (UPP) (Control)

Group 2: Ripe plantain peels (RPP)

Group 3: Unripe banana peels (UBP)

Group 4: Ripe banana peels (RBP)

All samples were then oven dried at 50°C to constant weight, milled to flour and analyzed

Mineral and protein assay

An Atomic Absorption Spectrophotometer (Analyst 200, Perkin Elmer, Waltham, MA, USA) was used to analyze the calcium, magnesium, zinc, copper, lead and iron contents of the flours, the molybdate method Onwuka, [7] was used in the analysis of phosphorous while the sodium and potassium contents of the flours were determined using a flame photometer. The protein contents of the flour samples were determined using the method of the Association of Analytical Chemists [8].

Statistical analysis

The statistical package for social sciences (SPSS), version 17.0 (SPSS Inc., Chicago, IL, USA) was used to analyze all data. Results are presented as means ± standard deviation.

***Corresponding author:** Okorie DO, Michael Okpara University of Agriculture, Umudike, Nigeria, Tel: +2348034164686; E-mail: eleazon@yahoo.com

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Results

The calcium contents of ripe plantain peel, unripe plantain peel and ripe banana peel did not differ significantly from each other (P>0.05) while they were significantly lower than the calcium contents of unripe banana peel (Table 1).

The magnesium contents of ripe banana peel and unripe banana peel were not significantly different from each other (P>0.05) while they were significantly higher (P<0.05) than that of ripe plantain and unripe plantain peels (Table 1).

There were no significant differences (P>0.05) in the potassium, sodium and phosphorous contents of ripe plantain peel, unripe plantain peel, ripe banana peel and unripe banana peel (Table 1).

Unripe plantain peel contained significantly (P<0.05) higher amounts among of zinc compared with other peel samples investigated while unripe banana peel had the least although it did not differ significantly (P>0.05) from that of ripe plantain peel (Table 2).

There were no significant differences (P>0.05) in the amounts of copper in the peels of ripe plantain, unripe plantain, ripe banana and unripe banana (Table 2).

There were no significant differences (P>0.05) in the lead contents of ripe plantain peel, ripe banana peel and unripe banana peel while the lead contents of ripe banana peel was significantly higher (P<0.05) than that of unripe plantain peel (Table 2).

In terms of iron, unripe plantain peel contained significantly (P<0.05) higher levels than other peel samples investigated while ripe plantain peel and ripe banana peel had the least (P<0.05) (Table 2).

The percentage crude protein contents of the peel samples investigated ranged from 2.5 to 7.8 with unripe banana peel having significantly (P<0.05) higher protein contents compared with other peel samples while the peels of unripe plantain and ripe banana which did not differ significantly from each other (P<0.05) were significantly lower (P<0.05) than other peel samples studied (Figure 1).

Discussion

Calcium is an important component of intracellular processes that occur within insulin responsive tissues like skeletal muscle and adipose tissue. Alteration in calcium flux can have adverse effects on insulin secretion which is a calcium-dependent process [9]. Thus the considerable amounts of calcium in the peel of unripe banana as observed in this study, suggest the importance of these peels to diabetics. Furthermore, the study also showed that there is significant loss of calcium with ripening of banana.

Magnesium is a cofactor of hexokinase and pyruvate kinase and it also modulates glucose transport across cell membranes [9].The study showed that unripe and ripe banana peels contain significantly higher amounts of Mg than unripe and ripe plantain peels.

Groups	Ca	Mg	K	Na	P
RPP	6.81 ± 1.15^{a}	0.84 ± 0.23^{a}	10.60 ± 0.85^{a}	6.09 ± 1.29^{a}	0.59 ± 0.01^{a}
UPP	7.62 ± 0.17^{a}	1.22 ± 0.45^{a}	9.32 ± 0.59^{a}	6.07 ± 0.10^{a}	0.60 ± 0.14^{a}
RBP	6.01 ± 0.27^{a}	2.31 ± 0.44^{b}	9.83 ± 1.17^{a}	6.09 ± 0.13^{a}	0.49 ± 0.01^{a}
UBP	11.02 ± 1.44^{b}	3.04 ± 0.06^{b}	9.89 ± 1.17^{a}	6.18 ± 0.03^{a}	0.61 ± 0.01^{a}

Values are means ± SD. $^{a\text{-}b}$Means with the same superscript along each column are not significantly different (P>0.05).

Table 1: Mineral composition of the peels of banana and plantain (mg/100 g).

Groups	Zn	Cu	Pb	Fe
RPP	1.49 ± 0.13^{ab}	0.95 ± 0.35^{a}	0.05 ± 0.03^{ab}	22.48 ± 0.68^{a}
UPP	2.60 ± 0.28^{c}	0.86 ± 0.06^{a}	0.11 ± 0.01^{b}	346.10 ± 22.77^{c}
RBP	1.86 ± 0.23^{b}	0.85 ± 0.07^{a}	0.40 ± 0.01^{a}	20.40 ± 0.57^{a}
UBP	0.95 ± 0.07^{a}	0.49 ± 0.01^{a}	0.07 ± 0.03^{ab}	215.75 ± 8.13^{b}

Values are means ± SD. $^{a\text{-}c}$Means with the same superscript along each column are not significantly different (P>0.05).

Table 2: Mineral composition of the peels of banana and plantain (mg/100 g).

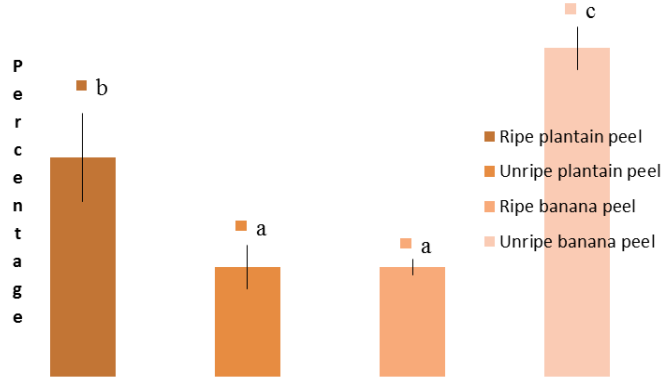

Figure 1: Percentage protein contents of plantain and banana peels. Values are the means ± SD of two determinations. $^{a\text{-}c}$Means with different superscripts for each peel differ significantly in protein contents

The higher amounts of K than Na in the peel samples investigated are considered of comparative advantage. This is because intake of diets with higher Na to K ratio has been related to the incidence of hypertension [10].

Phosphorus is involved in several biological processes such as: bone mineralization, energy production, cell signaling and regulation of acid-base homeostasis. The study indicates insignificant increase of this mineral as unripe banana or plantain ripens.

Zinc plays a key role in the regulation of insulin production by pancreatic tissues and glucose utilization by muscles and fat cells [11]. Findings from this study indicate that unripe plantain peel contains higher quantities of Zn than ripe plantain peel, unripe and ripe banana peels respectively.

Copper is found in all living organisms and is a crucial trace element in redox chemistry, growth and development. Copper is being explored as a treatment for a number of conditions, including degenerative neurological disorders like Alzheimer's disease, Parkinson's disease [12].

The main threats to human health from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic [13]. Lead is toxic to the heart, bones, intestines, kidneys, reproductive and nervous systems. It interferes with the development of the nervous system and is therefore particularly toxic to children, causing potentially permanent learning and behavior disorders [13]. However, the range of Pb in all the peel samples investigated may be considered too low to give any cause for concern.

The considerable amount of Fe in unripe plantain peel is an important finding in this study. Iron is an essential component of hemoglobin and it is critical to the proper function of the immune system and the production of energy [10].The study further revealed

that the considerable amount of proteins especially in the unripe banana peels underscores its nutritional relevance.

Conclusion

The study underscores the nutritional relevance of the peels of plantain and banana. More studies are recommended in this direction that will help in the conversion of the peels of these plants into more useful products.

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