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Original Research

Varietal variations in the nutritional and anti-nutritional compositions of unripe *Musa paradisiaca l.* Peels and leaves

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ABSTRACT

This research was conducted to evaluate varietal variations in the nutritional and anti-nutritional composition of *Musa paradisiaca* (plantain) peels and leaves from Onne, Eleme, Rivers State, Nigeria. Peels and leaves of six different varieties of plantain (Cantebalon peel, Cantebalon leaves, PITA 26 peels, PITA 26 leaves, PITA 23 leaves, and PITA 23 peels) were used for the study. Samples of the peels and leaves of these varieties were collected from the Institute of Tropical Agriculture (IITA), Onne, Rivers State, Nigeria. They were dried and milled. These were analysed for proximate composition, fibre fraction, mineral composition, and anti-nutritional factors, using standard procedures. Results showed significant ($P<0.05$) differences in proximate composition, fibre fraction, mineral composition, and anti-nutritional factors. Thus, PITA 26 leaves showed the highest significant value for crude protein (21.33%), nitrogen free extract, NFE (41.20%), crude fibre (17.13%), acid detergent lignin, ADL (11.36%), neutral detergent fibre, NDF (48.89%), Ca (0.27), Mg (0.28), Zn (4.08), Cu (20.95), Mn (24.51), and Fe (145.50). Consequently, because of its high nutritive value, PITA 26 leaves could be utilized in addressing scarcity of feed ingredients, and nutrient deficiencies in ruminants.

Keywords: Livestock feed, PITA 26, plantain peels, plantain leaves, proximate composition.

INTRODUCTION

Plantain (*Musa paradisiaca L.*) is a tropical plant that constitutes a stable food crop in Central and West Africa. Over 2.11 million metric tons of plantains are produced in Nigeria annually which contributes sustainably to the nutrition of subtropical local populations (FAO, 2003). In Nigeria and other parts of Africa and in many other places in the world, plantain (*Musa paradisiaca*) serves as a major staple food and is particularly desired for the variability in the stages of ripeness and in cooking methods (Oladele & Khokhar, 2011). The peels are known to constitute a menace to the society thereby adding to the problem of environmental pollution particularly in places where ruminants (sheep and goat) are not allowed to roam about (Omole *et al.*, 2008). Plantain leaves (ashes) are used in eczema (Okoli *et al*., 2007) and as cool dressings for blister and burns (Ghani, 2013). Aqueous extract of unripe fruit peels and leaves of *M. paradisiaca* var. has been reported to show antimicrobial activity against *Staphylococcus* and *Pseudomonas* species in dehydrogenase assay (Alisi *et al*., 2008).

Peels are the major by-products obtained during the processing of various fruits and these were shown to be a very good source of polyphenols, carotenoids, dietary fibres, and other bioactive compounds which possess various beneficial effects on human health (Wolfe, *et al.*, 2003). Ajasin *et al.* (2004) observed that plantain peels have some nutritional values because they contain about 12% crude protein, 16% crude fibre, and 1300kcal/kg energy on dry matter basis. Anti-Nutritional factors (ANFS) may be defined as those substances generated in natural food stuffs by the normal metabolism of species and by different mechanisms (e.g. inactivation of some nutrients, diminution of the digestive process, or metabolic utilization of feed) which exert anti-nutritional effects (Kumar, 1992). These anti-nutrients can be acquired from fertilizer and pesticides and several naturally occurring chemicals (Igile, 1996). Some of these naturally occurring chemicals are known as "secondary metabolites" and they have been shown to be

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highly biologically active (Zenk, 1991). They are phytochemicals which includes saponins, tannins, flavonoids, alkaloids, trypsin (protease) inhibitors, oxalates, phytates, haemagluttinins (lectins), cyanogenic glycosides, cardiac glycosides, coumarins and gossypol. Most of these secondary metabolites elicit very harmful biological responses, while some are widely applied in nutrition and used as pharmacologically-active agents (Soetan, 2008). The study was therefore designed to determine the nutrients compositions and anti-nutritional factors of different varieties of plantain peels and leaves for possible utilization as livestock feeds.

MATERIALS AND METHODS

LOCATION OF STUDY

The research was carried out in the University of Port Harcourt Research and Demonstration farm, Department of Animal Science, Faculty of Agriculture, Port Harcourt, Rivers State, Nigeria. The study location is situated at latitude 4^{o}N and longitude 7^{o}E with a temperature range of 31.29^{o}C. The monthly rainfall of 650mm in Rivers state follows a sequence of increase from March to October before decreasing in the dry season months of November to February (Lamidi & Ogunkunle, 2016).

COLLECTION OF SAMPLES

Samples of peels and leaves of Cantebalon, PITA 23 and PITA 26 were collected from the Institute of Tropical Agriculture (IITA) Onne, Rivers state, Nigeria. This farm was visited for the collection of three (3) different varieties of unripe plantain and their leaves. The plant was given names according to the IITA standard (Cantebalon, PITA 26 and PITA 23). Unripe mature plantain bunches were harvested with machete, separated into the various parts. The plantain fingers were rinsed with distilled water in order to clean out sand and other attached debris before peeling.

PROCESSING OF THE PEELS AND LEAVES

The unripe peels and leaves were chopped into small sizes, wrapped with a foil and then oven dried for a week at 40ºC. The sample was recorded as sun dried weight and thereafter pulverized using a blender. The well ground sample was kept in a sterile cellophane sheet and preserved at 4^{o} until required for analysis.

ANALYTICAL PROCEDURE

Powdered sample of unripe plantain peels and leaves were subjected to proximate analysis as outlined by the AOAC, (2006).

The minerals; sodium, potassium, calcium, zinc and phosphorus were analysed using Atomic Absorption Spectrophotometer (AAS) adopting the method of Al-Harrasi *et al*., (2012).

Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) of the milled plantain peels and leaves sample were determined following the procedure of Van Soest *et al*. (1991). Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was also calculated as the difference between NDF and ADF.

The sample was subjected to a quantitative and qualitative analysis for the purpose of detecting the anti-nutrient factors following standard protocols (Harborne, 1973; Trease & Evans 1989, Sofowora, 1993).

STATISTICAL ANALYSIS

Data obtained were subjected to analysis of variance (ANOVA) and significant differences observed were analysed using Duncan's multiple range test (Duncan, 1955).

RESULTS

PROXIMATE COMPOSITION OF PITA 23, CANTEBALON, AND PITA 26 PEELS AND LEAVES

The proximate composition of PITA 23, Cantebalon, and PITA 26 peels and leaves is presented in Table I. There were significant ($P<0.05$) differences for crude protein, crude fat, crude fibre, ash, and nitrogen free extract, while dry matter showed no significant ($P>0.05$) difference among the various varieties of plantain peel and leaves under study.

Thus, varieties of PITA 26 leaves of plantain showed superior values for crude protein (21.33%), ether extract (5.14%), crude fibre (17.13%), and nitrogen free extract (41.25%) when compared to other varieties under study. Also, values for ash (19.24%) were statistically highest in Cantebalon leaves of plantain with respect to others.

MINERAL CONSTITUENTS OF PITA 23, CANTEBALON, AND PITA 26 PEELS AND LEAVES

Results from the study showed significant ($P<0.05$) differences in means of Na, K, Ca, Mg, Zn, Mn and Fe, for PITA 23, Cantebalon and PITA 26 peels and leaves. Thus, varieties of PITA 26 leaves of plantain showed superior values for Na (0.27), K (0.81), Ca (0.27), P (0.42), Zn (0.48), Mn (24.57), and Fe (145.50) when compared to other varieties of plantain peels and leaves under study. However, Mg recorded similar values between the varieties of PITA 26 peels (0.28) and PITA 26 leaves of plantain that are significantly highest with respect to others.

FIBRE FRACTION OF PITA 23, CANTEBALON, AND PITA 26 PEEL AND LEAVES

The results on fibre fraction of PITA 23, Cantebalon, and PITA 26 peels and leaves is shown in Table III. There were significant ($P<0.05$) differences in NDF, ADL, ADL, hemicellulose, and cellulose among the different varieties under study. However, values for NDF (48.89%), ADF (29.94%), and ADL (11.39%) were statistically highest in

Pita 26 leaves. Thus, the varieties of Cantebalon leaves recorded the highest values of hemicellulose (21.33%) and least value of cellulose (15.22%) with regards to other groups.

ANTI-NUTRITIONAL CONSTITUENTS OF PITA 23, CANTEBALON, AND PITA 26 PEEL AND LEAVES

Table 4 shows anti-nutritional constituents of PITA 23, Cantebalon, and PITA 26 peel and leaves. Result from the study showed there were significant (P<0.05) differences in phytates, oxalates and saponins, while tannins didn't differ significantly among the various varieties of plantain peel and leaves. However, values for phytates (0.37%) were statistically highest in PITA 26 leaves, while oxalates (0.24%) and saponins (0.54%) were higher in Cantebalon plantain leaves.

Table 1: Proximate composition of PITA 23, Cantebalon, and PITA 26 peels and leaves

Parameters (%)	PITA 23 leaves	PITA 23 Peels	Cante leaves	Cante peels	PITA 26 leaves	PITA 26 Peels	SEM
Dry matter	87.01	62.91	83.85	50.60	93.84	60.86	0.01
CP	19.63^{b}	13.72^{e}	18.82^{c}	11.62^{f}	21.33^{a}	15.83^{d}	0.05
Ether extract	4.90^{b}	2.90^{f}	4.27^{c}	3.00^{ef}	5.14^{a}	3.07^{d}	0.03
Crude fibre	16.02^{c}	17.04^{b}	15.35^{d}	13.49^{f}	17.13^{a}	13.83^{e}	0.02
Ash	8.70^{c}	4.22^{d}	9.24^{a}	3.65^{f}	9.04^{b}	4.09^{e}	0.01
NFE	37.76^{b}	25.03^{d}	36.17^{c}	18.84^{f}	41.20^{a}	24.04^{e}	0.08

$^{a, b, c}$ Means within row bearing distinct characters differ significantly (P≤0.05).

Table II: Mineral constituents of PITA 23, Cantebalon, and PITA 26 peel and leaves

Parameters (%)	PITA 23 leaves	PITA 23 peels	Cante leaves	Cante peels	PITA 26 leaves	PITA 26 peels	SEM
Na	0.26^{b}	0.22^{e}	0.23^{d}	0.21^{f}	0.27^{a}	0.23^{c}	0.01
K	0.78^{b}	0.64^{c}	0.65^{c}	0.61^{d}	0.81^{a}	0.65^{c}	0.02
Ca	0.26^{b}	0.24^{c}	0.24^{c}	0.22^{d}	0.27^{a}	0.25^{b}	0.01
P	0.41^{b}	0.39^{c}	0.31^{d}	0.30^{e}	0.42^{a}	0.41^{b}	0.03
Mg	0.27^{b}	0.25^{c}	0.24^{d}	0.23^{e}	0.28^{a}	0.28^{a}	0.02
Zn	72.17^{b}	57.83^{e}	65.18^{c}	49.94^{f}	74.08^{a}	58.14^{d}	0.02
Cu	19.50^{b}	15.80^{d}	15.75^{e}	13.40^{f}	20.95^{a}	16.45^{c}	0.16
Mn	22.50^{b}	21.65^{c}	18.50^{e}	19.30^{d}	24.57^{a}	22.49^{b}	0.11
Fe	139.35^{c}	123.75^{d}	114.10^{f}	116.80^{e}	145.50^{a}	142.50^{b}	0.42

$^{a, b, c}$ Means within row with different alphabets differ significantly (P≤0.05).

DISCUSSION

The different values in proximates of the varieties recorded from the present study is consistent with the works of Okareh *et al*. (2015) who affirmed similar result on the proximate composition of different varieties of plantain waste flour. Crude protein contents in this study are above the recommended 7% crude protein requirement for ruminants (Adepoju *et al*., 2006). This shows that all varieties, PITA 23, Cantebalon, and PITA 26 peels and leaves have the potential to be fully exploited in ruminant feeding. Crude protein is an essential component of diet needed for survival of animals, their basic function in nutrition is to supply adequate amount of required amino acids. However, the crude protein content reported for the different varieties of unripe plantain leaves and peels in this study was higher than 7.85% reported for the same plantain peels by Ukanwoko & Nwachukwu, (2017) and 6.69% reported by Adamu *et al*. (2017) for dried ripe plantain peels. The differences in the nutrient composition of plantain peels can be due to differences in sampling, procedures employed during analysis, stage of growth, soil type, maturity, environment and differences in variety (Gizzi & Givens, 2004).

Also, the ether extract in PITA 23, Cantebalon, and PITA 26 peels and leaves were very low compared to the range reported by Tsado *et al*. (2021). Notwithstanding, these low values of ether extract in this study may neither be good source of fat-soluble vitamins nor contribute significantly to energy content of the feeds that can be prepared with the wastes, but will increase the storage life of the peels and leaves by reducing the chances of developing rancidity.

Results of the present study indicated that NFE is the most abundant proximate contents and is highest in PITA 26 leaves. This high NFE content in PITA 26 leaves is an indication that they are of good sources of energy for the animals. The ash content of the samples was comparatively higher than those reported by previous researchers for agricultural hull (Adeyi and Oladayo, 2010). The high values of the ash were indicative of high mineral (especially the macro-minerals) content among the different varieties of unripe plantain peels and leaves.

Furthermore, values for the fibre content in the present study were comparably higher than the value obtained for plant

Table III: Fibre fraction of PITA 23, Cantebalon, and PITA 26 peel and leaves

Parameters (%)	PITA 23 leaves	PITA 23 peel	Cante leaves	Cante peel	PITA 26 leaves	PITA 26 peel	SEM
NDF	46.13[c]	48.40[b]	44.91[d]	41.09[f]	48.89[a]	41.65[e]	0.01
ADF	25.80[c]	29.87[b]	23.57[d]	22.07[f]	29.94[a]	22.15[e]	0.01
ADL	9.13[c]	11.24[b]	8.35[d]	6.24[f]	11.39[a]	6.36[e]	0.01
Hemicellulose	20.33[b]	18.53[f]	21.33[a]	19.02[d]	18.94[e]	19.31[c]	0.02
Cellulose	16.67[c]	18.63[a]	15.22[f]	15.83[d]	18.55[b]	15.78[e]	0.03

[a, b, c] Means within row bearing distinct characters differ significantly (P<0.05).

Where, NDF= Neutral detergent fibre, ADF= Acid detergent Fibre, ADL= Acid detergent lignin

Table IV: Anti-nutritional constituents of PITA 23, Cantebalon, and PITA 26 peel and leaves

Parameters (%)	PITA 23 leaves	PITA 23 peel	Cante leaves	Cante peel	PITA 26 leaves	PITA 26 peel	SEM
Phytate	0.34[c]	0.21[d]	0.35[b]	0.19[f]	0.37[a]	0.20[e]	0.01
Oxalate	0.21[c]	0.16[e]	0.24[a]	0.13[f]	0.22[b]	0.17[d]	0.01
Saponin	0.53[b]	0.41[d]	0.54[a]	0.39[e]	0.53[b]	0.43[c]	0.04
Tannin	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[a, b, c] Means within row bearing distinct characters differ significantly (P<0.05).

products such as Ube (Dacryodes edulis) having 2.1g/100g, reported by Adepoju & Adeniji, (2008) and fruit pulp, (4.3g/100g). High fibre content in diets reported caused increased removal of potential mutagens, steroids and xenobotics by binding or absorbing to dietary fibre components and thereby aids digestion (Tsado et al., 2021). This suggests that the superior value of fibre content in PITA 26 leaves could promote health conditions of livestock.

Mineral composition recorded in this study is consistent with the observations of Ighodaro (2012), who recorded notable difference on mineral composition from different plantain peels analysed. O'Connell (2011) posited that calcium is an essential part of intracellular processes that take place inside insulin responsive tissues like the adipose tissue and skeletal muscle. Changes in calcium flux can result in deleterious consequences on insulin secretion, a calcium dependent process. Therefore, the higher level of calcium in the PITA 26 leaves of plantain in this study hints the significance of these leaves to the metabolic role in the animal (Rolfe et al., 2009). Magnesium is a cofactor of hexokinase and pyruvate kinase and it also modulates glucose transport across cell membranes (O'Connell, 2009). The study showed that unripe PITA 26 leaves contain significantly higher amounts of Mg which signifies the ability to regulate the normal functioning of the cell membrane. Also, the higher amounts of K than Na in the PITA 26 leaves investigated are considered of comparative advantage. This is because intake of diets with higher Na to K ratio has been related to lower incidence of metabolic disorders (Chen *et al*., 2010). Phosphorus is involved in several biological processes such as: bone mineralization, energy production, cell signalling and regulation of acid-base homeostasis and the higher values of this mineral in PITA 26 leaves justify its relevance in livestock feeding. Zinc plays a key role in the regulation of insulin production by pancreatic tissues and glucose utilization by muscles and fat cells (Eleazu *et al*., 2013). Findings from this study indicate that PITA 26 leaves contains higher quantities of Zn which highlights its beneficial role in the regulation of blood insulin.

Copper is found in all living organisms and is a crucial trace element in redox chemistry, growth and development. So, the superior value of Copper in PITA 26 leaves indicates its potential in enhancing growth and development in livestock (Tisato *et al*., 2010).

The considerable amount of Fe in unripe plantain peel and leaves are an important finding in this study. Iron is an essential component of haemoglobin and it is critical to the proper function of the immune system and the production of energy (Chen *et al*., 2010). This shows that the highest value of Fe in PITA 26 leaves is suitable in the proper functioning of the immune system.

The significant (P<0.05) difference recorded for fibre fraction in PITA 23, Cantebalon, and PITA 26 peels and leaves was in agreement with the works of Ukanwoko *et al*. (2019) who recorded similar result on fibre fraction from in vitro digestibility and nutrient profile of dried and ensiled ripe and unripe plantain peels. Thus, fibre fractions that contribute to the nutritional value of the feed are the NDF and ADL (Happi-Emaga *et al*., 2011). The higher values of NDF and ADL recorded in PITA 26 leaves showed their potential influence in improving the nutritional value of livestock feed, and this agreed with the reports of Happi-Emaga *et al*. (2011).

Results of anti-nutritional factors was consistent with the works of Ukanwoko *et al*. (2019) who recorded similar anti-nutritional profile of dried and ensiled ripe and unripe

plantain peels. However, tannins are the main anti-nutritional factors of plantain and are mostly contained in the peels (Happi-Emaga *et al*., 2011). They act against the availability of proteins in the rumen decreases with ripening as a consequence of a migration of the polyphenols from the peel towards the pulp and the phenolic oxidative degradation by polyphenol oxidases and peroxidases. Thus, the absence of notable difference of tannins among the different varieties of plantain peel and leaves affirmed that its deleterious effect wasn't pronounced among the varieties understudy. Notwithstanding, all the peels and leaves in this study had their tannin contents below the 2% tannin level reported to have adverse effects on digestibility in sheep and goats (Onyeonagu & Njoku, 2010). Furthermore, Ojo *et al*., (2006) reported that saponins possess antimicrobial properties and could function as precursors of several steroidal substances with diverse physiological roles. The discovery of saponins in the peels and leaves of plantain also renders it ideal for utilization in the preparation of livestock feed.

CONCLUSION

The PITA 26 unripe *Musa paradisiaca* leaves and peels are more suitable as feedstuffs for ruminants because they have superior nutrient profile for ruminants. So, the usage of these peels and leaves to feed ruminants will help to reduce the scarcity of feed ingredients, menace of nutrient deficiencies as well as curtail the environmental pollution caused by the indiscriminate dumping of plantain peels. Further research is also encouraged to compliment the result from the present findings.

CONFLICT OF INTEREST

Authors declare no conflict of interest

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