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Proximate and mineral composition of corn cob, banana and plantain peels

[1]Abubakar US, [2] Yusuf KM, [3] Safiyanu I, [4] Abdullahi S, [5] Saidu SR, [6] Abdu GT, [7] Indee AM

[1, 2, 4, 5, 6] Bioresources Development Centre, Kano. National Biotechnology Development Agency (NABDA), Abuja, Nigeria
[3] Department of Biology, Kano University of Science and Technology, Wudil, Kano, Nigeria
[7] Department of Home and Rural Economics, Binyaminu Usman Polytechnic, Hadejia, Jigawa State, Nigeria

Abstract
This study was conducted in order to determine the proximate and mineral composition of three agrowaste materials (corn cob, banana and plantain peels) as possible sources of nutrients in formulating animal feeds. The proximate composition was determined using the standard methods of analysis of Association of Official Analytical Chemists (AOAC), while Atomic Absorption Spectrophotometre (AAS) and Flame Photometre were used to determine the mineral composition. The results showed that Plantain peel had the highest lipid content (37.53 ± 0.08%) and protein content (5.79 ± 0.04%), while banana peel had the highest ash content (9.83 ± 0.06%) and moisture content (13.49 ± 0.17%) ($P<0.05$). On the other hand, corn cob had the highest carbohydrate content (48.56 ± 0.14%) and crude fibre content (33.33 ± 021%). For the mineral composition, plantain peel had the highest amount of most of the minerals analyzed (Ca, Mg, K, P, Zn, Fe, Na, Cu, Cr, Pb, Ni and Mn) ($P<0.05$). Banana and plantain peels can serve as good sources of nutrients in animal feeds preparation, as they are high in lipid, protein, ash and essential minerals content. This will result in dual benefits of their use as animal feeds and proper waste management strategy.

Keywords: Proximate, mineral composition, agrowaste materials, animal feeds and waste management

1. Introduction
The plant genus, *Musa* is of extraordinary significance to human societies; it produces the fourth most important food in the world today (after rice, wheat, and maize), banana and plantain. *Musa* species grow in a wide range of environments and have different human uses, ranging from the edible banana and plantain of the tropics to cold-hardy fiber and ornamental plants. They have been a staple of the human diet since the dawn of recorded history. These perennial herbs which are between 2-9 m in height, evolved in Southeast Asia, New Guinea, and the Indian subcontinent, developing in modern times secondary loci of genetic diversity in Africa, Latin America, and the Pacific [1].

Banana is a valuable source of potassium, fibre, vitamin B and C. The fruit can be eaten raw or as a cooked vegetable. Ripe banana fruits can be used in a variety of products such as ice cream, yoghurt, cake, bread, nectar and baby food, and can also be dried and eaten or sliced, canned with syrup and used in bakery products, fruits salads and toppings [2].

Plantain contains a higher fibre content, and thus is capable of lowering cholesterol and helps to relieve constipation and hence prevention of colon cancer. Also, its high potassium content is found to be useful in the prevention of raising blood pressure and muscle cramp [3].

Plantain waste materials have been considered for use as organic fertilizer in Somalia. In Malaya, pigs fed with pseudostems are less prone to liver and kidney parasites than those on other diets [4]

Corn cob is the central core of an ear of maize (*Zea mays*). It is the part of the ear on which the kernels grow. When harvesting the corn, the corn cob may be collected as part of ear or instead may be left as a waste in the field. Corn cob serves as a source of furfural and biofuel. It is also used in the production of charcoal [5].

As mentioned earlier, banana and plantain fruits are consumed as foods, while their peels are discarded as wastes after the inner fleshy portions have been eaten, thereby constituting a menace to the environment, especially where their consumption is common [4]. The peels of these important crops also serve as by-products of the plantain and banana processing industries, which are normally dumped in landfills, rivers or unregulated grounds [6].

In view of the need for waste management and recent awareness of conversion of wastes to wealth, this study was conducted to determine the proximate and mineral composition of corn cob, banana and plantain peels as possible sources of nutrients in formulating animal feeds, this is because feed represent a major proportion of the overall production cost in poultry and livestock industries, and a major constraint in these industries is the availability of feed ingredients all the year round at economic price [7]. Therefore, alternative sources of energy for animal feeds which are nutritionally adequate and cheap must be found locally to reduce the cost.

2. Materials and Methods
2.1 Preparation of the Samples
Corn cob, ripe banana and plantain fruits were purchased at Kwangila, Zaria, Kaduna State, Nigeria. The peels and corn cobs were washed and dried for 12 days. The samples were then ground into powder using mortar and pestle.

2.2 Chemicals and Reagents
All the chemicals and reagents used in this study were of analytical grade and were products of British drug House Laboratory, England.

2.3 Proximate Composition
The proximate composition of the samples was determined

Using the standard methods of analysis of Association of Official Analytical Chemists [8].

2.4 Mineral Analysis

The following elements were determined using Atomic absorption spectrophotometer (AAS) [9]. The elements are Calcium, Chromium Manganese Copper Zinc, Iron, Magnesium, Nickel and Lead, while potassium and sodium were determined with flame photometer [10].

2.5 Statistical analysis

All determinations were carried out in triplicates. Descriptive statistics, analysis of variance (ANOVA) and Duncan Multiple Range Test were used to interpret the results obtained, and the level of significance was set at $P<0.05$.

3. Results

The proximate composition of corn cob, banana and plantain outer skins is presented in Table1. From the table, it was observed that banana peel has the highest moisture content (13.49± 0.17%), while corn cob has the lowest moisture content (6.00± 0.14%) and ash content (2.49± 0.01%) ($P<0.05$). The crude lipid content of the samples was significantly different from one another, with plantain peel having the highest lipid content (37.53±0.08%) followed by banana peel (23.93±0.68%) and corn cob (4.72±0.07%) ($P<0.05$).

The crude fibre content of the waste products was significantly different from one another, with corn cob has the highest value (33.33±0.21%) followed by banana peel (14.83±0.28%) and plantain peel (9.43±0.21%) ($P<0.05$). There was no significant difference between the crude protein content of banana and plantain peels ($P<0.05$). The carbohydrate content (by difference) of the samples differs significantly with corn cob having the highest carbohydrate content (48.56±0.14%) ($P<0.05$).

Table 1: Proximate Composition of Corn Cob, Banana and Plantain Peels

Parameter	Corn cob	Banana peel	Plantain peel
Ash (%)	2.49± 0.01^{c}	9.83± 0.06^{a}	8.63±0.12^{b}
Fibre (%)	33.33±0.21^{a}	14.83±0.28^{b}	9.43±0.21^{c}
Lipid (%)	4.72±0.07^{c}	23.93±0.68^{b}	37.53±0.08^{a}
Moisture (%)	6.00±0.07^{c}	13.49±0.17^{a}	11.43±0.07^{b}
Nitrogen (%)	0.7849±0.02^{a}	0.8847±0.11^{a}	0.9269±0.04^{a}
Protein (%)	4.19±0.10^{b}	5.53±0.11^{a}	5.79±0.04^{a}
Carbohydrate (%)	48.56±0.14^{a}	32.39±0.70^{b}	27.18±0.16^{c}

All values were mean ± standard deviation of triplicate determinations. Values in the same column with different superscript differs significantly (P<0.05)

The mineral composition (mg/100g) of corn cob, banana and plantain peels is presented in Table 2; there were significant differences in values of all the minerals for all the three samples. Plantain peel was highest in Magnesium, Phosphorus, Potassium, Iron, Lead, Cupper and Chromium, banana peel was highest in Calcium Zinc, Sodium and Manganese, while corn cob was highest in Nickel ($P<0.05$).

Table 2: Mineral Composition of Corn Cob, Banana and Plantain Peels (mg / 100g)

	Element	Corn Cob	Banana Peel	Plantain peel
1	Cupper	-150.82±0.09^{c}	2.55±0.01^{b}	5.82±0.03^{a}
2	Nickel	150.00±0.05^{a}	13.13±0.11^{b}	4.92±0.02^{c}
3	Zinc	-19.25±0.00^{c}	150.00±0.01^{a}	41.82±0.06 ^{b}
4	Chromium	10.97±0.00^{c}	71.33±0.07^{b}	73.91±0.02^{a}
5	Lead	22.91±0.05^{b}	3.74±0.02^{c}	44.55±0.08^{a}
6	Manganese	ND	27.28±0.10^{a}	11.81±0.03^{b}
7	Iron	26.18±0.09^{c}	41.03±0.05^{b}	55.08±0.07^{a}
8	Phosphorus	527.33±0.58^{c}	1460.00±0.30^{b}	2977.33 ±1.78^{a}
9	Sodium	129.19±0.06^{c}	812.87±0.52^{a}	672.96±0.17^{b}
10	Potassium	375.25±0.76^{c}	527.19±0.51^{b}	854.49±0.43^{a}
11	Magnesium	21.92±0.07^{c}	62.53±0.01^{b}	64.12±0.04^{a}
12	Calcium	17.19±0.06^{c}	4113.72±0.76^{a}	1702.38±0.63^{b}

All values were mean ± standard deviation of triplicate determinations Values in the same column with different superscript Differs significantly (P<0.05) ND=Not Determined

4. Discussion

The moisture level of all the samples was very high when compared to the value (5.43%) recommended for animal feeds [11]. The moisture content of foods or its processed products gives an indication of its freshness and shelf life, and high moisture content subjects food items to increased microbial spoilage and short shelf life, which can lead to its deterioration [12].

The lower ash content of corn cob (2.49± 0.01%) may suggest low minerals content [13]. On the other hand, the high values of the ash were indicative of high minerals content (especially the macro elements) of plantain and banana peels. Previous studies showed that an ash content of 1.5–2.5% has been recommended for animal feeds [14].

The crude lipid content of plantain and banana peels was very high and may be good sources of fat soluble vitamins and can also contribute significantly to energy content of the feeds that can be prepared with the wastes [7].

Corn cob had the highest value of crude fibre (33.33±0.21%). High fibre content in diets have been reported to result in increased removal of potential mutagens, steroids and xenobotics by binding or absorbing to dietary fibre components and thereby aids digestion; thus, corn cob will have health promoting benefits for livestock and fish farming [7].

Protein is an essential component of diet needed for survival of animals and human being, its basic function in nutrition is to supply adequate amount of required amino acids. The crude protein content of the samples was very low when compared to

other sources of protein rich foods such as soybeans, cowpeas, pigeon peas, and pumpkin and gourd seeds ranging between 23.1-33.0% [15]

The samples were very high in carbohydrate content and can be good sources of energy for the animals [7]. Corn cob had highest value of carbohydrate, while plantain peel had the lowest value.

For the mineral composition, plantain peel can be a good source of Iron, Magnesium, potassium and phosphorous, while banana peel can serve as a good source of calcium, zinc, sodium and manganese. Calcium and phosphorus are very important in the formation of strong bones and teeth, for growth, blood clotting, heart function and cell metabolism [16, 17]. Potassium is an important raw material in soap production and in soil neutralization [18]. Also, magnesium has been reported to be involved in maintaining the electrical potential and activation of some enzyme systems [19].

The iron level of all the samples was higher than the values recorded for dry guinea corn leaf extracts (1.2mg - 2.1mg/100g) and fresh and roasted *Dacryodes edulis* fruit (7.0mg and 3.0mg/100mg respectively) [20].

5. Conclusion

Plantain and banana peels are good sources of nutrients for the production of animal feeds. Also, the presence of good level of mineral elements showed their reliability in correcting nutritional disorders and also in the manufacture of organic fertilizer.

6. References

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