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Assessing the Potentials of Some Agro-Waste Peels Through Proximate Analysis

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Abstract: The economic potentials of some agro-waste peels were evaluated using proximate analysis. The substrates investigated were pineapple peels, banana peels, plantain peels, cassava peels, yam peels and potato peels. Their bioethanol production potentials were evaluated using their % carbohydrate content while their animal feed production potentials were evaluated using their total energy content on a dry weight bases. On comparative assessment, it was deduced that potato peels had the highest bioethanol production potential (84.64% carbohydrate content) while pineapple peels had the least (54.89% carbohydrate content). It was also deduced that potato peels had the highest animal feed production potential (383.04 Kcal/100g) while cassava peels had the least (356.84 Kcal/100g). Minerals were also found to be highest in plantain peels (11.41% ash) and cassava peels (9.85% ash). This research revealed that all the considered substrates were good sources of carbohydrates and energy when completely dried, although in varying degree.

Keywords: Agro-Waste Peels, Production Potentials, Bioethanol, Animal Feed, Substrates, Production Potential, Nutrients, Energy.

1. INTRODUCTION

Management of agricultural waste residues from food and fruit peels in Nigeria has been challenging and ineffective. They are still wrongly being discarded and disposed into drainages and other inappropriate areas. These renewable and widely available agricultural waste residues can be efficiently utilized in bioethanol energy production and in animal feed production. They are inexhaustible and are largely produced during the processing and consumption of agricultural products. Their usage neither competes with food production nor land resources [1].

The food and fruit peel wastes considered in this research are readily usable and more presentable when they are dry or their moisture content removed. Their components are also

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more accessible when they are pulverized. For adequate utilization, these agro-wastes require cleaning, washing, proper drying and pulverization [2]. Bioethanol is a fermentation derived alcohol that is obtained from carbohydrate materials as opposed to synthetically produced alcohol from petroleum sources. In bioethanol production, agro-wastes require pretreatment, saccharification and microbial fermentation [2,3]. It is noteworthy that the bioethanol potential of a biomass has been directly correlated with its carbohydrate content because, its carbohydrate content is the only source of its hydrolysate fermentable sugars [3]. Also, plant based biomass materials are utilized in the manufacturing of animal feeds. The energy content of an animal feed will determine its feeding value or its value to the body as fuel [4]. Animal feeds supply animals with energy which is the fuel needed for all bodily processes.
The goal of this study is to (i) investigate the proximate composition of some agricultural waste peels (pineapple peels, banana peels, plantain peels, cassava peels, yam peels and potato peels), (ii) determine their percentage carbohydrate composition (iii) determine their total energy value and (iii) compare the obtained results and make useful deductions.

2. MATERIALS AND METHODS

Sample Collection

The food items from where the peels were collected were obtained from Uselu Market, Benin-City, Nigeria. They were washed with distilled water, air-dried and their peels collected.

Determination of Percentage Moisture Content

Five (5) g of sample was weighed into a known-weight crucible and placed in an oven at 105°C for 2 hr. The sample and crucible weights were recorded and constantly checked until a constant weight was achieved. Loss in weight was calculated as the percentage moisture content according to the expression in equation 2 below [5].

$$\%\ \text{Moisture} = \frac{\text{Loss in weight due to dryness}}{\text{Weight of sample taken}} \times 100 \quad (1)$$

$$= \frac{W2 - W3}{W2 - W1} \times 100 \quad (2)$$

Where; W1 = weight of empty crucible,
W2 = weight of crucible + sample before drying and
W3 = weight of crucible + sample after attaining constant weight on drying

Determination of Percentage Ash Content

A porcelain crucible with cover was ignited in a hot Bunsen burner flame and then cooled in a desiccator before being weighed. Five (5) g of sample was accurately weighed into the crucible and gently placed in the muffle furnace at 600°C for 4 hr. The crucible was placed in the desiccator to cool. After cooling, the ashed sample in the crucible was weighed. Using the formula in equation 3 below, the ash content was calculated [5].

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$$\% \text{ Ash content} = \frac{W3-W1}{W2-W1} \times 100 \quad (3)$$

Where, W_1 = weight of empty crucible,
W_2 = weight of crucible + sample before ashing and
W_3 = weight of crucible + sample after ashing

Determination of Percentage Crude Protein Content

On ashless filter paper, five (5) grams of finely dried material was weighed. The paper with sample was folded and dropped into the digestion flask. Twenty (20) ml of sulphuric acid (H_2SO_4) and 4 pieces of granulated zinc were added and then heated gently inside a fume cupboard for 6 hr. The flask's contents were allowed to cool. Diluted with distilled water, the solution was transferred to an 800 ml Kjehldah flask. 100 ml of 40% NaOH was added and distilled. This was followed by titration against 0.05% of boric acid solution using methyl red as indicator. The protein content was estimated from the amount of nitrogen present in the sample according to equations 4 and 5 [6].

$$\% N = \frac{0.014 \times M \times V \times 100 \times D.F}{\text{Weight of Sample}} \times 100 \quad (4)$$

$$\% \text{ Crude Protein} = \% N \times 6.25 \quad (5)$$

Where M = the molarity of acid, V = the volume of acid used, and D.F = the volume ratio of solution.

Determination of Percentage Crude Fat

Two (2) gram of sample was put in a beaker and weighed; the weight was noted as "W". Thereafter, 10 ml of water was added, and the solid was dispersed by agitation. The solid particle was dissolved and the slurry turned brown when ten (10) ml of conc. HCl was added and placed in a boiling water bath. This was allowed to cool and 10 ml of ethanol was added and agitated vigorously. A clean flask "W1" was weighed and recorded. The ether layer was poured into the flask and placed in a boiling water bath in order to evaporate the ether. Using 50 mL diethyl ether, the extraction was repeated such as to evaporate the ether and leave the fat behind. The fat and flask were weighed and labeled "W2". The fat content was thereafter calculated as a percentage as shown in equation 6 below [5].

$$\% \text{ Fat} = \frac{W2-W1}{W} \times 100 \quad (6)$$

Where, W = weight of the sample,
W1 = weight of dried flask and
W2 = weight of dried flask fat residue.

Determination of Crude Fibre

In a beaker, five (5) grams of sample was heated with 200 ml of 1.25 percent H_2SO_4 for 30 minutes and filtered. The residue was acid-free after being rinsed with distilled water. It was then boiled for 30 minutes with 200 ml of 1.25 percent NaOH, then filtered and rinsed with

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distilled water until it was alkaline-free. It was washed once with 10% HCl, twice with ethanol and thrice with petroleum ether. The residue was placed in a crucible and dried overnight at 105°C in an oven. It was ignited in a muffle furnace at 550°C for 90 minutes after cooling it in a desiccator to ascertain the weight of the ash [6].

Determination of Carbohydrate

The percentages of other components were added together and deducted from 100 percent to calculate the crude carbohydrate content of the sample [5].

Carbohydrate % = 100 – (moisture % + protein % + ash % + lipid % + crude fiber %). (7)

Determination of Gross Energy Value

The values of gross energy (Kcal/100g samples) of substrates were determined using the factors for fat (9 Kcal/g), protein (4 Kcal/g) and carbohydrate (4 Kcal/g) [7].

Food energy = (% Fat content x 9) + (% Crude protein x 4) + (% Carbohydrate x 4)

3. RESULTS AND DISCUSSION

TABLE 1: PROXIMATE ANALYSIS OF THE FOOD AND FRUIT PEELS

	%Moisture	% Ash	% Fat	%Crude Fibre	% Protein	% Carbohydrate	TN
Pineapple peels	72.42±0.03	1.80±0.07	1.10±0.14	2.22±0.06	7.32±0.10	15.14±0.12	27.58
Banana peels	78.56±0.10	2.08±0.09	1.66±0.03	1.93±0.05	1.27±0.07	14.50±0.16	21.44
Plantain peels	75.20±0.05	2.83±0.14	1.20±0.10	1.22±0.05	2.15±0.04	17.40±0.19	24.80
Cassava peels	72.50±0.07	2.71±0.15	1.00±0.06	1.51±0.09	2.18±0.03	20.10±0.20	27.5
Yam peels	76.50±0.04	2.18±0.03	1.42±0.09	2.01±0.05	2.51±0.06	15.30±0.13	23.42
Potato peels	70.97±0.07	1.17±0.22	0.28±0.32	0.41±0.03	2.60±0.05	24.57±0.40	29.03

Mean ± Standard deviation of three replications TN = % Total Nutrient contribution in the absence of moisture

TABLE 2: PERCENTAGE CONTRIBUTIONS OF OTHER NUTRIENTS WHEN MOISTURE CONTENT IS REMOVED

	%Ash	%Fat	%Crude Fibre	%Protein	%Carbohydrate	Energy Kcal/100g
Pineapple peels	6.53	3.99	8.05	26.54	54.89	361.63
Banana peels	9.70	7.74	9.00	5.92	67.64	363.90

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Plantain peels	11.41	4.84	4.92	8.67	70.16	358.88
Cassava peels	9.85	3.64	5.49	7.93	73.09	356.84
Yam peels	9.31	6.06	8.58	10.72	65.33	358.74
Potato peels	4.03	0.96	1.41	8.96	84.64	383.04

Percentage contribution of a nutrient in the absence of moisture $= \frac{\%\ contribution\ of\ a\ nutrient}{TN}$ *x 100*

Results from Table 1 show that all the substrates generally have high moisture and high carbohydrate contents compared to other available nutrients. The high moisture content is an indication that care must be taken for proper preservation as they will be susceptible to microbial attacks and deterioration. Table 2 is an extrapolation from Table 1. It shows the percentage contribution of other nutrients when the substrate's total moisture content is removed by drying. Drying makes them durable, readily usable and more presentable.
On the basis of bioethanol production potential, it can be deduced from Table 2 that potato peels had the highest carbohydrate content (84.64%) while pineapple peels had the least (54.89%). The order of decrease in the substrate's carbohydrate content or bioethanol production potential is as follows: potato peels > cassava peels > plantain peels > banana peels > yam peels > pineapple peels.
On the basis of animal feed production potential, it can also be deduced from Table 2 that potato peels had the highest energy content (383.04 Kcal/100g) while cassava peels had the least (356.84 Kcal/100g). It was discovered that the energy contents of these substrates were close and not significantly different. Nonetheless, the order of decrease in the substrate's energy content or their animal feed production potential is as follows: potato peels > banana peels > pineapple peels > plantain peels > yam peels > cassava peels.
It has also been noted that high amount of total ash of a substrate indicates high-value mineral composition [8]. Table 2 indicates that plantain peels had the highest ash content while potato peels had the least.

4. CONCLUSION

This research revealed that all the considered substrates were good sources of carbohydrates and energy when completely dried, although in varying degree. They can be directly utilized or combined with other materials in either bioethanol production or animal feed formulation. The use of these agro-waste peels of no commercial value will help in wealth creation, waste management and reduction in environmental pollution.

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