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Chemical Studies of Some Plant Wastes from Ghana

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The proximate composition of sodium, potassium, calcium, phosphorus and iron levels of the peels and trunk from banana and plantain plants and cocoa husk are reported. The samples were all characterised by high moisture content ranging from 78 g/100 g ripe plantain peel to 94 g/100 g for fresh plantain trunk. The peels and trunk of plantain and banana plants were poor sources of phosphorus and sodium but rich in iron and potassium. Plantain trunk contained 5 g of potassium per 100 g of dry sample. Because of their high potassium content the peels of banana fruit and the trunk of banana and plantain plants are recommended as additional raw materials for indigenous soap making in Ghana.

1. Introduction

It has been the practice of indigenous soap manufacturers in Ghana to use caustic potash extracted from plant materials in making soft soap. The raw materials employed are the ashes obtained from cocoa (*Theobroma cacao*) husks, plantain (*Musa paradisiaca*) peels, the calyx of *Bombax buenozenze* and *Amaranthus* spp. all of which have been found to posses strong caustic properties.[1]

However, banana (*Musa sapientum*) peels and the trunk from banana and plantain plants have not been used in the traditional soap making process perhaps because their high caustic nature was not known. The peels of banana become waste after removal of the edible portion. The trunk of banana and plantain plants are available after harvest or are blown down by heavy winds and allowed to rot on the farm. As the peels of plantain fruits are already used to a limited extent for feeding ruminants the possibility exists that the other plant wastes could be similarly used in the future. The nutrient composition of these materials was therefore evaluated.

In a study of the psychedelic properties of banana peel Krikorian[2] observed no halucinogenic substances in the smoke of banana peel but found dopa, dopamine, serotonim, indole-3- acetic acid and norepinephrine. Mulvena, Webb and Zerner[3] isolated 3, 4-dihydroxybenzaldehyde, a fungistatic substance, in the skin of green Cavendish banana, which was found to inhibit the growth of *Gloeosporium musarium* causing ripe fruit rot in banana.

Recently Ketiku[4] reported on the chemical composition of plantain peel excluding its mineral levels. Knapp and Nicholas[5] have identified some sterols and triterpenes in banana peels. Twyford and Walmsley[6] have observed that micronutrients such as

copper, zinc, boron, iron and manganese were taken up in healthy Robusta plants chiefly in the vegetative phase with high concentration of manganese in the leaves and iron in the pseudostem. This article discusses the caustic properties and nutrient composition of cocoa husks, the green and ripe peels and the trunk from banana and plantain plants.

2. Experimental

2.1 Materials

The samples analysed were collected from Accra, Bunso, Tafo and Suhum in Ghana. The samples of banana and plantain fruits grown on the same bunch were analysed in the green and ripe stages. Each sample was dried in oven at 105 °C. The dried sample was ground and stored in air-tight container prior to analysis.

2.2 Methods

Methods of the A.O.A.C.[7] were used in determining the moisture, crude fibre and ash content. For moisture determination, 10-g portion of the fresh sample was dried in an oven at 105 °C to a constant weight. Nitrogen was measured by the macroKjeldhal method. The determination of crude fibre involved first digesting the sample in sulphuric acid followed by sodium hydroxide. The difference between the residue and ash gave the crude fibre content. Ash was measured by igniting 2-g portion of sample at 550 °C in a muffle furnace.

The ash was dissolved in 10 ml 5 N-HCl and made up with water to 50 ml. Portions of this solution were used in determining the alkalinity, sodium, potassium, phosphorus, calcium and iron levels. The alkalinity was determined by titrating 25 ml of the filtrate against 0.1 N-H_2SO_4 using methyl orange as indicator. The alkalinity was the volume of 0.1 N-H_2SO_4 required to neutralise the filtrate obtained from the ash of one gram dry sample. Sodium and potassium were measured on the 'EEL' Flame Photometer using sodium and potassium filters, respectively. For potassium 1 ml of the filtrate was diluted to 100 ml prior to the determination. A slightly modified method of the A.O.A.C.[7] was used for the determination of calcium and iron as follows: calcium was precipitated as the oxalate. The precipitate was dissolved in 2 N-H_2SO_4 and the liberated oxalic acid was titrated against 0.02 N-$KMnO_4$ solution. Iron was determined on a 10-ml portion of the ash solution after reduction with ascorbic acid. After adding dipyridyl solution the intensity of the colour of the solution was measured in a Coleman model 8 Colorimeter using a 19-mm diameter cuvette and filter 8-206. The method of Fogg and Wilkinson[8] was used in determining phosphorus. The molybdophosphate was reduced with ascorbic acid and the optical density was measured with a Coleman model 8 Colorimeter using 12-mm diameter cuvette and filter 8-215.

3. Results and Discussion

The results for the materials analysed are presented in Table 1. All the samples were high in moisture ranging from 78 g/100 g of ripe plantain peel to 94 g/100 g for plantain trunk. For economic reasons these materials should be dried at the farm before being

TABLE 1. Chemical composition of some plant wastes

Common name of material	Botanical name	Moisture (g/100 g of fresh sample)	Nitrogen (g/100 g of dry sample)	Crude fibre (g/100 g of dry sample)	Ash (g/100 g of sample)	Alkalinity (ml 0.1 N H_2SO_4/g of dry sample)	Na^+ (mg/100 g of dry sample)	K^+ (g/100 g of dry sample)	Ca (mg/100 g of dry sample)	P (mg/100 g of dry sample)	Fe (mg/100 g of dry sample)
Green Banana peel	*Musa sapientum*	86.9	0.9	17.0	9.8	7.3	11.6	3.6	352.5	98.2	6.7
		86.1–87.7	0.8–1.0	9.5–19.8	8.4–11.0	6.0– 7.8	6.0–20.0	3.1–3.8	280.0–469.5	20.0–155.0	4.1–10.3
		(6)	(4)	(5)	(7)	(7)	(6)	(5)	(7)	(7)	(7)
Ripe Banana peel	*Musa sapientum*	83.4	1.0	12.0	10.6	7.7	10.2	4.2	454.9	98.5	6.0
		74.9–87.5	0.8–1.0	9.4–13.6	9.6–11.6	7.6–7.8	7.5–16.7	3.8–4.8	240.1–529.6	12.5–195.0	4.1–10.9
		(7)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Banana trunk	*Musa sapientum*	92.8	0.9	31.1	11.6	10.3	18.7	4.2	698.0	50.7	5.1
		86.5–95.6	0.6–1.2	28.3–35.5	5.8–12.4	7.1–15.8	7.5–31.8	1.8–7.7	269.9–1119.1	20.0–112.7	3.2–8.0
		(6)	(7)	(5)	(5)	(6)	(5)	(6)	(7)	(6)	(7)
Green Plantain peel	*Musa paradisiaca*	85.1	1.2	5.2	9.5	8.6	10.7	4.0	179.6	137.1	4.8
		84.8–85.7	1.0–1.4	1.1– 7.0	7.9–10.6	6.6–10.5	7.0–19.3	3.4–4.4	127.9–209.9	67.5–287.3	3.6–9.5
		(5)	(4)	(3)	(5)	(7)	(6)	(6)	(6)	(6)	(6)
Ripe Plantain peel	*Musa paradisiaca*	78.5	1.3	7.1	9.3	9.2	10.0	4.4	176.4	117.0	6.0
		73.2–80.5	1.0–1.4	5.3– 8.1	7.4–10.8	6.3–13.4	7.5–12.5	3.2–5.1	112.2–259.8	12.5–287.2	2.1–8.1
		(6)	(5)	(4)	(5)	(5)	(4)	(6)	(5)	(5)	(5)
Plantain trunk	*Musa paradisiaca*	94.0	0.7	25.2	13.1	10.0	18.3	4.9	695.9	60.5	4.7
		92.4–95.9	0.6–0.8	22.2–29.2	7.8–22.8	5.1–21.8	15.6–20.6	2.4–8.6	459.9–989.9	27.5–77.5	2.4– 7.3
		(5)	(4)	(5)	(4)	(5)	(5)	(5)	(5)	(5)	(5)
Cocoa husk	*Cacao theobroma*	78.7	1.0	27.3	8.1	7.2	13.5	3.2	434.9	84.9	3.4
		70.0–82.0	0.9–1.2	24.3–29.6	7.6– 8.7	5.6– 8.2	5.0–27.5	2.5–3.7	329.9–700.0	35.0–114.9	1.9– 5.0
		(5)	(5)	(4)	(5)	(5)	(5)	(5)	(4)	(4)	(5)

Figures represent the mean and range values: figures in parentheses are the number of samples analysed.

transported for use. The samples were low in sodium but high in potassium. Cocoa husk contained the lowest amount of potassium being 3 g/100 g of dry sample while plantain trunk contained the highest (5 g/100 g of dry sample). The caustic contents of plantain peel and cocoa husk were in agreement with the values found by Bediako.[1] Because the ashes of banana peels and the trunk of banana and plantain plants are high in potassium they can be used as additional raw materials in indigenous soap making.

Jagirdar and Ansari[9] have found that addition of K_2SO_4 to soils caused a cash return increase of 60% over the control in a study of the growth and production of Cavendish banana (*Musa cavendi*). For this reason similar use of the ashes of the materials analysed is recommended. The ashes of these plants wastes can also be used in raising the pH of acidic soils.

The ash and crude fibre content for ripe and green plantain peels were in agreement with the figures obtained by Ketiku[4] for samples from Nigeria. The trunk of banana and plantain plants were characterised by high crude fibre with means of 31 and 25% respectively. Banana peel was found to be richer in calcium (352 mg/100 g of dry material) than ripe plantain peel (176 mg/100 g of dry sample). The peels and trunk from banana and plantain plants were poor sources of phosphorus but rich in iron. Johri, Shrivastava and Uddin[10] fed banana (*Musa* spp.) leaves and salt to bullocks and observed an average increase in weight of 18 kg within 10 days. The samples analysed should therefore be biologically evaluated to assess their use as fodder for ruminants.

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