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Comparative Study on the Nutritional Composition of Two FHIA Tetraploids FHIA-21 (Tetraploid French Plantain) and FHIA-03 (Tetraploid Cooking Banana) in Ghana

B.M. Dzomeku, E. Adu-Kwarteng and S.K. Darkey
Crops Research Institute, P.O. Box 3785, Kumasi, Ghana, West Africa

Abstract: This study was conducted to compare the nutritional composition of the pulps of the green stages of fruits of two FHIA hybrids (FHIA-21 and FHIA-03) in Ghana. Fresh fruits were harvested from the plantain orchard of the Crops Research Institute in Kumasi, Ghana. The standard Association of Official Analytical Chemists (AOAC) methods were used to determine the moisture, crude protein, ash, crude fibre, potassium, iron, calcium, carbohydrate, sodium and crude fat. Pulp colour was measured with a Chromatometer (Minolta). The data was subjected to student t-test analysis. The results showed that the nutritional composition of the hybrids were similar to the local landrace. The hybrids however had higher fat content (1.94%) for FHIA-21 and (1.66%) for FHIA-03 compared to triploid plantains. The hybrids were slightly soft due to the high moisture content. There was a significant difference ($p > 0.05$) in the potassium content between FHIA-03 and FHIA-21 (1060 mg/100 g dry weight for FHIA-21 and 1725 mg/100 g dry weight for FHIA-03) compared to reported values. This could be due to the soil and agronomic practices. The pulp colours of the hybrids were orange for FHIA-21 and white to creamy for FHIA-03 showing the physiological maturity of the fruits. The bright orange pulp colour of FHIA-21 was indicative of the presence of provitamins and carotenoids. The high potassium level in the hybrid may be an advantage over the local for use as a therapy. The tetraploid hybrids (FHIA-21 and FHIA-03) could be described as high energy yielding carbohydrates.

Key words: Musa hybrids, plantain, cooking banana, FHIA-21, FHIA-03, nutritional value

INTRODUCTION

Plantains, banana and cooking banana (*Musa* spp. ABB, AAA and AAB groups) are major starchy staples of considerable importance in the tropics. They are consumed both as energy-yielding food and as dessert, providing more than 200 calories (food energy) a day (Stover and Simmonds, 1987).

Plantains and bananas belong to the non-traditional sector of the rural economy, where they are used to shade cocoa and are essential component of the diet. More than 90% of the cultivated area in Ghana belongs to smallholder farmers. In the agricultural sector, plantain is ranked fourth in Ghana (FAO, 2005) and contributes about 13.1% to the Agricultural Gross Domestic Product (AGDP). Its per capita consumption of 96.4 kg (Lescot, 2000) is higher than all other starchy staples. Plantain and banana are also very important sources of rural income (Ortiz and Vuylsteke, 1996). They are attractive to farmers due to their low labour requirement for production compared to cassava, maize, rice and yam (Marriott and Lancaster, 1983). Plantain cultivation has therefore become a feature of great socioeconomic importance in Ghana from the point of view of food security and job creation.

Plantains and bananas are grown mainly in the forest, semi-deciduous to forest-savanna transition zones of Ghana. The total annual production is about 2.0 million tonnes of which more than 95% is sold on the domestic market and the rest exported (SRID-MOFA, 2006). Production is concentrated in the three agro-ecological zones namely Rain forest, Moist semi-deciduous forest and Forest-savanna transition. The rainfall pattern is bi-modal from March to July as the major rainy season and August to November as the minor season. The rainfall amounts range from 1300 to 2200 mm per year.

Plantains, bananas and cooking bananas are known to be a great source of calcium, vitamins A, B1, B2, B3, B6, C and minerals such as potassium and phosphorous.

Ripe mashed banana is an excellent food for babies after the six month exclusive breast feeding. This advantage is due to the easy digestibility and the mineral and vitamin content. For elderly people, the fruit can be consumed in large quantities without being fattening or causing digestive disturbances (<http://www.turbana.com/index.htm>, Accessed December 05, 2006). *Musa* spp. are also known to be low in sodium (Chandler, 1995). They contain very little fat and no cholesterol; therefore useful in managing patients with high blood pressure and heart disease. They are free from substances that give rise to uric acid therefore, they are ideal for patients with gout or arthritis (<http://www.turbana.com/index.htm>, Accessed December 05, 2006).

Despite the high value of banana, cooking bananas and plantains, their production have been seriously affected by growing pest and disease pressures, the most notable being the fungal disease Black Sigatoka (*Mycosphaerella fijiensis*) (IITA, 1992; Stover and Simmonds, 1987; Swennen, 1990). Yield losses due to the disease are highly significant ranging from 20 to 50%. Under very severe conditions yield losses may be as high as 80% (Hemeng and Banful, 1994). Unfortunately all the landraces in Ghana are susceptible to the Black Sigatoka disease. In view of this, new hybrids continue to be introduced into Ghana to complement the landraces. The tetraploid hybrids have been evaluated for their agronomic performance and are recommended to be high yielding and disease tolerant thus of great economic value. To ensure the consumer acceptability and possible commercialization of the new hybrids, the assessment of the organoleptic qualities of the cultivars was important. This study was conducted to compare the nutritional composition of two FHIA tetraploid (FHIA-21, plantain and FHIA-03, cooking banana) to determine if the hybrid cooking banana has the same nutritive value as the hybrid plantain.

MATERIALS AND METHODS

Fruits were harvested from the plantain orchard of the Crops Research Institute in Kumasi, Ghana in 2004. Harvesting was done at physiologically matured stages of the fruits and taken to the laboratory for analysis.

Physiochemical Analysis

Green stage bananas were sent to the Biochemistry Department, Kwame Nkrumah University of Science and technology for analysis. Green stage banana fingers were knife peeled and stored in water to avoid blackening before slicing. The pulp: peel ratio was determined. The pulp was sliced using a kitchen knife into sizes of 5-10 mm and mashed in a mortar to obtain a smooth paste for analysis.

Moisture, crude fat, ash, crude protein and crude fibre contents was determined using Official Methods of Analysis (AOAC, 1990). All the minerals (i.e., Sodium, Potassium, Iron, Phosphorus and calcium) were determined using atomic absorption spectrophotometer after acid digestion of the sample.

Colour Determination

The pulp was sliced into thin slices of 5 mm thickness and placed in a petri dish. The colour was determined using the Chromameter (Model Cr-200 Minolta Camera Co. Ltd., Japan) on the L* a*b* colour notation. The sensor of the Chromameter was placed on the sliced pulp and the colour measured at three different positions and the mean calculated. The Chromameter was calibrated using a standard white tile [L* = 100.01; a* = -0.01; b* = -0.02].

All determinations were replicated three times and data was analyzed using studentized t-test as described by Bailey (1995) to separate means.

RESULTS AND DISCUSSION

The nutritional values of FHIA-21 (hybrid plantain) and FHIA-03 (hybrid cooking banana) were compared (Table 1). There was no significant difference in the pulp to peel ratio. The pulp to peel ratio (1.09 for FHIA-03 and 1.36 for FHIA-21) were within the range reported by Dadzie (1993). However the thin peels of the cultivars could predispose the fruits to mechanical damage. Their transportation over long distances would require care especially in developing countries like Ghana where most of these hybrids are grown, the roads are not very good. Moisture level was appreciably high in FHIA-03 (71.46%) compared to FHIA-21 (60%). This could be attributed to the high level of banana characteristic in FHIA-03 than in FHIA 21. This shows that FHIA-21 had higher dry matter than the FHIA-03. Pulp moisture content is known to have influence on general energy and nutrient density. The low water content in plantain is reported to have an influence on general energy and nutrient density (Gowen, 1995). The low moisture content of the pulp has greater energy content. FHIA-21 could be described as a high energy yielding carbohydrate compared to FHIA-03 (Table 1). The soft nature of the tetraploid hybrids makes them easy to cook and for mastication when prepared as slice compared to the triploids (Dzomeku *et al.*, 2006a). FHIA-03 could be boiled when green just like FHIA-21, however it could be eaten as dessert banana when ripe.

There was no significant difference ($p < 0.05$) level between the fat, ash and crude fibre contents of the two hybrids (Table 1). The crude protein was higher in FHIA-21 (2.08%) than FHIA-03 (1.09). Plantains are known to contain provitamin A which could be a contributing factor to the orange colour of the pulp of FHIA-21 and white/creamy of FHIA-03.

Iron level was lower in the hybrids (0.5 mg/100 g and 0.2 mg/100 g for FHIA-21 and FHIA-03, respectively). The iron content of FHIA-03 was however far lower than reported values (Chandler, 1995). There was a significant difference ($p < 0.05$) in the potassium content FHIA-03 (1725.0 mg/100 g) and FHIA-21 (1060.0 mg/100 g) between the hybrids. The high potassium content could be attributed to environmental factors especially the type of soils used for cultivation. It is reported that plantains are rich in vitamin B6 and the combination of the vitamin B6 and potassium makes it nature's brain food, since these two substances are essential for proper brain function

Table 1: Physicochemical properties of FHIA 03 (tetraploid cooking banana pulp) and FHIA-21 (tetraploid french plantain pulp)

Parameters	Experimental values	
	FHIA-03	FHIA-21
Moisture (%)	71.46 (2.57)	60.62 (0.49)
Fat (%)	1.66 (0.46)	1.94 (0.55)
Crude fibre (%)	1.08 (0.67)	1.02 (0.05)
Ash (%)	0.70 (0.07)	1.02 (0.06)
Crude protein (%)	1.09 (0.02)	2.08 (0.03)
Carbohydrate (%)	24.01 (2.41)	41.52 (0.03)
Pulp to peel ratio	1.09 (0.04)	1.36 (0.06)

Values in brackets are the standard deviations

Table 2: Mineral content of the pulp of FHIA-03 (tetraploid cooking banana pulp) and FHIA-21 (tetraploid french plantain pulp)

Mineral content (mg/100 g)	Experimental values	
	FHIA-03	FHIA-21
K	1725.0 (5.40)	1060 (0.002)
Na	41.3 (0.70)	49.5 (0.02)
Fe	0.222 (0.01)	0.45 (0.05)
Ca	45.9 (1.65)	11.2 (0.01)

Values in brackets are the standard deviations

Table 3: Pulp colour of FHIA-21 (hybrid) and FHIA-03 (hybrid cooking banana and apem (local french) plantain)

	FHIA-21	FHIA-03
Pulp colour (observed)	Orange	White/creamy
Pulp colour		
L*	100.36 (0.21)	99.12 (0.89)
a*	0.11(0.00)	-0.95 (0.15)
b*	27.0 (0.01)	0.34 (0.07)

(<http://www.turbana.com/index.htm>, Accessed December 05, 2006). The sodium levels are low while potassium levels are high; however, the high potassium provides a protective effect against excessive sodium intake (Meneely and Batterbee, 1976). The high potassium level in the hybrids may be an added advantage of the hybrid over the local for use as a therapy. Calcium and phosphorous on the other hand are vital for bone. The calcium content was slight higher in FHIA-03 (45.9 mg/100 g) compared to FHIA 21 (11.2 mg/100 g) (Table 2).

The results of the study showed that the nutritional composition of the hybrid related very well with the findings of Chandler (1995). The fat content of the hybrids was high signifying higher calorific value. The nutritional composition of the hybrid matches that of local Apem as reported by Dzomeku *et al.* (2006b). The hybrid could be recommended as a good starchy staple for consumers of plantain.

The peel and pulp colour of banana, cooking banana and plantain were assessed as they serve as major criteria used by consumers, growers and research workers to determine whether a fruit is ripe or unripe. In the consuming countries, most consumers tend to associate the colour of the pulp to maturity. If the colour of the pulp of plantains were orange/yellow or light orange then the fruit was matured, if on the other hand it was white it indicates immaturity. In general the two cultivars studied had green peel colour (at matured unripe stage). Like plantains the pulp colour of FHIA-21 was light or bright orange comparable to white/creamy pulp colour of FHIA-03 as indicated by the L, a, b values (Table 3). The orange colour of the pulp is an indicative of the rich provitamins and carotenoids (Gowen, 1995). The white/creamy pulp colour of FHIA-03 is indicative of the high banana characteristic of the parental genome. The results for the peel and pulp colours of the cultivars studied were similar to the results of (Dadzie, 1993). There was no difference between the peel and pulp colour of the hybrids and the landrace.

CONCLUSION

The study has revealed that FHIA-21 and FHIA-03 were high energy yielding carbohydrate FHIA-03 however has higher potassium content than FHIA-21 showing that though grown in the same area, it could mine the mineral more than FHIA-21. The fat content of the tetraploid hybrids was higher than that of reported values for triploids signifying higher calorific value. The nutritional composition of the hybrids matches that of the local. However the high moisture content of the hybrids makes them easy to cook to conserve energy.

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