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Nutritional Content and Functional Properties of French Horn, False Horn and FHIA-21

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ABSTRACT

Comparative study of the nutritional composition of the green stages of fruits of FHIA-21 (tetraploid hybrid), French Horn and False Horn as well as the effect of steam blanching on some selected functional properties of their flours were determined by the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana. The standard AOAC methods were used to determine the nutritional composition. The results showed that the nutritional composition of the hybrid were different from that of French and False Horn. The hybrid had higher fat content (4.05%) than French (1.24%) and False Horn (3.47%). FHIA-21 also compared favorably with that of False and French horn in terms of moisture (69.50%), ash (2.45%), fibre (1.62%), potassium (1150 mg/100 g), sodium (43 mg/100 g) and iron (1.01 mg/100 g). Blanching significantly increased the solubility of FHIA-21 but decreased that of False Horn and French Horn; increased the swelling power of all three plantain varieties and decreased the water binding capacity among all three plantain varieties. Blanching also increased the pH of the flour of FHIA-21 but decreased that of French and False Horn and though insignificant ($p>0.5$) increased moisture uptake in all three plantain varieties.

Key words: Tetraploid, nutritional value, flour, plantain, musa

INTRODUCTION

Plantain, cooking banana and banana (*Musa* sp. AAB, AAA and ABB groups) are important staple crops that contribute to the calories and subsistence economies in Africa. 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 are known to be a great source of calcium, vitamins A, B_1, B_2, B_3, B_6, C and minerals such as potassium and phosphorous. In Ghana plantain contributes about 13.1% of the Agricultural Gross Domestic Product (AGDP) and its per capita annual consumption of 96.4 kg per head (Lescot, 2000) is higher than other starchy staples except cassava. It is of great socio-economic and nutritional significance and generates considerable employment. Plantain cultivation is attractive to farmers due to the low labour requirements for production compared with cassava, maize, rice and yam (Marriott and Lancaster, 1983). Annual production in the country is about 1.8 metric tonnes for plantain (AAB subgroup) of which only 0.5 tonnes is exported (Lescot, 2000) and 7.9 metric tonnes for banana of which 3.4 metric tonnes is exported (Lescot, 2000). Several varieties of plantain are cultivated in West Africa. These are classified as

French Horn Plantain, False Horn Plantain, or the True Horn Plantain (Ahiekpor, 1996; Hemeng *et al.*, 1996). All these native varieties are classified as triploids with AAB as the genomic group.

Despite the high value of plantain and banana, growing pest and disease pressures have affected production, the most notable being the fungal disease Black Sigatoka *(Mycosphaerella fijiensis)* (UTA, 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 were introduced in 1994 to supplement the landraces. The tetraploids were produced when female fertile triploid landraces of plantain (AAB genomes) are crossed to diploid accessions of *M.acuminata* or *M. balbisiana* that are resistant to black Sigatoka disease (Oselebe *et al.*, 2006). They belong to the AAAB genomic group.

The tetraploid hybrids are high yielding and disease tolerant, however their nutritional composition and functional properties compared with the land races has not been determined. It was therefore necessary to evaluate the hybrids alongside the landraces. This study was to compare the nutritional composition as well as some selected functional properties of the hybrid (FHIA -21) with two local land race (False and French Horn).

MATERIALS AND METHODS

French Horn, False Horn and FHIA-21 were harvested from the Plantain orchard of the Crops Research Institute in Kumasi, Ghana in November, 2008. Harvesting was done at physiologically matured stages of the fruits and taken to the laboratory for analysis.

Nutritional analysis: Moisture, crude fat, ash, crude protein and crude fibre contents were determined on 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 (AOAC, 1990; Allen *et al.*, 1984).

Functional analysis: Sliced samples from each variety were thoroughly mixed and divided into two. One portion was steam blanched (BLA) for 10 min and the other was not pretreated and it served as the control (CON). The sliced plantains all of equal thickness (10 mm) were then placed in trays and dried using a Gas drier at a drying temperature of 60°C. Drying was completed when a constant weight was obtained. Dried samples were milled using an end runner mill to produce flour. Flours were analyzed for functional properties.

Moisture contents were determined by official method of analysis (AOAC, 1990). Swelling power and solubility determinations were carried out based on the method of Oduro *et al.* (2006). Water binding capacity of the flour was determined by the method of Yamazaki as modified by Medcalf and Gilles (1965). pH of the flour was determined by the method of Oduro *et al.* (2006). Bulk density was determined according to Horsfall *et al.* (2005). Rehydration ratio was determined by the method of Lewicki (1998).

Results were analyzed for variance using STATGRAPHICS CENTURION XV.

RESULTS AND DISCUSSION

The moisture content showed no significant difference ($p<0.05$) between French and False Horn and this could be attributable to the fact that these two varieties belong to the same genomic group.

Table 1: Comparison of the proximate and mineral analysis of French Horn, False Horn and FHIA-21

Parameters	French Horn	False Horn	FHIA-21
Moisture (%)	62.50 (1.24)^{a}	61.10 (1.51)^{ab}	69.50 (2.04)^{c}
ASH (%)	1.82 (0.30)^{a}	2.29 (0.11)^{ab}	2.45 (0.03)^{b}
Protein (%)	5.03 (0.02)^{a}	3.06 (0.00)^{b}	3.72 (0.04)^{c}
Fat (%)	1.24 (0.42)^{a}	3.47 (0.06)^{b}	4.05 (0.12)^{c}
Fibre (%)	0.50 (0.09)^{a}	0.69 (0.04)^{ab}	1.62 (0.54)^{c}
Carbohydrate (%)	28.91 (1.18)^{a}	29.39 (1.40)^{a}	18.66 (2.09)^{b}
Minerals			
K (mg/100 g)	794.50 (4.30)^{a}	1068.00 (3.7)^{bc}	1150.00 (4.80)^{c}
Na (mg/100 g)	33.10 (0.04)^{a}	39.83 (0.06)^{b}	43.20 (0.8)^{c}
P (mg/100 g)	0.75 (0.02)^{a}	0.95 (0.03)^{b}	0.52 (0.09)^{c}
Fe (mg/100 g)	0.71 (0.02)^{a}	0.87 (0.04)^{b}	1.01 (0.01)^{c}
Ca (mg/100 g)	15.40 (0.83)^{a}	21.40 (0.99)^{b}	7.50 (1.24)^{c}

Mean values with the same superscript on the same row are not significantly different at 5% level. Parameters in bracket are the standard deviations

Meanwhile that of FHIA-21 was significantly different from the two triploids. The value obtained for FHIA-21 and French horn were higher than what was reported (60 and 53%, respectively) by Dzomeku *et al.* (2006) whereas that of False Horn was slightly lower than that reported (61.6%) by Onwuka and Onwuka (2005). The difference might be due to age of the plantain as well as agronomic and environmental factors. Since moisture contents of the three varieties were all greater than 61% (Table 1) the implication is that the composition is mainly moisture and carbohydrate and this is consistent with plantains.

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 lower the moisture content the greater the energy content due to the high carbohydrate content.

Though the ash content of the three varieties were low, FHIA-21 recorded the highest ash (2.45%) content whereas French Horn recorded the lowest (1.82%) and were significantly different ($p < 0.05$). The ash content of False Horn however was not significantly different from that of FHIA-21. FHIA-21 recorded 1150.00 mg/100 g, 43.20 mg/100 g, 0.52 mg/100 g, 1.01 mg/100 g and 7.5 mg/100 g for K, Na, P, Fe and Ca (Table 1), respectively. This indicated that the levels of K, Na and Fe in FHIA-21 were significantly higher than False and French horn. It is reported that plantains are rich in vitamin B_6 and the combination of the vitamin B_6 and potassium makes it nature's brain food, since these two substances are essential for proper brain function (Gowen, 1995).

The sodium levels were low while potassium levels were high; however, the high potassium provides a protective effect in instances of excessive sodium intake (Meneely and Batterbee, 1976). The high potassium level in the hybrid may be an added advantage of FHIA-21 over False and French horn for use as a therapy (Dzomeku *et al.*, 2006). As regards iron, plantain is a poor source; however, unlike other foods the iron provided by plantain is 100% utilizable by the human body as reported by Dzomeku *et al.* (2006).

French horn recorded lower values in all mineral parameters determined. Meanwhile for Ca and P, False Horn recorded higher values than FHIA-21. Calcium and phosphorous are vital for the bone. This was consistent with the ash content recorded in False Horn. The values herein obtained were lower than reported values by Adeniji and Tenkouano (2008), (K, 1160 mg/100 g;

Na, 49.8 mg/100 g; P, 120 mg/100 g, Fe, 9.46 mg/100 g and Ca, 75 mg/100 g). This discrepancy could be attributed to differences in morphological traits and physiochemical characteristics.

The crude protein content of the three varieties was significantly different ($p<0.05$). French Horn (5.03%) recorded the highest protein content where as FHIA-21 (3.06) recorded the lowest. The crude protein content obtained was comparatively higher than those recorded in literature for some other *Musa* spp. Oduro *et al.* (2006) reported 1.09% for cooking banana whereas Onwuka and Onwuka (2005) reported 2.8% for False horn. These values may be due to environmental difference especially soil used in cultivation. The protein content obtained indicates that French Horn is comparatively rich in protein and could be taken as a high source of protein among Musa species.

Dietary fibre and fat content were significantly different ($p<0.05$) among the three plantain varieties. FHAI-21 recorded the highest values for both dietary fibre (1.62%) and fat (4.05%) content whereas French Horn (fibre, 0.5%; fat 1.24%) recorded the lowest signifying a higher calorific value for the tetraploid.

FHIA-21 had the lowest carbohydrate (18.66%) content which may be due to the high moisture of this variety. Also the low carbohydrate content can be attributed to high values obtained for all other parameters apart from moisture. False Horn (29.39%) recorded the second highest carbohydrate content though it had lower moisture content than French Horn (28.91%) and this is further attributable to high values obtained for the other parameters apart from moisture.

Although the protein and lipid contents of these plantain flours were low compared with infant formula from commercial outlets, fortification of wheat-plantain flour with animal protein sources such as powdered milk and ground crayfish would improve the nutrient contents of these flours.

The effect of blanching on the moisture content of the three plantain varieties under the two treatment conditions are consistent with those obtained (2.36%-11.75%) in literature (Emperatriz *et al.*, 2008; Kayisu and Hood, 1981) and are indicative of flours with a stable shelf life (<20.0% moisture). Meanwhile it was observed that blanching decreased the moisture content of FHIA-21 and False Horn but increased that of French Horn. Furthermore comparative study of the moisture content of the flour of the three plantain varieties indicated a significantly higher moisture content ($p<0.5$) of French Horn than False Horn and FHIA-21.

Blanching significantly increased the solubility of FHIA-21 but decreased that of False horn and French horn. In separate studies blanching increased the solubility of unripe banana flour (Muyonga *et al.*, 2000). The discrepancy here could be attributed to differences in variety, morphology and physiology. The solubility of French horn was significantly ($p<0.5$) higher than that of FHIA-21 and False horn for the blanched samples. The solubility measured for the three plantain varieties are much lower than 11.79% recorded for FHIA-03 a cooking banana (Oduro *et al.*, 2006). The low solubility observed for the three plantain varieties treated in different ways could be attributed to the inability of hydrogen bonds to continue to be disrupted when the aqueous suspension of flour is raised above its gelatinization range so that water molecules can become attached to the liberated hydroxyl groups (Rickard, 1991).

Blanching increased the swelling power of all three plantain varieties. Bainbridge *et al.* (1996) stated that good quality starch with high starch content and paste viscosity will have a low solubility and high swelling volume and power. A similar observation was made in that whilst the solubility values were low the swelling powers were appreciably high. The swelling power may be attributed to the low levels of fat (Table 2) by the three plantain varieties. This is because high levels of fat leads to the formation of amylose-lipid complexes that restrict swelling. It might also

Table 2: Effect of steam blanching on selected functional properties of flours form the three plantain varieties

	Variety					
	FHIA-21		False Horn		French Horn	
Functional property	CON	BLA	CON	BLA	CON	BLA
Moisture (%)	3.36^{b} (0.01)	3.48^{bc} (0.05)	3.75^{d} (0.11)	3.20^{a} (0.07)	3.95^{e} (0.07)	5.04^{f} (0.03)
Solubility (%)	0.40^{c} (0.01)	0.62^{d} (0.03)	0.29^{ab} (0.17)	0.15^{a} (0.06)	1.65^{e} (0.24)	1.51^{ef} (0.11)
Swelling power (%)	8.48^{ab} (0.07)	9.01^{c} (0.01)	8.55^{a} (0.07)	8.60^{a} (0.07)	8.66^{a} (0.04)	9.75^{d} (0.07)
Water binding capacity (g g^{-1})	0.50^{a} (0.07)	0.49^{a} (0.04)	0.57^{ab} (0.07)	0.50^{b} (0.19)	0.53^{a} (0.28)	0.42^{bc} (0.33)
pH	6.02^{a} (0.04)	6.22^{b} (0.00)	6.47^{c} (0.05)	6.21^{b} (0.01)	6.21^{b} (0.08)	6.14^{ab} (0.01)
Bulk density (g/cc)	0.56^{a} (0.01)	0.58^{a} (0.03)	0.58^{a} (0.03)	0.60^{b} (0.02)	0.52^{a} (0.01)	0.57^{a} (0.04)
Rehydration ratio (mg g^{-1})	1000.16 (0.04)^{a}	1002.33 (0.06)^{b}	1000.34 (0.01)^{a}	1000.38 (0.02)^{a}	1000.40 (0.04)^{a}	1000.64 (0.01)^{a}

Mean values with the same superscript on the same row are not significantly different at 5% level. Parameters in bracket are the standard deviations. CON: Untreated; BLA: Steam blanched

be due to a more highly ordered internal arrangement of the starch granules as found in yam with a swelling capacity of 9% (Soni *et al.*, 1985). These values determined were comparable those reported for soybean fortified yam flour (6.8-9.6%) by Jimoh and Olatidoye (2009).

Water binding capacity is an indication that particular flour would be useful in food system such as bakery products which require hydration to improve handling characteristics. Giami and Alu (1993) assert that water binding capacity of 1.25 g g^{-1} and above is an indication of good bakery material. These values were lower than what were reported for other flours. Oduro *et al.* (2006) reported 1.54 g g^{-1} for the water binding capacity of FHIA-03 a hybrid cooking banana. Mepba *et al.* (2007) reported 0.65-2.84 g g^{-1} for wheat/plantain flour. These lower values could be associated with lower carbohydrate content in these plantain flours whose complex molecule will demand less water during hydrolysis (Oduro *et al.*, 2006). Blanching mean while decreased the water binding capacity among all three plantain varieties.

Blanching increased the pH of the flour of FHIA-21 but decreased that of French and False Horn. Emperatriz *et al.* (2008) reported values in the range of 4.6-6.1 when plantain flours were produced from different dehydration procedures. Dadzie (1998) reported values within the range of 6.0-6.5. Deviations from reported values could be attributed to variations in temperature and pretreatment as well as differences in the morphology of the plantain varieties.

Though insignificant, blanching prior to dehydration increased the bulk density of the flours from the three plantain varieties. This was consistent with observations made by Muyonga *et al.* (2000). According to Bhattacharya and Prakash (1994) bulk density of foods increases with increase in starch content. Meanwhile, Okezie and Bello (1988) stresses that high bulk density of food material is important in relation to its packaging.

Ponting *et al.* (1966) pointed out that less rehydration would be an advantage for dried fruits as snack products because of low hygroscopicity of pretreated dried products since they can be exposed for several hours without becoming sticky and mouldy. Though insignificant ($p>0.5$) blanching increased moisture uptake in all three plantain varieties. The generally low rehydration ratios determined is an indication that flours produced from these three plantains varieties have good keeping qualities based on their low hygroscopicity and that they can be exposed for long without becoming sticky or going mouldy.

CONCLUSION

Comparison of the proximate analysis of the three varieties indicated marked variations in the nutritional status of the three plantain varieties with FHIA-21 comparing favorably with that of False and French horn in terms of ash, fat, fibre, potassium, sodium and iron. Blanching significantly increased the solubility of FHIA-21 but decreased that of False Horn and French Horn; increased the swelling power of all three plantain varieties and decreased the water binding capacity among all three plantain varieties. Blanching also increased the pH of the flour of FHIA-21 but decreased that of French and False Horn and though insignificant ($p>0.5$) increased moisture uptake in all three plantain varieties. The results obtained confirm the feasibility of producing plantain flour with moisture contents with adequate levels for a stable shelf life. The results also show that the functional properties of the flours are affected by blanching. Moreover, information is made available for the applicability of the flours as a function of their different functional properties as resulting from effects different pretreatments.

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