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PHYSICO-CHEMICAL COMPOSITION OF UNRIPE (GREEN) PLANTAIN AND BANANA HYBRID FRUITS

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ABSTRACT

Post harvest characteristics are important selection criteria in the genetic improvement of starchy staple food crops. This study aimed at determining the proximate chemical constituents of thirteen clones of new plantain and banana hybrids at harvest. Flour was produced and analysed for starch and sugar contents. The pulp dry matter content and texture were determined using pulp from unripe fruit. Results show that a triploid plantain, 23688-2 had the highest (38.7%) pulp dry matter content amongst the hybrids. The dry matter content of Agbagba and Obino l'Ewai were 38.8% and 37.8%, respectively. Starch content was highest (81.7%) in 25273-1 and lowest (71.0%) in 25502-S4. The highest total sugars (2.6%) was found in 1658-4, while 25729-5 had the lowest (0.4%). Pulp resistance was highest (33.7 N) in 15108-6 and lowest (16.0 N) in 25333-S90. Agbagba had a pulp resistance of 34.3 N, which was higher than that of Obino l'Ewai with 29.9 N. These observations suggest that there is potential for good cooking and sensory qualities in *Musa* hybrids.

KEYWORDS: Genetic improvement, dry matter content, pulp resistance, cooking and sensory qualities, shelf life.

INTRODUCTION

Plantain (*Musa* spp.) fruit is a staple food crop in West and Central Africa, Latin America and the Caribbean, where their starchy fruits are generally cooked or fried before consumption. In most developing countries, where plantains are consumed as staple food, the predominant method of cooking include boiling or steaming, frying, roasting, or baking. Flour may be produced from green fruit and reconstitute in boiling water to form a thick paste, which is often eaten with vegetable soup. The diversity of culinary uses of plantain depends largely on the texture and composition of the fruit. Dadzie (1995) reported that consumers of boiled green plantains usually prefer cooked fruits with firm and 'crunchy' texture rather than too soft and water soaked. The demand for new plantain and banana hybrid in Nigeria is increasing. This underscores the need for the dissemination of black Sigatoka resistant plantain and banana and their post harvest potentials. In this study, new plantain hybrids were screened for physico-chemical characteristics and compared to the existing black Sigatoka susceptible traditional plantains as part of strategies to evaluate their acceptability.

The International Institute of Tropical Agriculture (IITA) has bred several *Musa* hybrids, which combine high yield with disease resistance. Tetraploid hybrids produced heavier bunch than their parents (Vuylsteke *et al.*, 1997). However, the introgression of genes of bananas may alter fruit quality characteristics in the hybrids, which may in turn affect shelf life, chemical composition, cooking qualities, and consequently, consumer acceptability. Understanding of the major chemical components of *Musa* hybrids may form the basis for expanding their utilization. The aim of this study is to provide information to plant breeders to be used as criteria for plantain and banana improvement strategies.

MATERIALS AND METHODS

Fifteen *Musa* genotypes consisting of eleven plantain hybrids (1658-4, 15108-6, 23688-2, 23977-7, 25273-1, 25291-S41, 25333-S90, 25344-18, 25502-S4, 25729-5, A5-SPS 548-9), and two banana hybrids (5295-1 and FHIA 3) were used for this study. Two African plantain landraces, Agbagba and Obino l'Ewai were used as reference cultivars. Bunches were harvested at matured green unripe stage, and converted to flour using the method described by Adeniji and Empere (2001). Bunches were de-handed and individual fruit de-fingered into a bucket of water to wash the fruit from dirt and possible spray before peeling. Fresh pulps were oven dried at 60°C for 48 hours and milled to pass through 150-850 µm sieves. The starch and sugar content of the flour samples were determined using the method of Joslyn (1970) and Kayisu *et al.* (1981). The dry matter content of the fresh pulp was determined using AOAC (1990) procedures. Pulp texture (resistance) was determined using the method described by Dadzie and Orchard (1997). The fruit was cut transversely at the mid-point, 2-3 cm of fruit tissue (containing both the peel and the pulp), placed on a perspex with the pulp (which is to be measured) facing the pointed end of the probe. The probe was driven into the pulp up to the inscribed line (1.3cm) on the plunger at a constant speed. The force required to penetrate 1.3cm of pulp tissue with a 1.14cm diameter cylindrical probe mounted on a bench-top 250 N firmness tester was then taken. The readings were taken by a trained personnel for comparative and consistent results. All reagents were of analytical grade, and data analysis was performed using Statistical Analysis Systems (SAS) software package (SAS, 1996). Linear (Pearson) correlation and analysis of variance (ANOVA) were used to test for differences among samples. Both the Duncan's New Multiple Range Test and the Least Significant Difference (LSD) Test were employed to separate sample means that were significantly different at 5%, 1% and 0.1% level of probability.

RESULT AND DISCUSSION

The data on the dry matter content are presented in Table 1. Starch and sugar, and textural characteristics of fruit are shown in Tables 2 and 3, respectively. A triploid plantain genotype, 23688-2 had the highest dry matter content (38.7%) amongst the hybrids. The dry matter content of the plantain landraces, Agbagba and Obino l'Ewai were 38.8% and 37.8%, respectively. Pulp resistance for 15108-6 was 33.7N, while Agbagba and Obino l'Ewai had 34.3N and 29.9N, respectively. On a dry weight basis, 25273-1 had the highest starch (81.7%), while 25502-S4 had the lowest (71.0%). The two plantain landraces, Obino l'ewai and Agbagba had 81.5% and 81.4% starch, respectively. The highest sugar content (2.6%) was obtained in 1658-4. The total sugar in FHIA 3 and 25502-

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S4, were 2.2% and 2.1%, respectively. The hybrid 25729-5 had the lowest sugar content of 0.4%.

Table 1: Pulp dry matter content for a selection of *Musa* hybrids at harvest.

Plantain hybrids	Dry Matter Content (%)
1658-4	35.0
15108-6	31.0
23688-2	38.7
23977-7	29.7
25273-1	28.2
25291-S41	28.4
25333-S90	30.6
25344-18	30.5
25502-S4	33.5
25729-5	32.9
A5-SPS 548-9	33.7
Banana hybrids	
5295-1	31.3
FHIA 3	33.4
Plantain Landraces	
Obino l'Ewai	37.8
Agbagba	38.8

The starch content of 25273-1 (81.7%) at harvest was higher than that of Agbagba, the preferred plantain landrace in Nigeria. The starch content (81.0%) in A5-SPS 548-9 is comparable to the values obtained for the landraces, Agbagba and Obino l'Ewai. Pasting properties is a means of determining the potential cooking quality of plantain flour (PBIP, 1995). The triploid plantain hybrid 25273-1 is anticipated to have a comparably high viscosity due to its high level of starch. Plantain absorbs some quantity of water during boiling, and this results in softening of the pulp. The amount of water absorbed depends on the duration of cooking, starch content and the cultivar (Dadzie, 1995). Total sugar was highest in 1658-4 with 2.6%, while FHIA 3 and 23688-2 had 2.2% and 2.1% total sugars each. Agbagba was second to last in total sugars with 0.5% after 25729-5 with 0.4%. The preference for cooking qualities of Agbagba by Nigerians is as a result of high level of starch (Ferris *et al.*, 1996). It is therefore anticipated that triploid plantain genotype (25273-1) and tetraploid plantain (A5-SPS 548-9) could be recommended to farmers, processors, and consumers based on high level of starch associated with these cultivars.

The dry matter content of plantain fruit relates to good cooking qualities (Dadzie, 1995 and Vuylsteke *et al.*, 1997) and storage life (Vuylsteke *et al.*, 1997). This suggests that there is a potential to discriminate genotypes by dry matter content, where higher dry matter content would suggest better cooking qualities and extended storage life. Plantain hybrids, by this study have been shown to contain high dry matter content in the pulps. It was also observed that plantain landraces and most of the plantain hybrids had higher pulp resistance than banana hybrids.

Starch was highest in 25273-1 fruit and lowest in 25502-S4. Generally, the starch contents of the hybrids are comparable to those of the plantain landraces. Similar findings are contained in the report of Ketiku (1973), PBIP (1994) and Ferris *et al* (1996). Expectedly, the total sugars were low in green unripe fruit with 1658-4 having the highest value. In the hydrolysis of starch to sugar during ripening in *Musa* spp. fruit, there is a rise in the content of total soluble solids and total sugars as given by Collin and Dalnic (1991). Ripe plantain hybrids may be economical in the manufacture of bakery products, and other products that require sugar in their formulation, since the level of sugar may be reduced in the recipe formulation (Izonfuo and Omuaru, 1988). Black Sigatoka resistant *Musa* hybrids could complement the existing plantain landraces, which are all known to be susceptible to black Sigatoka disease considering the results of this study.

Table 2. Starch and Sugar contents on dry basis for a selection of *Musa* hybrids at harvest

Plantain hybrids	Starch Content (%)	Sugar Content (%)
1658-4	75.4	2.6
15108-6	75.7	1.1
23688-2	73.2	1.9
23977-7	76.5	0.5
25273-1	81.7	0.8
25291-S41	74.8	0.7
25333-S90	74.1	0.9
25344-18	79.8	1.3
25502-S4	71.0	2.1
25729-5	75.6	0.4
A5-SPS 548-9	81.0	0.6
Banana hybrids		
5295-1	74.3	0.7
FHIA 3	71.9	2.2
Plantain Landraces		
Obino l'Ewai	81.5	0.6
Agbagba	81.4	0.5

Table 3. Textural (fruit resistance) characteristics of selected *Musa* hybrids at harvest.

Plantain hybrids	Pulp resistance (firmness/hardness) N
1658-4	26.6
1F108-6	33.7
25273-1	25.7
25291-S41	20.2
25333-S90	16.0
25344-18	18.5
25502-S4	32.8
25729-5	31.9
A5-SPS 548-9	22.5
Banana hybrids	
5295-1	18.7
FHIA 3	17.9
Plantain Landraces	
Obino l'Ewai	29.9
Agbagba	34.3

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