NUTRITIONAL, PHYSICAL AND CULINARY CHARACTERISTICS OF TUBEROUS ROOTS OF NEWLY DEVELOPED SWEET POTATO GENOTYPES NIGERIA

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ABSTRACT

Randomly selected tuberous roots of eight newly developed sweet potato (Ipomea batatas) genotypes in National Root Crop Research Institute Umudike, Nigeria were assessed for their food quality characteristics amongst other relevant pre and post harvest traits. Ex- Igbariam and Tis 87/0087 cultivars of sweet potato were respectively used as local and national checks or controls. The result of the proximate composition of the fresh energy rich roots showed that seven of the new genotypes had high dry matter (DM) content of above 35%, with seven of them NRCRI, having starch content of above 20%. Only two of the largely white – cream fleshed genotypes (NRSP/05/007C and NRSP/05/006C) had carotenoid content of > 10µg/g. The result also showed that while only one genotype (NRSP 05/005A) had low after cooking sugariness, two of them had undetectable food browing (before and after cooking). The observed rotund and easy to cut, white fleshed tuberous roots of the low sugary (non-sweet) NRSP/05/10D genotype is likely to be popular with many Nigerian adult consumers that do not like the sugary taste of most sweet potatoes in the local markets.

Key words: Sweet potato, improved genotypes, tuberous roots, nutritional properties, culinary characteristics

INTRODUCTION

Sweet potato (*Ipomea batatas*) is one of the energy rich root crops in the tropics. (Degras, 2003). Collins and Walter (1990) and Loebenstein and Thottapilly (2009) also reported that the tuberous roots of sweet potato can be a source of other nutritionally important dietary factors. Efforts to increase consumption of sweet potato must go hand in hand with efforts to create awareness of nutritional composition of sweet potato tuberous roots, and to educate consumers on nutritional benefits of eating sweet potato. In many areas where a carbohydrate source can be exploited for human consumption (and where yields are relatively low), breeding and cultural efforts should be directed towards increasing yields, nutritive values and relevant culinary characteristics. Developing sweet potato varieties with roots containing utilizable balanced carbohydrate, proteins, minerals and other composites in sufficient quantity can sustain health if also eaten in sufficient quantity.

In the past few years, Sweet potato Programme of National Root Crops Research Institute Umudike (NRCRI) had succeeded in developing eight new high yielding sweet potato genotypes that are tolerant to major pests and diseases (with adequate cultural practices) through hybridization. However, before these new genotypes can be released to the local farmers and other end users (after their official registration); there is a need to document food quality characteristics amongst other relevant pre and post harvest traits. This study was therefore carried out to determine the proximate composition, physical attributes and relevant culinary characteristics of the root tubers of the developed sweet potato genotypes vis-à-vis those of the other elite sweet potato cultivars in Nigeria.

MATERIALS AND METHODS

Source of experimental tubers: Freshly harvested new sweet potato genotypes (NRSP/05/003, NRSP 05/005A, NRSP /05/007C, NRSP/05/008F, NRSP/05/10B, NRSP/05/005P, NRSP/05/006C and NRSP/05/10D) using Ex- Igbariam and TIS 87/0087 as controls or checks used for the experimentation were obtained from Sweet Potato Programme of National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria.

Proximate Composition, Starch and Carotenoid Determinations:

Oven drying (at 70^{O}c) to constant weight of triplicates of 10g diced root samples ($5mm^3$) from the fresh harvests of each of the experimental genotypes (after random selections) was used for the dry matter determination.

$$\% \text{ Dry matter} = \frac{\text{Final weight} \times 100}{\text{Fresh weight}}$$

Powdered samples (in triplicates) of the dehydrated roots of the experimental genotypes were used for the proximate composition (protein, fat, fibre, ash and carbohydrate) determinations using the standard AOAC methods (AOAC, 1997). The energy value (calorific value) of the dehydrated experimental materials, using the Atwater factors, were calculated in kcal per 100g as [(% carbohydrate x 4) + (% protein x 4) + (% fat x 9)]. (Davidson et al., 1975). Gravimetric or sedimentation method was used in triplicates for the starch analysis of the completely disintegrated tuberous samples (Onwuka, 2005), while spectrophotometric method (at 450nm wavelength) using petroleum ether as the final extracting solvent and blank (in 1 cm glass cuvette) for the carotenoid determination of the replicated (in triplicates) sweet potato samples (Rodriguez- Amaya and Kimura, 2004; Ukpabi and Ekeledo, 2009).

Physical and culinary characterizations

Physical and culinary characteristics of the experimental roots (peel loss, skin colour, flesh colour, sugariness before and after cooking) were also determined in triplicate where necessary. Manual peeling with kitchen knives of about 20kg heaps of the freshly harvested tuberous roots was used for the percentage peel loss determinations as follows:

$$\text{Peel loss } (\%) = \frac{\text{Peel weight} \times 100}{\text{Weight of tubers (20kg)}}$$

Visual observation by the authors was used to record the tuber skin and flesh colours before and after cutting of the tubers of the respective experimental genotypes. The buccal taste buds of the experimenters or authors were used to determine the levels of sugeriness of the peeled diced (1 cm^3) raw and boiled root tubers of the genotypes. Tuber shape was also visually done with the assistance of documented sweet potato tuberous roots by Degras (2003).

Statistical Analysis:

The statistical analyses were done with the statistical Analysis system (SAS) Software version 8 (TSMO) licensed to International Institute of tropical Agriculture, Ibadan, Nigeria (Site 0022206002)

RESULTS AND DISCUSSIONS

The proximate composition of the experimental energy rich roots in Table 1 shows that seven of the NRCRI new genotypes (like the control cultivars) have high dry matter (DM) content of above 35%; with NRSP/006C having above 45% DM. The observed variations in the proximate compositions of the experimental sweet potato roots is similar to earlier report on variation in the proximate composition of the roots of sweet potato cultivars or land races in Nigeria (Ukpabi *et a*l, 1987). Seven of the NRCRI new genotypes also have starch content of above 20% which shows that they are highly starchy and may also be used as a source of industrial search and fermentable carbohydrate for ethanol production (Degras, 2003).

Table 1: Dry matter content of the experimental roots and their proximate composition after dehydration

Genotype	Dry Matter (%)	Crude Fibre (%)	Fat (%)	Ash (%)	Crude protein (%)	Carbo-hydrate (%)	Calorific value (kcal/100g)
NRSP/05/003B	41.55±0.41	0.89±0.27	3.17±0.27	1.15±0.00	6.13	88.66	407.69
NRSP 05/005A	38.25 ±0.02	1.07±0.13	2.19±0.64	1.20±0.02	2.63	92.91	401.87
NRSP/05/007C	43.19 ±0.33	1.27±0.18	5.26±0.93	2.45±0.02	2.63	88.39	411.42
NRSP/05/008F	38.15±0.03	0.86±0.06	2.28±0.17	1.85±0.00	1.75	93.26	400.56
NRSP/05/10B	38.62±0.26	1.51±0.01	1.77±0.10	2.15±0.03	1.75	92.82	394.21
NRSP/05/005P	31.40±8.10	1.42±0.23	2.21±0.04	1.80±0.02	1.75	92.82	398.17
TIS 87/0087	37.36±0.22	1.31±0.07	2.51±0.16	1.85±0.23	2.63	91.70	399.91
Ex-Igbariam	41.39±0.33	1.58±0.14	2.10±0.14	1.10±0.13	0.89	94.33	399.78
NRSP/05/006C	45.79±0.02	1.85±0.04	2.29±0.38	1.15±0.00	2.63	92.08	399.45
NRSP/05/10D	40.29±0.41	1.29±0.01	3.54±0.08	1.25±0.21	1.75	92.17	407.54

Only two of the genotypes (NRSP/05/007C and NRSP/05/006C) have carotenoid content of >10 µg/g (Table 2) that are of even higher value than most of the carotenoid rich light yellow fleshed cassava root being developed in NRCRI (Egesi *et a*l, 2008) . High carotenoid content also cause the yellow to orange colouration of the tuberous roots of sweet potato (Degras, 2003). Though most of the sweet potato land races in Nigeria are white fleshed, orange flesh sweet potato (OFSP) with up to 50ppm carotenoid content is now being popularized in the country as it can contribute in the alleviation of vitamin A deficiency, especially amongst malnourished children and women (Ukpabi and Ekeledo, 2009). This is more so as β-carotene, which is the most potent pro-vitamin A carotene, is the predominant carotene in sweet potato root tubers (Rodriguez- Amaya and Kimura, 2004; Ukpabi and Ekeledo, 2009).

The results of the physical properties of the root tuber (Tables 3) indicated that only one of the newly developed genotypes (NRSP/05/007C) had light yellow colour while three of them (NRSP 05/005A, NRSP/05/10B and NRSP/05/10D) had roundish shape that will make for easier use of mechanical harvesters (Degras, 2003). Visually observed skin colours (red, purple and cream) had no observable direct relationship with the flesh

Table 2: Starch and Carotenoid contents of the fresh roots

Genotype	Starch (%)	Carotenoid (µg/g)
NRSP/05/003B	25.64±1.44	0.50±0.01
NRSP 05/005A	23.46±0.73	2.25±0.02
NRSP/05/007C	23.79±1.23	11.99±1.10
NRSP/05/008F	20.57±0.98	0.98±0.78
NRSP/05/10B	19.46±1.90	0.71±0.71
NRSP/05/005P	21.63±0.73	2.25±0.02
TIS 87/0087	21.10±0.23	6.45±0.00
Ex-Igbariam	25.07±0.57	5.33±3.92
NRSP/05/006C	23.61±1.21	10.36±0.01
NRSP/05/10D	22.07±0.01	5.01±0.59

colour (Table 3). Only one new NRCRI genotype (NRSP/05/005A) had low sugarineafter cooking while 2 of the NRCRI new genotypes (NRSP/05/008F and NRSP/05/006C) showed undetected browning phenomenon before and after cooking (Table 4). It could therefore be deduced that many of the experimental roots are prone to enzymatic browning
as earlier research reports has shown that some varieties of sweet potato exhibit oxidative browning during post harvest processing. (Okaka and Okaka, 2001). Like the control cultivars (TIS 87/0087 and Ex-Igbariam) , five of the new NRCRI genotypes are soft to cut, with all the newly developed genotypes having manual tuber peel loss of less than 13% (Table 4).

Table 3: Physical properties of the root tubers

Genotype	Shape	Skin colour	Flesh colour
NRSP/05/003B	Cylinderical	Red	White
NRSP 05/005A	Roundish	Purple	White
NRSP/05/007C	Cylinderical	Red	Light yellow
NRSP/05/008F	Cylinderical	Purple	White
NRSP/05/10B	Roundish	Cream	White
NRSP/05/005P	Cylinderical	Red	White
TIS 87/0087	Cylinderical	Light-red	Cream/white
Ex-Igbariam	Roundish	Cream	Light yellow
NRSP/05/006C	Cylinderical	Red	Cream
NRSP/05/10D	Roundish	Red	White

It is also pertinent to note that the agronomic yields obtained from the on-station field trials (in Umudike, Abia State and NRCRI out -station at Otobi, Benue State) showed that the yields of the experimental improved varieties were not inferior to those of the control cultivars. Infact, the field results of these breeders lines in the aforementioned on-station locations showed that their agronomic yields of 17-23 t/ha were higher than those of the locally preferred controls used in this study (Afuape *et al*, 2008).

Table 4: Culinary characteristics of the experimental roots

Genotype	Peel loss (%)	Cutting Hardness	Browning rate	Sugariness before boiling	Sugariness after boiling
NRSP/05/003B	4.36 ± 0.02	Not hard	Slow	High	Very high
NRSP 05/005A	6.02 ± 0.01	Hard	Slow	Very low	Very low
NRSP/05/007C	3.87 ± 0.05	Not hard	Fast	Very high	High
NRSP/05/008F	10.00± 0.03	Not hand	Nil	Moderate	Moderate
NRSP/05/10B	4.00 ± 0.01	Hard	Slow	Very high	High
NRSP/05/005P	6.21 ± 0.01	Hard	High	High	High
TIS 87/0087	7.82 ± 0.03	Not hard	Nil	Moderate	Moderate
Ex-Igbariam	10.46± 0.06	Not hard	Nil	Low	Low
NRSP/05/006C	12.21 ± 0.04	Not hard	Nil	Moderate	Low
NRSP/05/10D	9.58 ± 0.02	Not hard	High	Low	Low

CONCLUSION

Amongst the newly bred genotypes, NRSP/05/005A has tuberous roots with low sugariness (after cooking) while NRSP 05/005A, NRSP/05/10B and NRSP/05/10D have rotund tuberous root that are good for mechanical harvesting. The dehydrated edible roots of all the new genotypes have high energy or calorific value of 394 – 411 kilocalories/100g or 1649.3 – 1720.5kiljoules/100g (approximately 1.65MJ – 1.72MJ/100g) using 4.186 as the conversion factor (from kilocalories to kilojoules). Finally, tuberous roots from seven of the newly developed sweet potato genotypes were found to be good sources of food and industrial starch for relevant end users.

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