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Physicochemical, Nutritional and Processing Properties of Promising Newly Bred White and Yellow Fleshed Cassava Genotypes in Nigeria

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Abstract: Randomly selected fresh roots of sixteen experimental cassava cultivars (fourteen improved cultivars and two controls) in National Root Crops Research Institute, Umudike, Nigeria were assessed for their food quality characteristics amongst other relevant pre and post harvest traits. TMS 30572 and TME 419 cultivars of cassava were used as local and national checks or controls. The result of the physical properties of the experimental roots showed that those with yellow and cream pulp have high carotene content which is a precursor of Vit.A. The proximate composition result of the experimental energy rich roots showed that ten of the genotypes (like the control cultivars) have high Dry Matter (DM) content of above 30%; with nine genotypes having high protein content above 3% like the controls also. Seven of the new genotypes also have starch content of >20%, with only four of them having relatively high carotenoid of > 3 µg/g when compared with the control. It was observed also from this study that the yellow fleshed cassava gari look similar to the yellow gari (cassava+oil) found in Nigerian local market.

Key words: Cassava, newly bred cultivars, fresh roots, physicochemical, nutritional properties, processing properties

INTRODUCTION

Cassava is a major staple food crop in Nigeria and therefore the potentials of its products in the life of people of sub-Saharan Africa cannot be over emphasized. The importance of cassava to humanity, most especially in the tropics where food security is still a dream; the expanding demands for cassava food, feed and industrial raw material justify the need for the release of new varieties to the local farmers. According to Dapaah (1991), no continent depends as much on roots and tubers for feeding its population as does Africa. Of all root and tuber crops, cassava (*Manihot esculenta* Crantz) is the most important; it ranks 4th after rice, sugarcane andmaize as source of calorie for human need (CIAT, 1992).

However, the determination of biochemical properties and food quality characteristics of cassava varieties with a view to enhance their economic potentials to the end users should not be neglected. The selection of cassava materials for new release is likely to substantially depend on some biochemical properties such as starch and dry mater, cyanide level, root colour, garification to mention but a few. Before these new cultivars can be released to the local farmers and other end users (after their official registration), there is a need to document their food quality characteristics amongst other relevant pre and post-harvest traits. This study was therefore carried out to determine the proximate composition, physical attributes, gari properties and relevant carbohydrate characteristics of the cassava cultivars being evaluated for selection vis-á-vis 2 cassava varieties as control.

International Institute for Tropical Agriculture (IITA) Ibadan collaborated with National Root Crops Research Institute (NRCRI) Umudike in the breeding of the cassava varieties. Based on the determination and documentation of these biochemical properties and food qualities of the evaluated cassava cultivars carried out in this study some cassava genotypes have been released by the national variety release committee. All the released yellow cassava varieties have relatively high amylopectin content though they seemed to have relatively low starch content of 14-20%. Before this effort, Nigeria has no available history of yellow fleshed cassava cultivars.

MATERIALS AND METHODS

Source of experimental roots: Freshly harvested roots of the 16 experimental cassava cultivars (fourteen improved cultivars and two controls) used for the experimentation were obtained from Cassava Programme of National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria.

Physical characterizations: Physical characteristics of the experimental roots (Skin colour and pulp colour) were also determined in triplicate where necessary. Visual observation by the authors was used to record the root skin and pulp colours before and Jafter cutting of the root of the respective experimental genotypes.

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Carbohydrate Properties, Starch and Carotenoid Determination: Gravimetric or sedimentation method was used in triplicates for the starch analysis of the completely disintegrated root samples (Onwuka, 2005), while spectrophotometric method (at 450nm wavelength) using petroleum ether as the final extracting solvent and blank (in 1 cm glass cuvette) was used for the carotenoid determination of the replicated (in triplicates) cassava samples (Ukpabi and Ekeledo, 2009).

Dry matter content and Proximate Composition Determinations: Oven drying (at 70°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:

$$\text{Dry mater (\%)} = \frac{\text{Final weight}}{\text{Fresh weight}} \times 100$$

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).

Peel loss and gari properties determination: 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:

Fresh cassava root

↓

Peeling (manual or mechanical)

↓

Grating (mechanical grater)

↓

Bagging (Hessian or woven polypropylene)

↓

dewatering/fermentaion (2 to 5 days)

↓

Pulverizing/sifting (4mm sieve)

↓

Garification

↓

Cooling (ambient temperature)

↓

Gari

Packaging

Fig. 1: Flow chart for the production of gari

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

Furthermore, gari yield, bulk density, mash wt. andchaff weight of the roots were determined respectively using TME 419 and TMS 30572 as local and national checks or controls.

Gari processing method: Gari is a dry pregelatinized free flowing, granular, fermented, acidic (pH<4.5) product made from cassava roots. It is the most popular form in which cassava is presently eaten in West Africa. Figure 1 is the flow-chart for the production of high quality gari. The garification stage which involves the roasting (with stirring) of the partially dewatered and sifted cassava mash on a heated metallic (e.g., cast iron) surface, leads to dehydration of the mash and gelatinization of its starch.

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 results of the physical properties of the experimental roots (Table 1) indicate that the observed yellow and cream pulp have high carotene content which was found to be of appreciable quantity (Table 2). Recently in 2012, the National variety Release Committee has approved the release of three of the yellow fleshed cassava genotypes (TMS 01/1368, TMS 01/1412 and TMS 01/1371) for cultivation by the local farmers. Upon their release, the names of these varieties have been changed as follows: TMS 01/1368 to UMUCAS 36, TMS 01/1412 to UMUCAS 37 and TMS 01/1371 to UMUCAS 38. Researchers in National Root Crops Research Institute Umudike (NRCRI) and IITA, Ibadan are

Table 1: Physical properties of the experimental roots

Genotypes	Skin colour	Pulp colour
AR- 37- I08	Cream	White
TMS 30572	Brown	White
CR- 36- 5	Brown	White
01/1412	Light brown	yellow
02/0007	Brown	White
TME 419	Brown	Cream
01/13171	Brown	Yellow
CR- 12- 45	Brown	White
NR 03/0211	Brown	Cream
NR 03/0155	Brown	White
NR 02/0018	Brown	White
01/1368	Brown	Yellow
01/1206	Pinkish brown	Cream
AR 1- 82	Brown	White
03/0174	Brown	White
98/2132	Cream	Light yellow

Table 2: Carbohydrate properties and Carotenoid content of the fresh roots

Genotypes	Amylose (%)	Amylopectin (%)	Starch (%)	Starch Yeild (t/ha)	Carotenoid(μg/g)
AR- 37- I08	9.79±4.85	90.21±4.85	28.14±2.62	2.53±2.33	0.51±0.54
TMS 30572	22.88±0.33	77.12±0.33	30.97±2.62	5.73±2.38	1.28±0.46
CR- 36- 5	18.69±4.19	81.31±4.19	26.85±2.02	3.16±1.11	2.26±1.91
01/1412	21.39±2.21	78.61±2.21	14.29±0.95	1.85±1.03	3.31±1.29
02/0007	20.47±4.89	79.53±4.89	23.22±1.49	6.82±4.02	1.30±0.04
TME 419	16.92±0.82	83.08±0.82	19.22±4.16	3.07±2.26	1.13±0.16
01/13171	24.48±4.24	89.04±4.38	20.00±2.89	2.72±0.27	3.63±0.64
CR- 12- 45	21.21±0.02	78.79±4.03	13.47±0.60	3.09±2.17	1.09±0.15
NR 03/0211	14.84±0.211	85.16±0.21	38.56±14.37	5.93±3.08	2.58±0.94
NR 03/0155	14.47±0.73	85.53±0.74	24.40±1.90	7.46±2.82	0.51±0.04
NR 02/0018	13.89±0.95	86.11±0.96	17.84±2.63	4.37±0.18	0.96±0.02
01/1368	13.31±0.74	86.69±0.04	17.83±2.64	5.16±2.23	4.44±0.69
01/1206	2.88±1.04	97.13±0.73	22.91±2.19	4.28±0.27	1.91±0.24
AR 1- 82	10.16±1.39	89.84±1.39	17.26±0.57	2.99±0.03	0.86±0.16
03/0174	10.96±0.26	89.05±0.26	13.69±0.69	3.02±1.09	2.29±0.13
98/2132	14.54±0.13	85.47±0.13	18.07±3.56	3.18±2.37	4.79±0.01

Table 3: Dry matter content of the experimental root and their proximate composition after dehydration

Genotypes	DM	CF (%)	Fat (%)	Ash (%)	CP (%)	CHO (%)	Energy (KJ/100g)
AR-37-I08	42.54±0.11	1.53±0.18	3.66±0.01	0.38±0.04	2.79±0.27	91.11±0.18	1751.15
TMS 30572	42.22±0.47	4.92±6.34	2.71±0.33	0.40±0.00	5.47±0.06	89.58±1.60	1716.46
CR- 36- 5	39.49±0.12	1.13±0.24	3.21±0.18	1.10±0.07	3.46±0.43	91.11±0.78	1726.29
01/1412	26.51±0.01	1.81±0.13	3.20±0.76	1.04±0.01	3.72±0.05	90.31±0.79	1716.74
02/0007	28.44±0.50	1.89±0.41	3.08±0.17	0.88±0.11	2.07±0.04	92.08±0.11	1714.51
TME 419	30.91±0.55	1.09±0.21	0.33±0.01	0.11±0.01	3.87±0.09	94.60±0.28	1686.2
01/13171	33.84±0.89	2.14±0.15	3.16±0.14	0.55±0.01	2.75±0.07	91.39±0.09	1717.3
CR- 12- 45	24.09±1.61	1.18±0.14	2.63±0.38	0.82±0.03	6.12±0.02	89.09±0.00	1715.79
NR 03/0211	38.18±1.02	0.85±0.04	0.36±0.03	0.35±0.07	2.89±0.13	95.55±0.18	1686.80
NR 03/0155	37.71±0.48	0.62±0.06	0.17±0.04	0.45±0.07	7.92±0.05	90.85±0.04	1686.32
NR 02/0018	31.91±1.77	1.14±0.17	0.02±0.00	0.3 3±0.04	2.65±0.21	95.69±0.35	1679.09
01/1368	31.84±0.02	1.07±0.04	0.38±0.11	0.95±0.14	8.10±0.06	89.50±0.01	1673.26
01/1206	39.79±0.33	1.00±0.03	0.30±0.03	0.61±0.01	4.63±0.15	93.47±0.13	1678.80
AR 1- 82	29.1±0.65	0.83±0.24	0.1±0.08	0.68±0.11	5.59±0.13	92.80±0.02	1676.42
03/0174	30.09±1.52	1.24±0.08	0.23±±0.18	0.33±0.18	4.44±0.03	93.77±0.47	1715.37
98/2132	33.65±0.14	1.95±0.24	0.29±±0.24	0.58±0.11	5.22±0.08	91.52±0.07	1716.73

Table 4: Gari processing properties of the experimental roots

Genotypes	Peel loss (%)	Chaff wt (%)	Mash wt. (%)	Gari yield (%)	Bulk density (gml)
AR-37-I08	16.87±0.02	1.57±0.01	29.37±0.1	16.87±0.04	0.53±0.05
TMS 30572	25.22±0.08	1.06±0.04	45.65±0.08	26.52±0.02	0.55±0.03
CR-36-5	26.25±0.12	1.34±0.02	36.44±0.01	20.45±0.03	0.54±0.01
01/1412	11.59±0.07	0.99±0.07	20.87±0.04	11.59±0.08	0.51±0.02
02/0007	21.48±0.12	1.00±0.07	36.3±0.07	20.38±0.08	0.48±0.03
TME 419	26.69±0.15	0.73±0.03	39.55±0.02	14.11±0.13	0.58±0.06
01/13171	33.52±0.09	0.83±0.06	31.42±0.02	15.85±0.21	0.52±0.08
CR-12-45	23.18±0.06	0.48±0.08	34.55±0.05	15.85±0.05	0.57±0.05
NR 03/0211	31.98±0. 1	1.8±0.06	33.70±0.08	15.63±0.13	0.53±0.07
NR 03/0155	34.2±0.13	0.71±0.07	33.28±0.10	20.91±0.02	0.57±0.04
NR 02/0018	26.87±0.04	1.19±0.07	33.96±0.02	20.14±0.07	0.57±0.02
01/1368	27.56±0.06	0.78±0.04	32.89±0.05	22.67±0.09	0.59±0.03
01/1206	30.76±0.05	1.02±0.06	28.41±0.06	18.57±0.04	0.58±0.09
AR 1-82	28.4±0.12	0.83±0.02	33.83±0.08	15.59±0.1	0.53±0.06
03/0174	13.55±0.18	4.50±0.05	33.5±0.02	25.5±0.43	0.55±0.07
98/2132	23.14±0.08	0.51±0.09	32.55±0.06	29.02±0.08	0.52±0.07

intensifying efforts to breed for cassava genotypes that will have pro Vitamin A content to satisfy the Vit. A deficiency syndrome.

The proximate composition of the experimental energy rich roots in Table 1 shows that ten of the NCRP new genotypes (like the control cultivars) have high dry matter (DM) content of above 30% which is suitable for production of flour; with nine genotypes having high protein content above 3% like the controls also. Seven of the new genotypes also have starch content of above 20%, with only four of them having relatively high carotenoid content of >3 μg/g when compared with the control cultivars (Table 3). Four genotypes have high starch yield of >5 t/ha more than that of the control cultivars (TME 419 and TMS 30572) respectively.

Gari yield of the cultivars (Table 4) show that 98/2132 had the highest gari yield of 29%. Gari yield of 20% and more have been associated with high yielding cultivars (Achinewhu *et al*., 1998). One of the major food products of cassava is gari and it was observed from this study that the yellow fleshed cassava gari look similar to the yellow gari (cassava + oil) found in Nigerian local market. 01/368 and 02/0007 had the highest and lowest bulk density of 0.59 and -0.48 g/ml, respectively. The bulk density is influenced by the size, geometry and surface properties of the gari particles. High bulk density is a good physical attribute when determining mixing quality, transportability, storage and packagibility of particulate matter (Lewis, 1990) such as gari.

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