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Use of Newly Bred β-Carotene Cassava in Production of Value-Added Products: Implication for Food Security in Nigeria

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USE OF NEWLY BRED -CAROTENE CASSAVA IN PRODUCTION OF VALUE-ADDED PRODUCTS IMPLICATION FOR FOOD SECURITY IN NIGERIA

Strictly as per the compliance and regulations of :

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Aniedu, C. [α] & Omodamiro, R. M. [σ]

Abstract - The investigation into food qualities of six (6) newly bred **β**-carotene cassava namely; NR07/0427, NR07/0432, NR07/0326, NR07/0506, NR07/0497 and NR07/0499 of the National Root Crops Research Institute (NRCRI), Umudike, Nigeria using TMS 30572 as control was carried out. The chemical composition of the fresh roots to determine their carotenoid, moisture and starch contents was also carried out. Furthermore, the six of newly bred **β**-carotene cassava and the TMS 30572 (control) were processed into high quality cassava flours (HQCF) with which their physico-chemical properties were determined. The HQCF were also used in making 10% cassava bread, chin-chin, cakes, strips and salad cream and evaluated organoleptically. The result showed that the moisture contents of the fresh cassava roots ranged from 71.27% (TMS 30572) to 75.26% (NR07/0427) while the starch contents ranged from 11.69% (NR07/0427) to 29.16% (NR07/0499).The starch contents of the flours produced from the roots ranged from23.18(NR07/0427) to 61.05% (TMS30572), crude fibre ranged from 0.62 to 1.74% and ash ranged from 0.93 to 1.85%; Packed bulk density ranged from 0.68 to 1.53g/ml, loose bulk density ranged from2.3 to 3.5g/ml and pH from 5.05 to 5.70. The carotenoid content of fresh root samples had values from 0.528 μg/g for TMS 30572 (control) to 3.876μg/g for NR07/0326. The values for the HQCF ranged from 0.146 μg/g to 0.877μg/g TMS30572 and NR07/0326 respectively. The sensory evaluation result of the 10% cassava bread, *chin-chin*, cakes, strips and salad-cream produced from **β**-carotene cassava varieties revealed that in general acceptability, all the samples were acceptable to the panelists. This study showed that the processed **β**-carotene cassava varieties contained adequate quantities of carotenoid to combat vitamin A deficiency. The physico-chemical properties and sensory evaluation indicated that **β**-carotene cassava varieties are good sources of starch, minerals and fibre and could be very useful in nutritional applications and diet formulations.

Keywords : β-carotene, cassava, carotenoid, physico-chemical, high quality cassava flour, value added products.

I. Introduction

Cassava (*Manihot esculanta* Crantz) is cultivated in the tropical regions for its starchy roots. The roots are used for human consumption, animal feed and as raw material in many industries (Vimala *et al,* 2008). Cassava is drought tolerant, requires limited land preparation and grows well in poor soil, all these attributes makes it an extremely adaptable crop. Bradbury and Holloway (1988) reported that cassava tuber generally posses a cream or white flesh colour and contain legible amount of carotenoids. Vitamin A remains very important component of human nutrition, as it involved in vision, cell differentiation, synthesis of glycoprotein, reproduction and overall growth and development (Woolfe, 1992).Vitamin A problem and the severity of the consequences, prevention and therapy become a ubiquitous concern (Noel, 2001 and WHO, 1995). Million of Nigerians irrespective of age, gender or geographical location get less vitamin A than they require. To address Vitamin A deficiency (VAD), Nigeria provides Vitmin A supplements to children (6months to 5 years) during immunization days and has mandated the fortification of wheat and maize flours, vegetable oil, and sugar vitamin A since 2000. The development and dissemination of yellow root cassava will compliment current efforts to address VAD by delivering vitamin A through a staple food consumers eat every day (www.harvestplus.org). Cassava roots are rich in carbohydrates, but deficient in proteins and many essential micronutrients. The recent introduction of yellow root cassava or **β**-carotene cassava varieties is ideal and proper. .

In recent years, National Root Crops Research Institute (NRCRI), Umudike in collaboration with International Institute of Tropical Research Institute (IITA), Ibadan was involved in the development of highly nutritious root and tuber crops including cassava through a process known as biofortification in other to complement Nigeria Government's efforts to check Vitamin A malnutrition in Nigeria. The new yellow root cassava varieties have potential of providing up to 25% of daily Vitamin A requirements of children and women.

Since the presence of pro-vitamin A (**β**-carotene) in the new cassava would improve the nutritional status of the consumers, there is therefore need to evaluate various food forms from these newly bred crops for value addition to enhance better and wide range utilization of the crop. Since cassava is a major staple food crop in Nigeria, consumption of this **β**-

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carotene cassava can help in combating vitamin A deficiency, which is a serious public health problem in many parts of the World. Formulation of different food products from these cassava varieties will also help to enhance it consumption. Studies have shown that the variety, processing method and initial carotenoid content of the fresh root influences the retention of carotenoids (Bai Vimala *et al*, 2010, Sagar K. T *et al*, 2009 and Omodamiro, *et al* 2011).

II. Materials and Method

Six (6) varieties of newly bred β-carotene cassava namely; NR07/0427, NR07/0432, NR07/0326, NR07/0506, NR07/0497 and NR07/0499 with TMS 30572 (control) were obtained from the Cassava Programme, NRCRI, Umudike.

a) Preparation of flour samples

The different cassava varieties were processed into high quality cassava flour (HQCF) and starch, following the methods described by Anabolu *et al* (1998). By harvesting, peeling, washing, grating and dewatering fresh cassava root samples. The caked dewatered cassava mash was broken down and spread out to dry on a raised platform. The dried grated cassava was then milled into flour using Hammer miller. The flour samples were then sieved with a muslin cloth and the resultant HQCF were used in production of 10% cassava bread, cakes, *chin-chin* and strips as described by Anabolu *et al* (1998).

Fresh cassava roots
↓
Peel
↓
Wash
↓
Grate into a mash
↓
Dewater
↓
Break (caked Mash)
↓
Sun-dry on a raised platform
↓
Mill into flour
↓
Sieve with a muslin cloth
↓
High Quality Cassava Flour

Figure 1 : Production of High Quality Cassava Flour (HQCF).

b) Preparation of starch samples

The starch samples were produced by harvesting cassava roots, peeling, washing and grating fresh cassava roots. The cassava mashed produced was then soaked in water 10 times the volume of the cassava mash, then the soaked mash was sieved with muslin cloth to produce starch samples. The samples were washed 4 times to produce food quality starch used in the preparation of salad-cream.

The starch samples were used in production of salad-cream as described by Anabolu *et al* (1998).

Fresh cassava roots
↓
Peel
↓
Wash
↓
Grate into a mash
↓
Soak in water (10 times the volume of the mash)
↓
Sieve (with a muslin cloth)
↓
Allow the filtrate to settle. Decant the supernatant.
↓
Wash the starch to remove impurities
↓
Dewater
↓
Spread to dry
↓
Mill into powder (use in making salad-cream)
↓
Cassava starch

Figure 2 : Production of food quality Starch.

c) Preparation of 10% cassava bread samples

The process was measuring out 900g of wheat flour and 100g of HQCF to which 100g sugar, 120g margarine, 3g instant yeast, a level teaspoon of nutmeg and salt were added and thoroughly mixed together. Then ½ litre of lukewarm water was added to the mixture to form bread dough which was kneaded until smooth and fluffy. The fluffy dough was put into greased bread pans and baked in a hot oven at 200˚C until golden brown to produce 10% cassava bread samples.

d) Preparation of cake samples

The cakes samples were produced by first creaming together 240g sugar and 240g margarine until fluffy. Then 480g of HQCF, 120ml milk, 2 eggs, 10ml vanilla and ½ teaspoon of nutmeg and a pinch of salt were added to the margarine and sugar mixture to form cassava cake batter. The batter samples were put in

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greased cake pans and baked at 175˚C until evenly brown.

e) Preparation of chin-chin samples

In producing the *chin-chin* samples 120g g of HQCF was cooked in boiling water. Thereafter, 360g of HQCF, 80g sugar, 60g margarine, one egg, pinch of salt and nutmeg were added to the cooked HQCF to form *chin-chin* pastry samples. The pastry samples were spread on a board and cut into bits and the bits were fried in deep hot oil until attractively brown in colour.

f) Preparation of strips samples

The cassava strips samples were produced by mixing together 120g of HQCF, 225g bean paste, 50g grated onion and salt to taste. The product of this mixture was then passed through manual extruder into deep hot oil and allowed to fry until golden brown.

g) Preparation of salad-cream samples

The food quality starch samples were used in producing salad-cream samples by mixing together 100g starch, 2g mustard, 15g sugar, 2g salt, 175ml vinegar, 225ml water in a pot and cooked until the starch gelatinized. The gelatinized product was mixed with the yolk of 2 eggs and 225ml of vegetable oil. Then the whole mixture was put in a kitchen blender and allowed to run for about 5mins to produce a homogenized salad-cream samples.

h) Chemical Analysis

The fresh root samples and the flour samples were analyzed in duplicates for their starch, crude fibre, ash and pH using AOAC (1995) methods.

i) Physical Properties

The methods described by Onwuka (2005) were used to determine the dry matter and moisture content of the fresh cassava samples. Also, the same method was used to determine the packed bulk density and the loose bulk density of the flour samples.

j) Carotenoid Analysis

The method of Harvest-plus for carotenoid analysis was used for the determination of the total β-carotene content of the samples. Five (5) grams of each fresh root sample was grinded with the aid of hyflosupercel in 50ml of cold acetone and filtered with suction through a Buchner funnel with filter paper. The filtrate was extract was extracted with 40ml of petroleum ether (P.E.) using separating funnel. Saturated sodium chloride solution was used to prevent emulsion formation.

The lower phase being water was discarded while the upper phase was collected into a 50ml volumetric flask, making the solution pass through a small funnel containing anhydrous sodium sulfate to remove residual water. Then, the separating funnel was washed with P.E. and the standard flask made up to 50ml mark. The absorbance at 450ml of the solution was taken using specffophtometer and the total carotenoid content was calculated as follows;

$$\text{Total Carotenoid } (\mu/g) = \frac{A \times \text{volume (ml)} \times 10}{A1\% \times \text{sample weight (g)}}$$
$$1\text{cm}$$

Where A = absorbance, Volume = total volume of extract (50ml), A1% 1 cm = absorption coefficient of β-carotene in P.E. (2592)

k) Sensory Evaluation

The sensory evaluation of the food products were carried out with a 20-man Taste Panel drawn from the staff of NRCRI, Umudike. A seven (7) point hedonic scale (where 1 represented dislike extremely and 7 represented like extremely) was used to evaluate for attributes such as colour, taste, texture/mouth-feel and general acceptability (Iwe, 2002).

l) Statistical Analysis

The Genstat Discovery 3.0 version was used for the statistical analysis of the sensory scores. This involved analysis of variance (ANOVA) and mean separation by Least Significant Difference (LSD) at 5% probability level.

III. Results and Discussion

Table 1 shows that the moisture contents of the cassava roots ranged from 71.27% (TMS 30572) to 75.26% (NR07/0427) while the starch contents ranged from 11.69% (NR07/0427) to 29.16% (NR07/0499). The moisture content of NR 07/0427 was exceptionally high and hence the low starch content. Apart from NR07/0432, the β-carotene cassava varieties had high starch contents.

Table 1 : Moisture and Starch Contents of β-carotene Cassava Fresh Roots.

Cassava Variety	Moisture Content (%)	Starch Content (%)
NR 07/0427	75.26	11.69
NR07/0432	72.05	17.07
NR07/0326	74.48	27.58
NR07/0506	74.68	29.13
NR07/0497	73.91	29.16
NR07/499	73.75	24.31
TMS 30573*	71.27	29.13

* *Nota β-carotene Variety; a control sample*

Table 2 shows that starch contents of the flours produced from the roots ranged from 23.18 to 61.05%, crude fibre ranged from 0.62 to 1.74% and ash ranged from 0.93 to 1.85%; Packed bulk density ranged from 0.68 to 1.53g/ml, loose bulk density ranged from 2.30 to 3.50g/ml and pH from 5.05 to 5.70. High bulk density increases the rate of dispersion (Brenen *et al*, 1976), which is important in the reconstitution of cassava flours in hot water to produce cassava *fufu* whereas the varieties with low bulk density are appropriate in bakery industry. The pH values were not low because no fermentation was allowed to occur in the processing of the cassava roots into HQCF. This precluded production of organic acids which would have imparted some flavour to the flour. The values obtained for the proximate composition complies with Standard Organization of Nigeria (SON) specifications.

Table 2 : Some Physico chemical Properties of Total β carotenoid Cassava Flours.

Sample	Starch (%)	Crude Fibre(%)	Ash (%)	Packed Bulk Density (g/ml)	Loose Bulk Density (g/ml)	pH
NR07/0427	23.18	1.38	1.05	1.17	3.00	5.05
NR07/0432	37.51	1.20	1.05	1.10	3.00	5.21
NR07/0326	53.56	1.74	1.85	1.53	3.50	5.49
NR07/0506	43.02	0.62	0.93	0.68	2.30	5.70
NR07/0497	48.54	1.17	1.82	1.02	3.10	5.63
NR07/0499	50.42	1.20	1.60	1.01	3.00	5.47
TMS30572*	61.05	1.63	1.15	1.42	2.80	5.49

*Values are means of duplicate data. *Not a β-carotene Variety; a control sample*

The result of the carotenoid content of the fresh and high quality cassava flour (HQCF) in Figure 1 showed that the fresh root samples had values from 0.528 μg/g for TMS 30572 (control) to 3.876μg/g for NR07/0326. The values for the HQCF ranged from 0.146μg/g to 0.877μg/g for NR07/0326 and TMS30572 respectively. The sharp reduction in carotenoid content observed may be as a result of losses during processing. It was observed by Kosambo *et. al.* (1998) that as much as 41% of carotenoid content of orange flesh sweetpotato was lost during dehydration and boiling of the food.

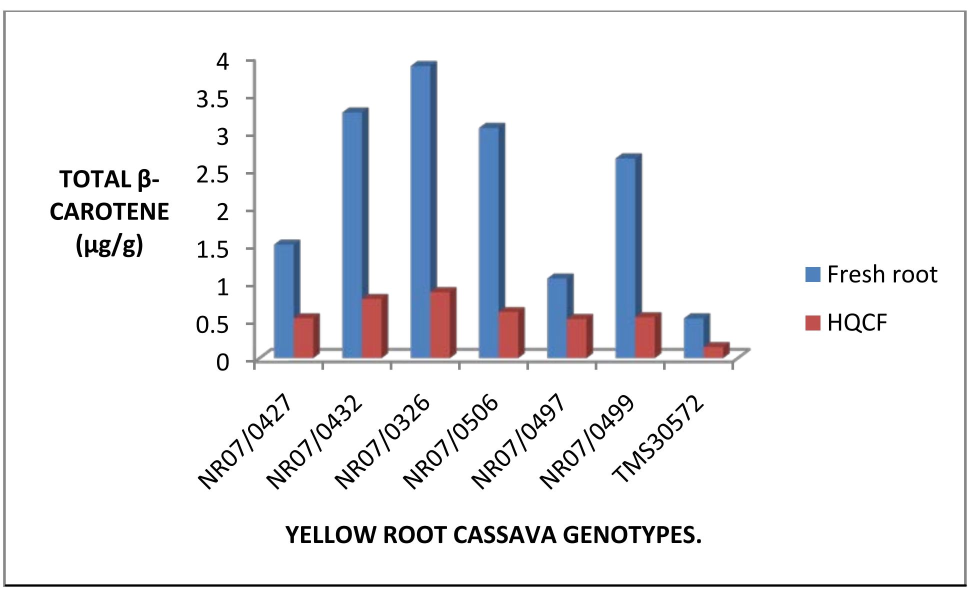

Figure 3 : Total Carotenoid Content of the Yellow Root Cassava Genetypes.
NB : 30572 is white root (control).

The sensory evaluation result of the cake, bread, chin-chin, strips and salad-cream produced from β-carotene cassava genotypes are as shown in Table 3. On the bases of general acceptability, all the samples were acceptable to the panelists. There was no significant difference among the products in all the genotypes.

Table 3 : Sensory Evaluation of the β-carotene Cassava Confectioneries.

SAMPLE	COLOUR	TASTE	TEXTURE/ MOUTH-FEEL	GENERAL ACCEPTABILITY
		10% CASSAVA BREAD		
A	5.88	5.24	5.06	5.76 [a]
B	5.71	5.06	5.29	5.41 [a]
C	5.59	5.29	5.53	5.71 [a]
D	5.82	4.76	5.00	5.29 [a]
E	5.88	5.76	5.59	5.82 [a]
F	5.71	5.47	5.41	5.94 [a]
G	5.94	5.88	5.76	5.82 [a]
LSD	0.68	0.93	0.95	
		CHIN-CHIN		
A	5.41	5.06	5.18	5.47 [a]
B	5.65	4.88	5.18	5.29 [a]
C	5.35	5.24	5.65	5.94 [a]
D	5.76	5.18	5.24	5.71 [a]
E	5.94	5.65	5.59	6.12 [a]
F	5.33	5.67	5.36	5.79 [a]
G	5.80	5.60	6.00	6.00 [a]
LSD	0.68	0.79	0.81	
		CAKES		
A	5.50	5.69	5.44	5.69 [a]
B	5.82	5.65	6.00	6.00 [a]
C	5.63	4.75	4.88	5.31 [a]
D	5.76	4.82	5.29	5.53 [a]
E	5.76	5.47	5.29	5.47 [a]
F	6.12	6.00	5.65	5.94 [a]
G	5.94	5.81	5.75	5.94 [a]
LSD	0.76	0.87	0.87	
		STRIPS		
A	6.24	5.18	5.65	5.71 [a]
B	5.53	5.06	4.94	5.24 [a]
C	5.53	5.24	5.53	5.17 [a]
D	5.65	5.29	5.35	5.24 [a]
E	5.88	5.94	5.94	6.06 [a]
F	5.63	5.75	5.38	5.88 [a]
G	5.33	5.50	5.17	5.67 [a]
LSD	0.67	0.85	0.82	
		SALAD-CREAM		
A	4.67	4.80	4.67	5.33 [a]b
B	4.53	5.07	4.67	4.60 b
C	4.93	5.00	5.40	5.13 [a]b
D	5.13	4.93	5.53	5.60 [a]b
E	4.07	4.20	4.67	5.40 [a]b
F	5.73	5.13	5.40	5.73 [a]
G	3.40	4.73	4.27	4.53 b
LSD	1.17	1.06	0.93	

A=NR07/0499, B=NR07/0497, C=TMS30572, D=NR07/0427, E=NR07/0506, F=NR07/0326, G=NR07/0432.

IV. Conclusion

The results obtained in this study showed that the processed β-carotene cassava varieties contained adequate quantities of carotenoid to combat vitamin A deficiency. The results obtained for the physico-chemical properties and sensory evaluation indicated that β-carotene cassava varieties are good sources of starch, minerals and fibre and could be very useful in nutritional applications and diet formulations.

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