

EFFECT OF PROCESSING ON CAROTENOID CONTENT OF ORANGE FLESHED SWEETPOTATO (OFSP) AND THE SUITABILITY OF OFSP IN THE PRODUCTION OF VALUE-ADDED PRODUCTS

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ABSTRACT

The investigation on the effects of processing on carotenoid content of orange fleshed sweetpotato (OFSP) and the suitability of OFSP in production of value-added products were carried out using two genotypes of sweetpotato – Ex-Igbariam (a white fleshed sweetpotato [WFSP] and a newly bred UM11/022 (an OFSP). The sweetpotato genotypes were processed into high quality sweetpotato flour (HQSF) and its fermented counterpart – the sweetpotatofufu flour (SFF). The physico-chemical and carotenoid analyses were determined on both the raw roots and the processed flours and the flours were used in producing value-added products. The result showed that processing into HQSF and SFF depleted the carotenoid by 50% and 75% respectively. Also, the result of the physico-chemical analysis indicated that OFSP had higher contents of dry matter, ash, crude protein, carbohydrates and starch than the WFSP and sensory evaluation showed that the OFSP value-added products were acceptable to the panelists.

Keywords: Carotenoid, high quality sweetpotato flour, sweetpotato *fufu* flour, physico-chemical and value-added products

INTRODUCTION

Sweetpotato (*Ipomoea batatas*) is an important tropical food crop mostly cultivated for its starchy roots (Onwuneme, 1978). The poor state of health in Nigeria has been blamed on the persistent use of starchy root and tuber crops as staple foods in all parts of the Nigeria hence, huge efforts have been made in bio-fortification of some of the staple root and tuber crops. National Root Crops Research Institute (NRCRI), Umudike in conjunction with IITA, Ibadan released Pro-vitamin A cassava varieties in 2011. The essence was to incorporate β -carotene (carotenoid) which is a precursor of vitamin A into the cassava root as a way of ameliorating Vitamin A deficiency among cassava consumers. However, sweetpotato is a root crop reported to contain significant quantities of the antioxidants, β -carotene, vitamins C and E which can be preferentially oxidized thus inhibiting the formation of free radicals which have been implicated in the development of coronary diseases and cancer (FAO, 1990). In observance of this and the fact that sweetpotato is becoming a staple food in Nigeria, due to the promotion efforts of NRCRI, Umudike which has sweetpotato as one of her mandate crops, the institute has gone further to improve on β -carotene contents of the sweetpotato by bio-fortification which gave rise to some orange fleshed sweetpotato genotypes. The report of Institute of Medicine, (2001) indicated that consumption of 120g of this orange fleshed sweetpotato (OFSP) had potentials of providing daily need of vitamin A (300 μ g in 1 -3years, 700 μ g in 19 – 30years and 55 μ g in adult) in humans. The work of Omodamiro and Ani (2015) showed that consumption of orange fleshed sweetpotato eradicated vitamin A deficiency in experimental rats. Consequent upon that, this study is aimed at determining the effects of processing on total carotenoid content of orange fleshed

sweetpotato (OFSP). Also, the work of Aniedu and Oti (2007) indicated that confectionaries and other exotic foods can be produced from sweetpotato landraces. To this effect, this study also intends to evaluate the suitability of orange fleshed sweetpotato in the production of some confectionaries and other foods. It is important to note here that β -carotene is the major content of carotenoid.

MATERIALS AND METHOD

Orange fleshed sweetpotato genotype (UM/11/022) and white fleshed sweetpotato landrace (Ex-Igbariam) were obtained from sweetpotato programme of NRCRI, Umudike. The two genotypes of sweetpotato were processed into unfermented flour (high quality sweetpotato flour) for use in confectionary production and fermented flour (sweetpotato *fufu* flour), intended for reconstitution into *fufu* paste (a Nigerian delicacy usually eaten with soup). The methods used are given below.

Preparation of flour samples

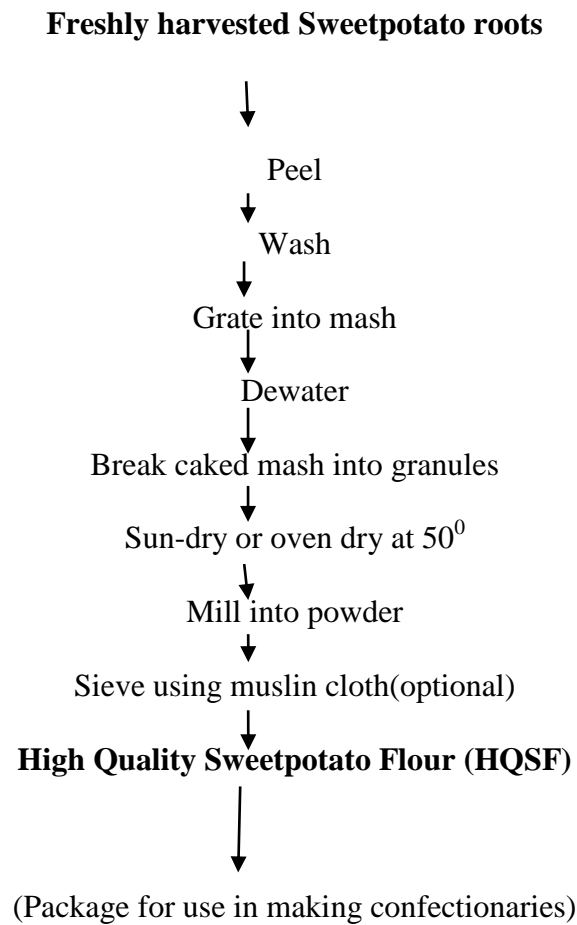


Fig 1: Flowchart for production of unfermented sweetpotato flour (High Quality Sweetpotato Flour (HQSF))

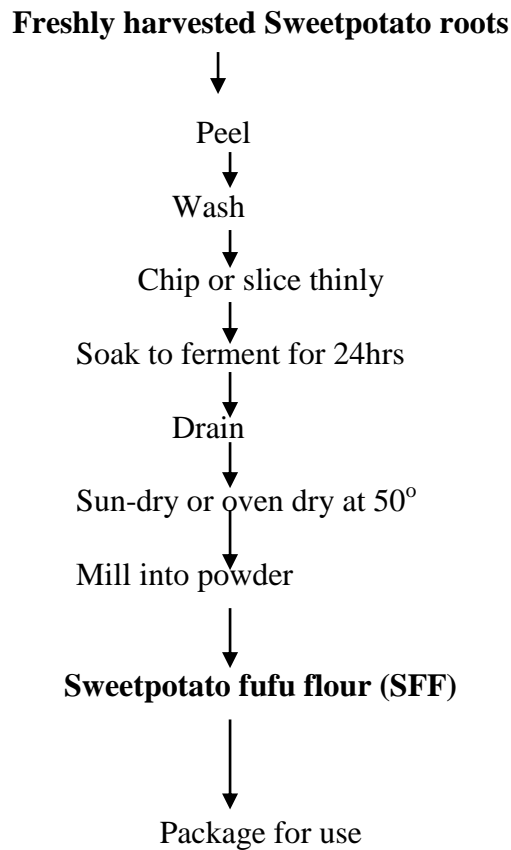


Fig 2: Flowchart for production of fermented sweetpotato flour (Sweetpotato fufu flour (SFF))

Preparation of 10% sweetpotato bread samples

The process was by measuring out 900g wheat flour and 100g HQSF which was put in a mixing bowl. Then, 50g sugar, 120g margarine, 3g instant yeast, a level teaspoon of nutmeg and a pinch of salt were added to the flours and thoroughly mixed together. Thereafter, ½ litre of lukewarm water was added to the mixture to form dough which was kneaded until smooth and fluffy. The fluffy dough was moulded into shape and put into greased bread pan and allowed to proof for 45min. Thereafter, the dough was baked in a hot oven at 200°C until golden brown to produce 10% sweetpotato bread.

Preparation of cake samples

The cake samples were produced by first creaming together 200g sugar and 240g margarine in a mixing bowl until fluffy. Then, 480g HQSF, 2 eggs, 10mls vanilla essence, ½ teaspoon nutmeg and a pinch of salt were added to the creamed mixture to form sweetpotato cake batter. The batter samples were put in greased cake pan and baked at 175°C until golden brown.

Preparation of *chinchin* samples

100g HQSF was cooked with 1 cup of boiling water in a mixing bowl. Thereafter, the cooked HQSF was rubbed into another 3HQSF to which 50g margarine, 50g sugar, 1 level teaspoon of nutmeg, a pinch of salt and an egg were added. The resultant pastry was rolled on a board, cut into bits and fried in deep hot oil until golden brown and crispy.

Preparation of sweetpotatofufu paste samples

200g Sweetpotato *fufu* flour (SFF) was cooked in 500ml boiling water in a pot by stirring vigorously for about 3 min on a low heat to form a stiff paste.

Chemical Analysis

The fresh roots samples and the flour sample from the two genotypes of sweetpotato were analyzed in duplicates for their starch, carbohydrates, crude fibre, ash, fat and crude protein using the methods described by AOAC, (1995).

Physical Properties

The methods described by Onwuka (2005) were used to determine the dry matter and moisture contents of the fresh sweetpotato samples and also the pH and packed bulk density of the flour samples.

Carotenoid Analysis

The method described by Delia B. Rodrigiez-Amaya and Mieko Kimura (2004) for carotenoid analysis was used for the determination of the total β -carotene contents of the samples. Five (5) gram of each of the samples 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 extracted with 40ml 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 spectrophotometer and the total carotenoid content was calculated as follows;

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

Where: A= Absorbance, Volume = Total volume of extract(50ml)

A1% 1cm = Absorption coefficient β -Carotene in P. E. (2592)

Sensory Evaluation

The sensory evaluations of the confectionaries and food products were carried out with a 20-man Taste Panel drawn from the staff of NRCRI, Umudike who were conversant with the products. A five point hedonic scale (where 1 represented dislike extremely and 3 represented neither like nor dislike and 5 represented like extremely) was used to evaluate for attributes such as colour, tasted, texture/mount-feel, draw ability and overall acceptability (Iwe 2002).

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.

RESULTS AND DISCUSSION

The result in Table 1 showed that moisture, dry matter, ash, crude fibre, fats, crude protein, carbohydrate (CHO) and starch contents of fresh root OFSP were 78.5%, 21.5%, 2.4%, 2.5%, 2.2%, 3.2%, 11.3% and 20.4% respectively while those of fresh root WFSP were 70.2%, 29.9%, 3.1%, 1.9%, 2.0%, 4.1%, 59.1% and 24.2% respectively.

Table 1: Physico-chemical Properties of Raw and Processed Orange Fleshed Sweetpotato

S/N	CONTENTS	ORANGE	FRESHED (OFSP)	S/POTATO SAMPLES	WHITE	FLESHED (WFSP)	S/POTATO SAMPLES
		Fresh root	SFF	HQSF	Fresh root	SFF	HQSF
1	% Moisture	78.5	91.1	91.8	70.2	92.6	92.8
2	% Dry Matter	21.5	8.9	8.2	29.9	7.4	7.2
3	% Ash	2.4	1.7	2.1	3.1	2.2	3.7
4	% Crude fibre	2.5	0.2	1.3	1.9	1.1	1.4
5	% Fats	2.2	1.1	1.5	2.0	1.1	1.3
6	% Cr. Protein	3.2	4.8	3.4	4.1	5.1	5.8
7	% CHO	11.3	83.9	83.7	59.1	83.1	81.2
8	% Starch	20.4	31.6	34.1	24.2	35.0	36.4
9	Packed Bulk Density(g/ml)	-	0.7	0.9	-	0.9	0.9
10	pH	5.5	6.3	5.8	5.3	6.3	5.5

This indicated higher moisture, crude fibre and fat contents in OFSP than WFSP while WFSP has higher contents of dry matter, ash, crude protein, CHO and starch. The result in Table 1 also showed the fermented flours (SFF) from OFSP, had moisture, dry matter, ash, crude fibre, fats, crude protein, carbohydrate (CHO) and starch contents of 91.1%, 8.9%, 1.7%, 0.2%, 1.1%, 4.8%, 83.9% and 31.6% respectively whereas those of WFSP were 92.6%, 7.4%, 2.2%, 1.1%, 1.1%, 5.1%, 83.1% and 35.0%. The high quality sweetpotato flour (HQSF) from OFSP had 91.8% moisture, 8.2% dry matter, 2.1% ash, 1.3% crude fibre, 1.5% fats, 3.4% crude protein, 83.7% CHO and 34.1% starch contents while that of WFSP were 92.8% moisture, 7.2% dry matter, 3.7% ash, 1.4% crude fibre, 1.3% fats, 5.8% crude protein, 81.2% CHO and 36.4% starch. The packed bulk densities for OFSP were 0.7 and 0.9 for SFF and HQSF respectively while that of WFSP were 0.9 for both SFF and HQSF. High packed bulk density increases the rate of dispersion (Brenen *et al*, 1076), which is important in the reconstitution of flour in hot water to produce *fufu* whereas low packed bulk density is appropriate in bakery industry. The packed bulk densities of 0.7 – 0.9 could be regarded as medium range and therefore indicated that the flour were good for both *fufu* and for use in bakery.

The result of pH of the fresh roots and the HQSF of both OFSP and WFSP (Table 1) showed lower values than that of their SFF and it ranged from 5.5 to 5.8. This showed that fermentation did not take place which precluded production of organic acids which would have imparted some flavours to the foods. However, the higher pH values of the SFFs (6.3) showed that fermentation took place therefore some flavours were imparted in the flours.

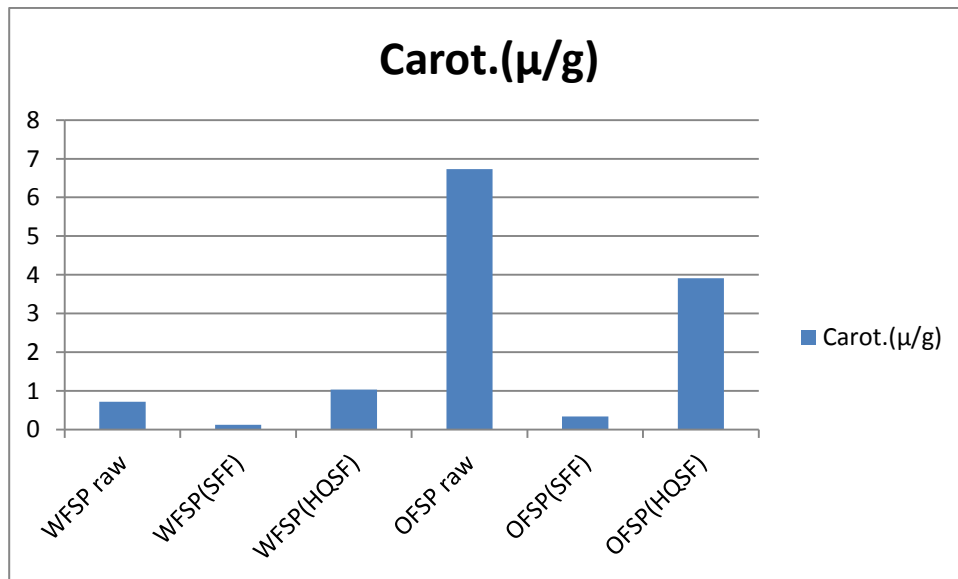


Fig. 3: Effects of processing on total Carotenoid Content of Sweetpotato

The result in Fig. 3 showed that processing into HQSF reduced the carotenoid content of both the OFSP and the WFSP by almost a half while fermentation reduced the carotenoid contents of OFSP and WFSP by about 75%. This can be seen from the fresh root carotenoid values which were WFSP 0.72µg/g and OFSP 6.73µg/g but reduced to 0.34µg/g and 3.91µg/g respectively, after the roots were

processed into HQSP. The carotenoid values further went down to WFSP0.12µg/g and OFSP1.03µg/g when fermentation took place to produce SFF.

Table 2: Sensory Evaluation of Value-added Products from HQSF and WFSPF

10% SWEETPOTATO BREAD

S/N	SAMPLE	COLOUR	TEXTURE	TASTE	OVERAL ACCEPT
	WFSP	3.3	3.8	4.0	4.0
	OFSP	4.3	3.8	4.0	4.0
	WHEAT(control)	4.5	4.2	3.8	4.3
	LSD(0.05)	0.9	0.7	0.9	0.8

CAKE

S/NO	SAMPLE	COLOUR	TEXTURE	TASTE	OVERAL ACCEPT.
1.	WFSP	4.1	3.8	4.4	4.2
2	OFSP	3.8	3.5	3.5	4.0
3.	Wheat (Control)	4.7	4.1	4.5	4.6
	LSD (0.05)	0.8	0.7	0.9	0.7

CHIN-CHIN

S/NO	SAMPLE	COLOUR	CRISPINESS	TASTE	OVERALL ACCET.
1.	WFSP	3.7	3.7	4.1	4.0
2.	OFSP	3.6	3.6	3.5	3.8
3.	Wheat (Control)	4.6	4.5	4.4	4.8
	LSD (0.05)	0.8	0.8	0.9	0.7

SWEETPOTATOFUFU

S/NO	SAMPLE	COLOUR	TEXTURE	DRAWABILITY	OVERAL ACCEPT.
1.	WFSP	1.7	3.8	3.7	4.0
2.	OFSP	3.7	3.0	2.9	3.0
3	Control (Odorless cassava fufu)	2.4	4.4	4.3	4.6
	LSD(0.05)	1.1	0.7	1.1	0.9

The sensory evaluation result of value-added products from OFSP and in Tables 2 showed that the 10% OFSP and WFSP bread were generally very acceptable and showed no significant (P = 0.05) difference from the control made from 100% wheat. However, the colour of the PFSP and WFSP tended towards darker colour than that of 100% wheat (used as control). This colour made panelists assume that OFSP and WFSP bread were richer in nutrient content than the control. In cake, the samples were acceptable with no significant (P=0.05) difference among them. The darker colour of the sweetpotato samples made them look more nutritious than the control as stated by the panelists. The result of the chin-chin (Table 2) indicated a significant (P=0.05) difference among the samples with the control being more acceptable than OFSP and WFSP samples. This could be attributed to the fact that *chinchin* is a snack

expected to be golden brown in colour but its products from sweetpotato were dark brown, and hence were not easily recognizable by the panelists. This notwithstanding, the panelists reasonably accepted the products. The sensory evaluation result of the sweetpotato *fufu* (Table 2) revealed that there was no significant ($P=0.05$) difference between WFSP and odourless cassava *fufu* (control) samples. The OFSP sample was less acceptable than the other samples, but was in itself not rejected by the panelists.

CONCLUSION

In agreement with the report of Kosambo *et al*, (1998) which reported that 41% of carotenoid of OFSP was lost during dehydration and boiling of the food this study revealed that up to 50% and 75% of carotenoid content of both WFSP and OFSP are lost during production HQBF and SFF respectively. Also, both the physic-chemical properties of samples and the carotenoid analysis indicated that although OFSP had high carotenoid content, the WFSP had higher contents of dry matter, ash, crude protein, carbohydrates and starch than the OFSP.

REFERENCES

- Aniedu, C. and Oti, E. (2007): Sweetpotato Based Recipes. National Root crops Research Institute (NRCRI) Umudike.
- AOAC (1995); Official Method of Analysis Association of Official Analytical Chemists, Washington D.C, USA.
- Brenen, J.C., buttler, T.R., Cowell, N.D. and Lielly, A.E.V. (1996); Effect of Agglomeration on the properties of spray-dried Rocoibus Tea. *Int.J. Food Sci. Tech.* 23:43-48.
- Delia B. Rodrigriez-Amaya and Mieko Kimura (2004); Harvest-plus Handbook for Cartenoid Analysis: Harvest-plus, D.C and Cali: International Food Policy Research Institute (IFPRI) and International Center for Tropical Agriculture (CIAT), pp 35-36.
- FAO (1990); Food and Nutrition Series No. 24. Roots, Tubers, Plantains and Bananas in Human Nutrition.
- Iwe, M.O. (2000); handbook of Sensory methods and Analysis. Rejoin Communication Services Ltd, 65 Adelabu St. Uwani Enugu, Nigeria.
- Institute of Medicine (2001); Food and Nutrition Board. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Iodine, Iron, Manganese, Molybdenium, Nickel, Silicon, Vanadium, and Zinc. Washington DC; National Academy Press; 2001.
- Kosambo, L.M., Carey, E.E., Misra A.K, Wilker, J. and Hagen-Mana, V. (1998); Influence of age, Farming site and Boiling on Pro-vitamin A content in Sweetpotato storage root. *Journal of Food composition and Analysis* 11:305 -321.
- Omodamiro, R.M. and Ani, J. C. (2015); Impact of Consumption of OFSP based drink on vitamin a deficiency (VAD) Eradication using Animal Model. Paper Presented during 2015 In-House Technology Review Meeting of NRCRI, Umudike held April 22-25, 2015.
- Onwueme, I. C. (1978); *The Tropical Crops* Chichester, UK. John Wiley, pp 234.
- Onwuka, G.I. (2005); *Food Analysis and Instrumentaion Theory and Practice*. Naphthali Prints: A division of AG Support Nig Ltd., 6 Adeniyi Jones Close, Surulere, Lagos, Nigeria, pp133-139.