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Production of fufu from yellow cassava roots using the odourless flour technique and the traditional method: Evaluation of carotenoids retention in the *fufu*

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ABSTRACT

Yellow root cassava varieties are being propagated in Nigeria to aid in combating dietary vitamin A deficiency in the country due to their high content of β-carotene (a precursor of vitamin A). Three newly released yellow root cassava varieties: Umucass 36, Umucass 37 and Umucassa 38 (with Breeders' names TMS/01/1368, TMS/01/1412 and TMS/01/1371, respectively) were assessed for their potential usage in processing into acceptable fufu using the odourless flour technique and by the traditional method. Carotenoid content in the intermediate and finished products of these varieties were evaluated. Results showed that while the fresh yellow roots had 6.26-7.76 µg/g and the fresh white root check variety (TMS 30572) had 0.35 µg/g total carotene (TC) contents, the intermediate products of the yellow root varieties namely grated cassava mash and fermented cassava mash respectively had TC content of 6.24-7.75 µg/g (TC retention of 97.68-98.48 %) and 5.97-7.48 µg/g (94.68-96.66% retention capacity). The final products of the three varieties had 5.41-7.03 µg/g (86.42-90.24% retention capacity). This implies negligible loss (<2.3%) of TC incurred during grating, less than 6% loss incurred during fermentation of the grated mash and less than 14% loss incurred during the entire process of production of fufu from the yellow cassava roots by the traditional method. The intermediate products using the odourless flour technique had 5.93-7.53 µg/g (TC retention ranged from 94.68-94.73%) for grated cassava mash; 1.50-2.12 µg/g (21.55-33.87% retention) for fermented cassava flour; and the final product (cassava fufu) had 1.20-2.00 µg/g (17.24-31.94% retention). The losses were mainly incurred during the drying processes. Sensory evaluation results showed that, generally, fufu produced from the yellow cassava roots (fufu produced by the traditional method) was more acceptable by the Taste Panel than the fufu produced using the odourless flour technique. The use of traditional method for production of fufu when using yellow root cassava varieties is therefore recommended for maximum utilization of the nutrient in the newly released yellow cassava varieties.

Key words: Yellow cassava roots, odourles flour technique, traditional method, β-carotene, total carotene, Taste Panel and pro-vitamin A.

INTRODUCTION

Cassava (*Manihot esculenta* crantz) is a staple food for over 500 million people in the developing world (Cock, 1985). Cassava is grown mainly for its storage roots (Nweke, 1996). It is known to produce 250,000 calories/hectare/day compared to 200,000 for maize, 176,600 for rice, 114,000 for sorghum and 110,000 for wheat (Onabowale, 1988). In Nigeria, cassava is processed into *gari*, *fufu*, pellets for compounding animal feeds, kpokpo *gari* and also into instant aromatized (fermented) flour (Oyewole, 1991). As at date, new cassava varieties are being introduced to farmers for their agronomic benefits with little considerations for the quality of the end products

(Akoroda, 1992). Cassava roots contain mainly carbohydrate of which 80% is starch, the level of protein (1-2%) and fat less than 1% are not nutritionally significant (Goomez *et al*., 1984).

Vitamin A remains a very important component of human nutrition as it is involved in vision, cell differentiation, synthesis of glycoproteins, reproduction and overall growth and development (Woolfe, 1992). African countries are not only faced with problem of food security but that of nutritional insecurity leading to different forms of micronutrients deficiencies in the diet. Biofortification of cassava is therefore highly appropriate as this will contribute to the alleviation of diseases associated with vitamin A deficiency (VAD) which is a common dietary health problem, especially in countries where cassava is a major staple. Processing can affect the nutrient content of food (Akingbala *et al.*, 1991). Reduction in the carotenoid contents during processing of yellow root cassava into some food forms has been reported (Bai *et al*, 2010; Sagar *et al.*, 2009; Omodamiro *et al.*, 2011). There are many different forms of processing to which food may be subjected before consumption. Traditional *fufu* production is a local method of producing *fufu* from fresh cassava roots into a wet *fufu* mash used for preparation of ready-to-eat *fufu*. It has a characteristic sour aroma. Modern *fufu* production is an improved method of *fufu* production from fresh cassava roots into *fufu* flour used for preparation of odour free ready-to-eat *fufu*.

The objectives of this research work were therefore to screen yellow cassava roots for their amenability to processing into acceptable *fufu* using the odourless flour technique and by the traditional method and to determine the level of carotenoids in the intermediate and finished products.

MATERIALS AND METHODS

Sources of Experimental samples

Fresh roots of three yellow root varieties namely: UMUCASS 36 (TMS 01/1368), UMUCASS 37 (TMS 01/1412) and UMUCASS 38 (TMS 01/1371) and white root variety, TMS 30572 (check) were obtained from the Cassava Programme of NRCRI, Umudike. All the cassava roots were harvested at about 11 months after planting.

Preparation of *fufu* samples

About 20kg each of the three yellow root cassava varieties were used for the production of *fufu*. Roots of each variety were peeled, cut into small sizes of about 7cm average size, washed, mixed together and divided into two equal parts of about 8.5kg each. Traditional method of producing *fufu* as shown in Figure 1 (Omodamiro *et al.*, 2011) and the modern method as shown in Fig.2 (Aniedu and Oti, 2008) were employed in processing the cassava roots into *fufu*. Oven dry method was equally used for production of the *fufu* flour.

Total Carotenoids Content Analysis

The Harvest Plus procedure for carotene analysis was used to analyze the total carotenoids content of the fresh cassava roots, grated mash, fermented *fufu* mash, fermented *fufu* flour, and reconstituted *fufu*. The method of HarvestPlus for carotenoid analysis procedures is as follows: 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 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 spectrophotometer and the total carotenoid content was calculated as follows;

$$\text{Total Carotenoid } (\mu g/g) = \frac{A \times \text{ volume (ml) } \times 10^4}{A^{1\%}_{1cm} \times \text{ sample weight (g)}}$$

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

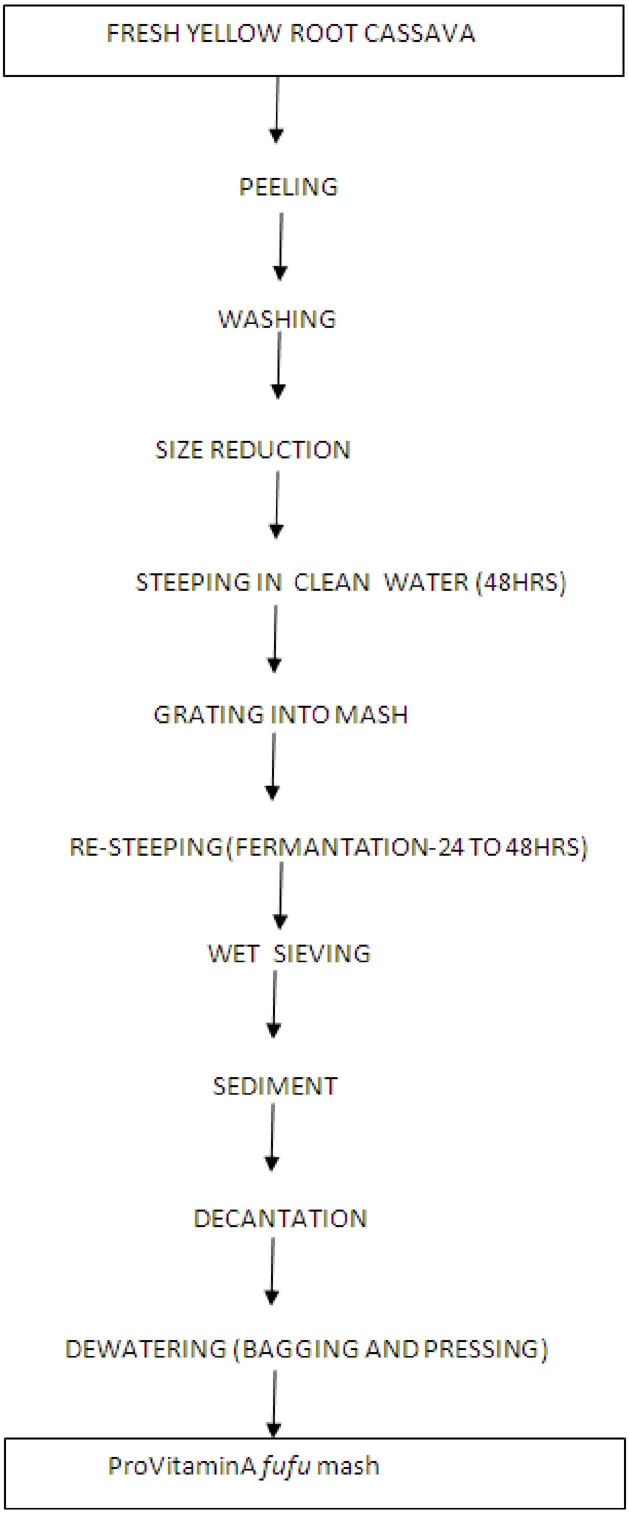

Fig 1: Traditional method of production of high Pro-Vitamin A *fufu* mash.

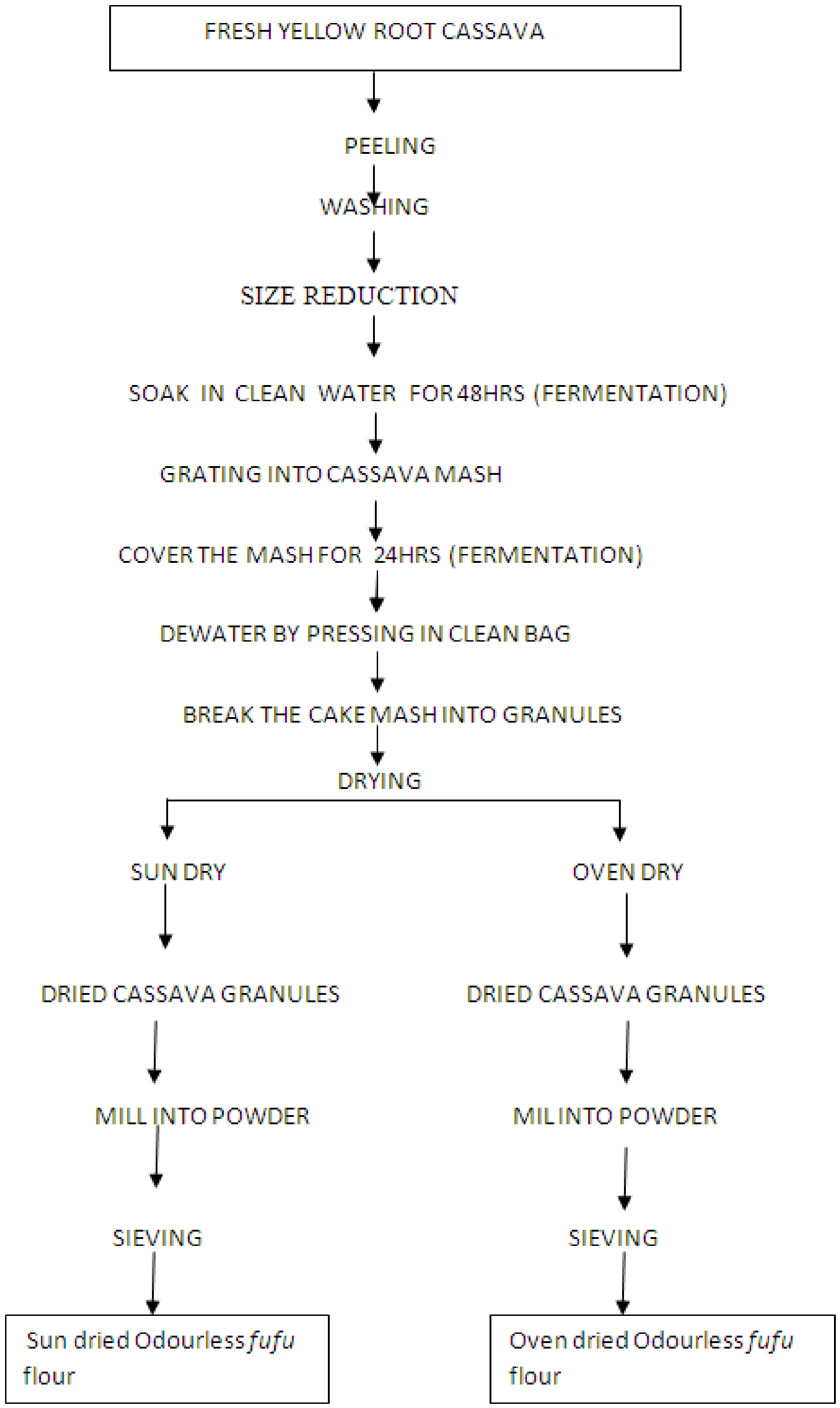

Fig 2: Production of sun-dried and oven-dried odourless *fufu* flour.

Sensory Evaluation
The three products obtained: odourles *fufu* flour (oven dried and sun dried) and wet *fufu* mash (pro-Vitamin A *fufu*) and a traditionally made commercial *fufu* mash bought at Oriugba village market (a major producer of *fufu* in the study area) were used to prepare *fufu* dough.

Twenty-member sensory panels were used for the sensory evaluation (Iwe, 2005). The panelists were asked to indicate their preference for colour, hand feel, mouldability, odour and general acceptability using a 9-point hedonic scale, where 9 indicates like extremely, 5 indicates neither like nor dislike and 1 for dislike extremely.

Statistical Analysis
Data from the sensory evaluation were statistically analyzed using a Statistix 8.0 software package for analysis of variance (ANOVA) and mean separation was done using Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) to establish if there were significant differences among the samples.

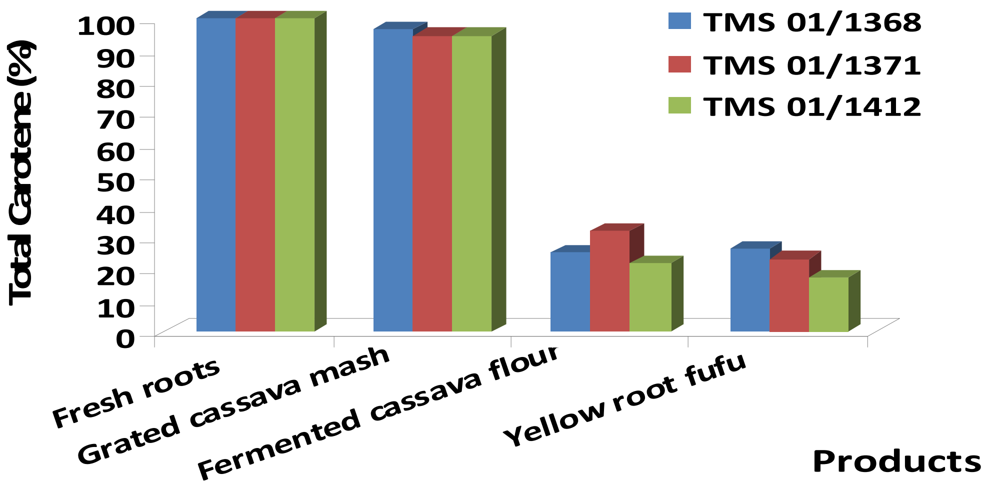

Figure 3: Trend of total carotenoid retention during Traditional production method of *fufu* from yellow-root cassava varieties

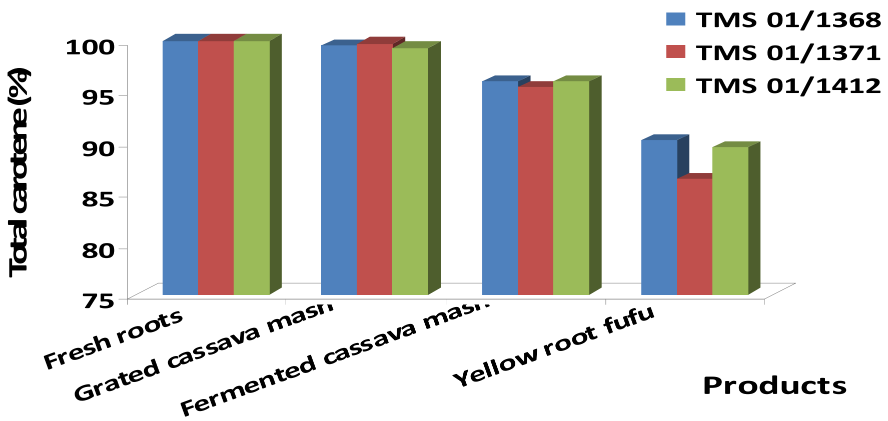

Figure 4: Trend of total carotenoid retention during modern production method of *fufu* from yellow-root cassava varieties

RESULTS AND DISCUSSION

Results showed that while the fresh roots had 6.26-7.76 µg/g TC contents and TMS 30572 (white root) had 0.35 µg/g TC content, their intermediate products namely grated cassava mash and fermented cassava mash respectively had TC content of 6.24-7.75 µg/g (TC content retention of 97.68-98.48%) and 5.97-7.48 µg/g (94.68-96.66%). The final products of the three varieties had 5.41-7.03 µg/g (86.42-90.24%) as shown in Fig. 3. This implies that there was a negligible loss (<2.3%) of carotenoids incurred during grating, less than 6% loss incurred during fermentation of the grated mash and less than 14% loss incurred during the entire process of production of *fufu* from the yellow cassava roots by the traditional method. The intermediate products using the odourless flour technique had 5.93-7.53 µg/g (carotenoids retention ranged from 94.68-94.73%) for grated cassava mash, 1.50-2.12µg/g (21.55-33.87% carotene retention) for fermented cassava flour and the final product (cassava *fufu*) had 1.20-2.00 µg/g (17.24-31.94% retention) as shown in Figure 4. The losses were mainly incurred during the drying processes. Oven dried odourless *fufu* had lesser detrimental effect than the sun-drying method in terms of loss in TC content. Table 1 shows the results of the sensory evaluation. Generally, yellow *fufu* was more acceptable by the Taste Panel than the *fufu* produced using the odourless flour technique. Fig. 5 shows visual retention of yellowness in traditional method [B] of the *fufu* production, slight retention [A] and loss of yellowness [C] by using the odourless flour technique as well as the commercial *fufu* [D]. The yellowness of the *fufu* produced traditionally was an added advantage to the panelists' appetite as well as the slight fermented odour which may be due to residual effect of lactic acid bacteria. These attributes did not adversely affect the acceptance of the *fufu*, hence the *fufu* may serve as a potential probiotic food (functional food). The *fufu* produced from commercial *fufu* mash were acceptable by the panelists. *Fufu* produced from UMUCASS 38 using the odourless *fufu* flour technique was not acceptable but the one produced by the traditional method was highly acceptable. Also, *fufu* produced from sun-dried flours was not acceptable. *Fufu* produced from UMUCASS 36 and UMUCASS 37 through odourless flours by oven-drying and by the traditional method were acceptable.

Table 1: Sensory evaluation of cassava *fufu*

SAMPLE	COLOUR	HANDFEEL	MOULDABILITY	ODOUR	GEN'ACPT
TMS1368(T)	6.83ab	6.50ab	6.58ab	6.17a	6.33a
TMS1368(OV)	5.42bc	4.83cd	5.17bcd	5.50ab	5.50abc
TMS1368(OS)	5.00cd	5.50bcd	5.00cd	4.92ab	4.67bcd
TMS1371(T)	6.33abc	6.50ab	6.17abc	5.00ab	6.08ab
TMS1371(OV)	2.50e	4.08d	4.25d	3.92b	3.58d
TMS1371(OS)	2.75e	4.00d	4.08d	3.92b	3.50d
TMS1412(T)	7.17a	7.08a	7.08a	5.25ab	6.33a
TMS1412(OV)	5.17cd	5.25bcd	5.50bcd	4.75ab	4.92abcd
TMS1412(OS)	3.75de	5.00bcd	5.17bcd	4.66ab	4.33cd
REF'(OM)	6.17abc	5.83abc	6.25abc	4.58ab	6.17ab
LSD(0.05)	0.7485	0.7652	0.7419	0.8067	0.7638

Means with the same letters in each column are not significantly different (p>0.05) from one another. 1 = dislike extremely; 5 = neither like nor dislike and 9 = like extremely using 9-point Hedonic scale. OM = fufu made from commercial fufu mash; T = fufu made from Traditional fufu mash; OV = fufu made from oven dried odourless fufu flour; OS = fufu made from sun dried odourless fufu flour and GEN'ACPT = General acceptability

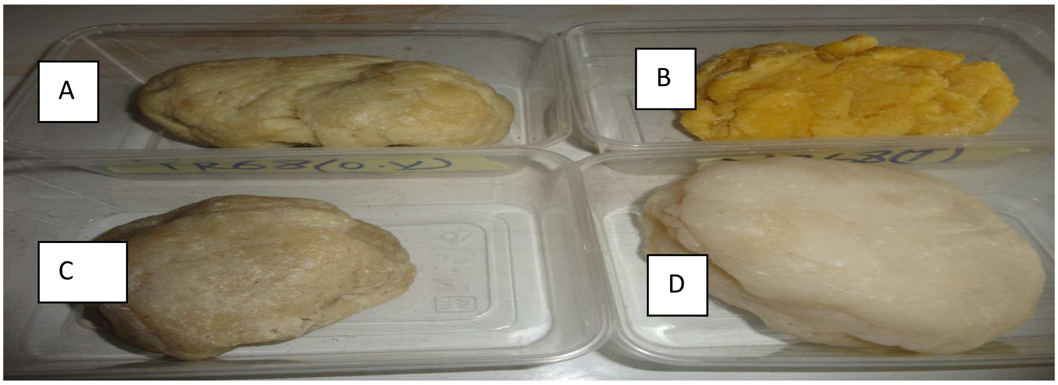

Figure 5: A= odourless *fufu* (made from oven dried odourless *fufu* flour), B = Traditional *fufu*, (made from traditional fermented cassava mash), C= odourless *fufu* (made from sun dried odourless *fufu* flour) and D= Commercial *fufu*.

CONCLUSION

Leaching in water and heat did not adversely affect the carotene content during processing. Drying in sun (ultraviolet light) had detrimental effect on the production of pro-Vitamin A *fufu*. The use of traditional method for the production of *fufu* from yellow root cassava varieties is therefore recommended for maximum utilization of the nutrient in the newly released yellow cassava varieties. There is need to transfer this technology to the rural populace who are the main target for breeding these yellow root cassava varieties in other to alleviate VAD among them.

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