EFFECT OF PROCESSING METHODS ON CONSUMERS' ACCEPTABILITY OF VITAMIN A BIOFORTIFIED CASSAVA GRANULATED FOOD PRODUCT (*GARI*)

D. L. ALABI

Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife, Nigeria.
alabidorcas@yahoo.com; +2348062915547

ABSTRACT

The study aimed at establishing a standard method of processing Vitamin A biofortified cassava into gari, using four processing techniques. In the first method, the gari production from harvesting to roasting was completed within 24 hours, the second and the third was by allowing the harvested cassava tubers to stay for 24 and 48 hours respectively before the commencement of peeling and other activities while the last was by fermenting the cassava mash (grated on the first day) for 4 days before roasting on the fifth day. Five replicates were used per technique and a- 10-member taste panel was selected per replicate to assess the effect of processing methods on taste, colour, appearance, texture, binding ability, drinkability, sourness, swelling ability and overall acceptability of the gari produced using a 4-point scale. Result revealed that product 1 has the highest binding ability but the least drinkability and sourness while product 4 has the highest drinkability and sourness but the least binding ability. Although all the products from the four methods were acceptable but the gari produced with method 3 had the highest overall acceptability while the one produced using method 2 has the least. Based on the findings, the study concluded that method 3 should be popularized for adoption among the gari processors. It also recommended that home economics extension should play major roles in the dissemination of the most acceptable processing method and also provide adequate consumer education on the nutritional, health and economic benefits of vitamin A biofortified gari over the common white alternative.

Keywords: Processing methods, Vitamin A biofortified cassava, fortification, "gari"

INTRODUCTION

Vitamin A deficiency (VAD) has been a major health problem in many developing countries including Nigeria where many, irrespective of age, gender and geographical location, get less Vitamin A than required. It has been reported that about 30 percent of children under age five in Nigeria and almost 20% of pregnant women are deficient in Vitamin A (International Institute for Tropical Agriculture (IITA), 2010), resulting in stunted growth, diarrhea, measles and premature death in children as well as severe night blindness and high mortality rate in pregnant women (World Health Organizations (WHO), 2017). Animal foods are good sources of Vitamin A but they are not affordable by the poor, thus leaving foods of plant origin an important source of pro-Vitamin A (Tumuhimbise *et al*, 2013). To combat the prevalence of VAD, various strategies including fortification and bio-fortification methods have been developed by scientists across the world (Bouis and Saltzman, 2017). Recognizing the severity of the problem, the Nigerian government had also embarked on supplementation programmes with Vitamin A for children within the age range of 6 months to 5 years during immunization and has mandated the fortification of certain food items like sugar, wheat flour and vegetable oil with Vitamin A since the year 2000 (WHO, 2012), however, this approach is cost-intensive.

Biofortification is a cost-effective and sustainable strategy whereby staple food crops are developed to contain high micronutrient contents using conventional plant breeding technology and/or modern biotechnology (Nestel *et al.*, 2006). Staple crops are the predominant food source for many low-income families in developing countries. Through biofortification, these crops are loaded with high levels of minerals and vitamins in their seeds and roots. Once the biofortified crops are developed, their seeds and roots can be multiplied and shared among farmers locally and internationally.

Cassava (*Manihot esculenta*) is a major staple food crop in Nigeria providing food for over 100 million persons (Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), 2016) and grown in 24 out of the 36 states (Omoregbee and Banmeke, 2014). It has a shelf life of 24 to 48 hrs after harvest (Andrew, 2002). The global effort to bio-fortify cassava has targeted the development of varieties with high levels of provitamin A carotenoids, primarily to help reduce the prevalence of VAD in subsistence-farming communities (Pfeiffer and McClafferty, 2007). Consumption of carotene-rich cassava is expected to become home-grown therapies for sustainable improvement in the nutrition of communities whose dietary needs heavily depend on cassava (Mayer *et al.*,2008; Nassar &Ortiz, 2010).

Unfortunately, the commonly consumed white cassava varieties in Nigeria lack micronutrients like Vitamin A (www.harvestplus, 2014). Due to the important role of cassava in the diets of Nigerians, National Root Crops Research Institute (NCRI) Umudike and International Institute of Tropical Agriculture (IITA), Ibadan jointly developed bio-fortified cassava varieties with Vitamin A. These varieties are yellow in colour owing to their high beta-carotene (pro-Vitamin A) content; hence they are called yellow cassava. The new yellow varieties are also high yielding and resistant to major diseases and pests. It is strongly believed that the yellow cassava varieties being introduced to farmers would be an effective tool in reducing VAD among the population.

Cassava granulated food product, locally called “*gari*” in the Southern part of Nigeria, is one of the many kinds of food products that can be gotten from cassava root and it is the most widely traded processed cassava product in Africa. It is estimated that more than 75 percent of the cassava produced in Africa is processed into “*gari*” (John-Paul, 2013). It is considered the most widely consumed staple food in Nigeria. In the southern part of the country, it accounts for about 60% of the total calorie intake of the people (Okpeke and Onyeagocha, 2015). *Gari* is a creamy-white (or yellow in case of Vitamin A bio-fortified varieties) cassava product with a slightly fermented flavour and slightly sour taste. Traditionally, it is processed by harvesting mature cassava roots, peeling, washing, grating and fermenting the grated mash for a few days (usually between three to five days depending on preference), de-watered and then roasted in a fryer manually or mechanically. It is consumed in different forms either directly or soaked in cold water with sugar, coconut, roasted peanut, or fried fish/meat, or eaten with soft boiled beans or as a dough (*eba*) prepare with hot water and eaten with soup or stew (Egwim *et al*., 2013).

Vitamin A biofortified cassava was introduced to Nigeria by IITA in the year 2011 and the crop was disseminated to farmers by various extension service providers. Initially, it was readily accepted and adopted by the generality of farmers in the study area, only for many to discontinue later. The excuses for the discontinuance are associated with the poor quality of the *gari* including lack of sour flavour/taste and lack of binding capacity when it is being prepared with hot water to make a dough (*eba*). This is because traditionally, *gari* consumers always look out for qualities like sour taste, fleeting aroma, particle size and binding capacity when used for making a dough. Since the processing techniques usually determine the quality of the end product of *gari*, it is therefore, necessary to assess various methods for processing vitamin A biofortified cassava into *gari* with the view to determine the effect of these processing methods on the quality of the gari and to come up with the most acceptable method that can be disseminated to processors.

MATERIALS AND METHODS

The vitamin A biofortified cassava that was used for this study was obtained from the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria. Four processing methods were employed and 23 kilograms of fresh vitamin A biofortified cassava root was used to produce an average of 7.5 kilograms of *gari* per sample. With the first method, the gari production from harvesting to roasting was completed within 24 hours, the second and the third was by allowing the harvested cassava tubers to stay for 24 and 48 hours respectively before the commencement of peeling and other activities based on Andrew (2002) assertion that cassava has a shelf life of 24 to 48hrs after harvesting. The last method was by fermenting the cassava mash (grated on harvest) for 4 days before roasting on the fifth day. The steps involved in producing *gari* from each method were as shown in the production chart below with all the processing activities done manually. The gari produced was used for direct drinking and for making dough (*eba*). 1/2kg of each product was used for drinking while 1kg was used for making dough per replicate. To produce the dough (eba), 3 litres of water was allowed to boil and poured into a neat bowl where 1kg of gari was evenly poured into it and cover with a lid for 3minutes before stirring. Five replicates of sampling per technique were carried out in Osun State, Nigeria.

Production Flow Chart for Processing Vitamin A Bio-fortified Cassava to Gari

	Method 1 (24hrs)	Method 2	Method 3	Method 4 (control)
Day 1	Harvesting	Harvesting	Harvesting	Harvesting
	Peeling			Peeling
	Washing			Washing
	Grating			Grating
Day 2		Peeling		
	Sieving wet cake			
		Washing		
	Roasting			Fermentation
		Grating		
		Dewatering overnight		
Day 3		Sieving of wet cake	Peeling	
		Roasting	Washing	
			Grating	
			Dewatering overnight	
Day 4			Sieving of wet cake	Dewatering overnight
			Roasting	
Day 5				Sieving of wet cake
				Roasting

SENSORY EVALUATION

For each replicate, the organoleptic properties of the *gari* such as taste, colour, appearance, texture, binding ability, drinkability, sourness, swelling ability and overall acceptability were assessed by a – 10-member taste panel familiar with the product. The scores were ranked based on 4 points hedonic scale with 1 representing extreme dislike, 2 represent dislike, 3 equals moderately like while 4 denotes extreme like. Analysis of variance (ANOVA) was used to determine the difference while Duncan multiple range test was used to separate the means where there was a significant difference.

RESULTS AND DISCUSSION

Table 1 shows that at P<0.05, significant difference exist in the taste, colour, appearance, texture, binding ability, drinkability and sourness of the *gari* processed using method 1 and that of method 4 (which is the popular processing method used in the study area and therefore serve as the control). Also, the means were significantly different for colour, appearance, texture, binding ability and sourness of the *gari* processed with method 2 and that of method 4, whereas, only the texture and the binding ability of the *gari* processed with method 3 are significantly different from that of method 4. Product 4 (i.e., gari produced from method 4) has the highest drinkability and sourness but with the least binding ability while product 1 has the highest binding ability but the least drinkability and sourness. Although, there is no significant difference in the overall acceptability of all the products, product 3 has the highest overall acceptability which may be due to the fact that the product is both moderately sour and binding, therefore good for both drinking and dough (*eba*) making which are the major ways of consuming *gari* in the study area. Product 1 is the second in acceptability probably because of its highest binding property which increases its acceptability among the panel members who mainly consume *gari* in dough form. This is followed by product 4 which has the highest sourness and therefore preferred by those who mainly consume *gari* in drinking form. The finding implies that these acceptable methods of processing vitamin A biofortified cassava into *gari* should be disseminated to the processors who will decide on the one they most preferred based on their customers' requirements.

Table 1: Sensory evaluation of Vitamin A Biofortified Cassava Granulated Food Product (Gari) from Four Processing Methods

Parameter	Sample1	Sample 2	Sample 3	Sample 4	LSD
Taste	3.36^{a}	3.06^{ab}	3.16^{ab}	2.96^{b}	0.097
Colour	3.64^{a}	3.60^{a}	3.46^{ab}	3.32^{b}	0.064
Appearance	3.62^{a}	3.58^{a}	3.54^{ab}	3.30^{b}	0.066
Texture	3.44^{a}	3.36^{a}	3.48^{a}	3.02^{b}	0.081
Binding ability	3.74^{a}	3.42^{b}	3.24^{b}	2.50^{c}	0.073
Drinkability	2.84^{b}	2.96^{b}	3.24^{a}	3.40^{a}	0.088
Sourness	2.82^{c}	2.94^{c}	3.24^{ab}	3.46^{a}	0.088
Swelling ability	3.30^{a}	3.16^{a}	3.18^{a}	3.10^{a}	0.088
Overall acceptability	3.18^{a}	3.00^{a}	3.24^{a}	3.10^{a}	0.082

a,b,c = Means in the same row followed by the same letter are not significantly different from each other at p< 0.05

Sample 1: Vitamin A biofortified gari processed with method 1 (Product 1)
Sample 2: Vitamin A biofortified gari processed with method 2 (Product 2)
Sample 3: Vitamin A biofortified gari processed with method 3 (Product 3)
Sample 4: Vitamin A biofortified gari processed with method 4 (Product 4)

Table 2 shows that at p≤0.05, taste, colour, drinkability and swelling ability were significantly and positively correlated with overall acceptability while at p≤0.01, appearance, texture, binding ability and sourness were positively and significantly correlated with overall acceptability of vitamin A biofortified *gari*. It implies that these parameters are the major determinant of the product's acceptability to the consumers; hence, the processing method (such as method 3) that is capable of producing vitamin A gari with the combination of these parameters should be popularised among the processors.

Table 2: Correlation matrix showing relationships among sensory evaluation parameters

	Taste	Colour	Appearance	Texture	Bind ability	Drink Ability	Sour Ness	Swell ability	Overall Accept
Taste									
Colour									
Appearance		0.806**							
Texture	0.543**								
Binding Ability									
Drinkability			0.298*	0.498**					
Sourness	0.472**	0.349*	0.415**	0.553**	0.366**	0.656**			
Swelling Ability				0.546**	0.305*	0.585**	0.507**		
Overall Acceptability	0.324*	0.295*	0.364**	0.502**	0.364**	0.318*	0.514**	0.312*	

** Significant (P < 0.01)
* Significant (P < 0.05)

CONCLUSION AND RECOMMENDATIONS

The result showed that all the vitamin A biofortified gari produced by the four processing methods were acceptable but the one produced with method 3 was the most acceptable, implying that this processing method should be popularised. Awareness of proper processing method will enhance the quality of the product and consequently, increase its consumption and demand for the product. It will also increase the income of farmers and processors and eradicate or at least minimize VAD problem especially among the resource-poor households where children drink gari almost every day.

The study recommended the involvement of home economic extension personnel in carrying out demonstrations on the appropriate processing method especially among the local processors who dominate the study area. Adequate consumer education on the nutrition and health benefits of vitamin A biofortified cassava should also be provided to enhance consumers' preference for the product above the white alternative with poor nutritive value, which is presently the most popular in the study area.

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