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CHEMICAL AND SENSORY PROPERTIES OF GARI ENRICHED WITH SESAME SEED FLOUR (*SESAMUM INDICUM L.*)

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ABSTRACT

The study was carried out to determine and compare the chemical and sensory qualities of gari enriched with both defatted and full fat sesame seed flours. Sesame seed was processed into full- fat and defatted flours. The full fat and defatted flours were used to co-enrich the fermented, dewatered and sifted cassava meal during toasting at 5, 10 % levels to produce enriched gari. The samples were subjected to chemical and sensory evaluations. Chemical analysis showed that enrichment significantly increased ($P < 0.05$) the protein content from 1.90% in the control sample to a range of 8.29% - 18.20%. The hydrocyanic acid content was reduced from 14.63 mg/kg in the control "gari" to a range of 8.12 mg/kg – 12.62 mg/kg for the enriched samples. The energy values increased significantly ($P < 0.05$) from 1372.50 kJ/g to a range of 1442.58 – 1771.15 kJ/g. The pH was increased by enrichment with sesame meal. It increased from 3.81 in the control sample to a range of 3.89 – 4.22. The acidity was correspondingly reduced from 0.572% in the control "gari" to a range of 0.228 - 0.382% lactic acid in the enriched samples. The sensory evaluation shows that the sample enriched with 10% full fat supplement (FS) had the lowest score of 3.00 for appearance, which was rejected by the panelist as being too dark. The enriched samples were less sour than the control sample, but the sample enriched with defatted supplements tasted similarly as the control. The texture was also found to be a bit more fluffy and less cohesive. On the basis of overall acceptability, the control sample was found to be the best followed by the sample co-enriched with defatted supplement, closely followed by the sample enriched with full fat supplements. Therefore, enriching gari with defatted sesame seed flours produced the best acceptable gari up to 10% level in terms of the chemical and sensory properties.

Keywords: Sesame seed, chemical, pasting characteristics, sensory evaluations

INTRODUCTION

In the tropical and sub-tropical areas of the world, feeding of the fast growing population has continued to pose a serious problem and are also characterized by a shortage of animal protein and incidence of energy malnutrition (Hernandez *et al.*, 1996). These regions are however rich in starchy tubers such as cassava, yam and cocoyam. Cassava (*Manihot esculenta* Crantz) is a tuber that is grown throughout the tropics and sub-tropics, where it contributes a considerable proportion of the total calorific intake (Okezie and Kosikowski, 1982). It is a staple food for more than half of the Nigerian population. It is processed into various products that are useful as human and animal foods including "gari" (Lancaster *et al.*, 1982). Gari, toasted, fermented cassava

semolina, is the most popular cassava product consumed in West Africa and the most important item in the diet of millions of Nigerians (Kordylas, 1990). It forms a significant part of the diet in many countries such as Ghana, Cameroun, Zaire and Brazil where it is called "farinha de manioc". Although cassava is high in linamarin (Vasconcelos, 1990), about 83% of the total cyanogenic glucoside (linamarin and lotaustralin) are detoxified during processing of the tuber into gari and 98% of the cyanide is lost when gari is made into "eba", a hot water reconstituted paste (Mahungu *et al.*, 1987). However, cassava and its product are low in protein, deficient in essential amino acids and therefore have poor qualitative protein content. Thus continuous dependence on gari without

supplementation with meat, fish and other protein- rich sources would result in protein deficiency. However, because of the high cost of animal protein the majority of the population cannot afford such supplementation of gari (Fashakin *et al.*, 1986; Aletor, 1993a). Supplementary protein sources must therefore be provided if cassava is to maintain its role as a major source of calories. Many attempts have been made to enrich cassava products with proteins from different vegetable sources in order to alleviate this problem (Edwards *et al.*, 1977; Oshodi, 1985; IITA, 1990; Sanni and Sobamiwa, 1994; Banjo and Ikenebomeh, 1996) but the use of sesame has not been exploited. Sesame being one of the world's most important oil seed crops offers good source of edible oil and nutrients for humans. It is extensively used in baked goods and confectionary product, whereas it is also a valuable feed for farm animals (Mukhopadhyay and Ray, 1999). It is also believed that it has effect on cholesterol level. With its high level of unsaturated acid (83%), it is believed to have reducing effect on coronary heart disease (Sirato-Yasumoto *et al.*, 2001). With a positive amino acid structure, there is a high level of methionine and tryptophan which makes it an excellent protein complement to other plant proteins. Sesame seeds contain calcium, potassium, phosphorus, vitamin B complex and iron. It adds a unique nutty flavour with a crunchy sensation to a variety of food. Sesame, an oil seed rich in protein with good essential amino acid profile is potentially useful for this purpose. Since the unit cost of sesame protein is cheap compared with other vegetables and animal proteins, sesame seed flour will be an inexpensive high quality protein source in food fortification and enrichment programmes. The objectives of this study are therefore to process cassava into sesame seed (full fat and defatted) enriched gari at 5 and 10% supplementation level during toasting and compare the chemical and sensory qualities of the enriched with both the full fat and defatted flours.

MATERIALS AND METHODS

Materials:

The materials used were cassava and sesame seed. The cassava (*Manihot esculenta* Crantz) were obtained from Federal University of Technology Teaching and Research farm, Akure, Nigeria; while the sesame seeds

(*Sesamum indicum* L) were purchased from Oba market in Akure, Ondo State, Nigeria. They were sorted, cleaned, packed and kept under refrigeration until use.

Methods of Processing

Sample preparation

Selected sesame seeds were cleaned, toasted and then ground into a meal. The meal was divided into two in which one part was defatted and the other full fat was then added into the cassava mash at 5 and 10% levels. Sesame enriched gari was produced from cassava tubers using the amended methods of Banjoh and Ikenebomeh (1996) who produced soy-enriched gari and Oluwamukomi and Adeyemi (2012) using similar methods of enrichment. Cassava tubers were peeled manually with a sharp knife, washed and grated in a locally fabricated mechanical grater which was connected through a belt to a 7 hp driving motor (Agunbiade, 2001). They were then packed into Hessian sack and allowed to ferment for 72 hours after which they were pressed in a mechanical press (Addis Engineering Nig. Ltd, Nigeria) to dewater the mash. The dewatered wet cassava cakes were pulverized manually and sifted to remove the fibers. The sifted cassava meal obtained was enriched with full fat and defatted sesame meal at 5 and 10% supplementation levels (Oluwamukomi and Adeyemi, 2013). It was then toasted in a wide aluminum pan (called garifier) being heated over wood fire. The toasted sesame enriched gari was removed from the iron pot and allowed to cool. The cooled gari samples were then packaged in HDPE film and kept under refrigerated storage until ready for further analysis.

Analyses

Chemical Composition

The proximate compositions were determined according to the standard methods of AOAC (2000). The crude protein was determined by multiplying the total nitrogen by 6.25. The carbohydrate was obtained by difference. The energy values were calculated by multiplying with the Atwater factors of 16.80, 16.80 and 37.80 kJ for carbohydrate, protein and fat respectively. The pH was measured with a pH meter. The total cyanide (mg/100g) was determined by the standard method of (AOAC, 2000). The Phytic acid was determined by the method of Wheeler and Ferrel (1971).

Sensory Evaluation

Sesame enriched gari samples were reconstituted into ‘eba’ with boiling water in ratios 1:2.2 (w/v) using the method of Oluwamukomi *et al.* (2005). The reconstituted “eba” samples were evaluated in terms of colour, flavour, taste and overall acceptability by a trained panelist of ten people who were already used to the consumption of gari in form of “eba”. Eba is a stiff dough prepared from gari by reconstituting it with hot water, after which it was mixed well with spoon to form a stiff dough. The stiff dough is usually consumed by dipping it in a soup made from a mixture of vegetables, meat, pepper, tomatoes, onion, salt and other seasoning blends (Collins and Temalilwa, 1981). The parameters were scored on a 9 point Hedonic scale ranging from 1= disliked extremely to 9= liked extremely (Larmond, 1977). The mean scores

were subjected to analysis of variance (ANOVA) and separated by Duncan multiple range tests.

Statistical Analysis

All results were reported as means of replicate analysis. Data obtained were subjected to one way Analysis of Variance (ANOVA) using SPSS version 17 to determine significant differences (P < 0.05). Differences between means obtained from the ANOVA were ascertained using Duncan’s Multiple Range Tests (Steel *et al.*, 1997).

RESULTS

Chemical composition

The results of the chemical composition of gari enriched with sesame seed meal is presented in the Table 1.

Table 1: Chemical composition of sesame enriched gari

PARAMETERS	CONTROL	FULL FAT SAMPLE		DEFATTED SAMPLE	
		5%	10%	5%	10%
		Crude protein%	1.90±0.02d	8.29±0.02c	10.62±0.02bc
Fat content%	0.33±0.02d	10.20±0.02b	16.01±0.02a	5.42±0.02c	7.01±0.02c
Ash content %	1.20±0.03c	2.06±0.02b	2.58±0.02b	7.51±0.03a	6.04±0.03a
Crude fibre %	5.03±0.03a	4.37±0.02b	4.60±0.23b	4.40±0.03	4.65±0.03b
Moisture content %	10.90±0.03a	8.20 ±0.02b	5.36±0.02d	7.33±0.02c	4.05±0.02e
Carbohydrate %	80.64±0.02a	66.88±0.02b	60.83±0.02d	62.55±0.02c	60.05±0.02d
Energy (kJ/gm)	1372.50±0.02e	1617.02±0.01b	1771.15±0.02a	1442.58±0.01d	1549.49±0.01c
pH	3.81±0.02d	4.16±0.03b	4.17±0.02a	3.89±0.02c	4.22±0.02a
Titratable acidity (%lactic acid)	0.572±0.03a	0.232±0.03	0.291±0.04	0.382±0.02	0.228±0.03
%Phytate	0.196±0.02c	0.210±0.02b	0.330±0.02a	0.231±0.02b	0.290±0.03a
Hydrocyanic acid (mg/kg)	14.63±0.02a	8.12±0.04d	9.21±0.03d	12.13±0.03c	12.62±0.03b

Values are means of 3 replicate readings

^{a,b,c} *Means followed by different letters in a column are significantly different (P < 0.05)

± Standard errors of mean

KEY:

5%FS= Full-Fat Sesame Enriched Gari
 10%FS= Full-Fat Sesame Enriched Gari

5% DS= Defatted Sesame Enriched Gari
 10%DS= Defatted Sesame Enriched Gari

Table 2: Means panel scores for Reconstituted Gari (“sesame eba”) enriched with defatted and full fat of sesame meals.

Samples	Flavour	Colour	Taste	Texture	Overall
CONTROL	7.02±0.02a	7.23±0.01a	7.13±0.01 ^a	6.56±0.01a	7.43±0.01a
5% FS	4.05±0.01 ^c	4.30±0.02 ^{bc}	3.00±0.02 ^d	3.55±0.01 ^c	4.30±0.01 ^{bc}
10%FS	4.40±0.01 ^{bc}	3.00±0.01 ^d	3.50±0.02 ^c	3.80±0.02 ^c	3.60±0.02 ^c
5%DS	5.05±0.02 ^{bc}	3.90±0.02 ^c	3.90±0.01 ^c	4.95±0.01 ^b	4.70±0.02 ^b
10%DS	5.80±0.01 ^b	5.3±0.01 ^b	5.35±0.02 ^b	5.10±0.02 ^b	5.35±0.01 ^b

Values are means of 20 panelists scores

^{a,b,c} *Means followed by different letters in a column are significantly different ($P < 0.05$)

± Standard errors of mean

KEY:

5%FS= Full-Fat Sesame Enriched Gari

5% DS= Defatted Sesame Enriched Gari

10%FS= Full-Fat Sesame Enriched Gari

10%DS= Defatted Sesame Enriched Gari

Protein Content: Enrichment significantly increased the protein content from 1.90% in the control sample to a minimum of 8.29% for “gari” enriched with 5% full fat sesame seed meal and a maximum of 18.20% for gari enriched with 10% defatted sesame seed flour ($P < 0.05$). This means that the defatted samples had the highest mean protein content followed by those with full fat supplements ($p < 0.05$).

Fat content: The fat content significantly increased from 0.33% in the control sample to a range of 5.42 – 7.01% in defatted samples and a range of 10.20 – 16.01% in full fat samples ($P < 0.05$). The higher the level of enrichment, the higher the fat content ($P < 0.05$).

Ash content: Enrichment significantly increased the ash content of the gari sample ($P < 0.05$). It significantly increased from 1.20% in the control “gari” to a minimum of 2.06% in “gari” enriched with 5% full fat sesame flour to a maximum of 2.58% in “gari” enriched with 10% full-fat flour. Defatting also significantly caused an increase in the ash content from a range of 6.04 -7.51% in the defatted samples ($P < 0.05$).

Crude fibre: Crude fibre lightly decreased from a value of 5.03% to a range of 4.37% in sample with 10% full fat flour to 4.65% in the sample with 5% defatted flour sample.

Carbohydrate content: The carbohydrate content was significantly reduced from

80.64% to a minimum value of 60.05% in the sample enriched with 10% defatted sesame meal and the maximum value of 66.88% in the sample enriched with 5% full fat sesame meal ($P < 0.05$). The higher the level of enrichment the lower the carbohydrate content. Defatting caused a decrease in the carbohydrate content and a corresponding increase in the protein contents.

Total energy value: The energy values increased significantly ($P < 0.05$) from 1372.50 kJ/g to a range of minimum value of 1442.58 kJ/g in the “gari” sample enriched with 10% defatted supplement and a maximum value of 1771.15 kJ/g in the sample enriched with 10% full fat meal. The higher the fat content the higher the energy values.

Hydrocyanic acid (HCN): The hydrocyanic acid content was consistently lower in all the enriched samples than the control “gari”. HCN was reduced from 14.63mg/kg in the un-enriched “gari” to a range of 8.12mg/kg for sample toasted with 5% full fat to 12.62mg/kg for sample toasted together with defatted sesame meal.

pH: The pH of “gari” was increased by enrichment with sesame meal. It increased from 3.81 in the control sample to the minimum value of 3.89 in the sample enriched with full fat supplement after toasting and the maximum value of 4.22 in the sample toasted together with defatted meal. The acidity was correspondingly reduced from 0.572% in the

control “gari” to a minimum value of 0.228% lactic acid in the sample toasted together with defatted sesame meal and a maximum value of 0.382% in the sample enriched with full fat sesame meal before fermentation.

Sensory properties of the reconstituted sesame-enriched gari (‘sesame eba’)

The result of sensory properties of the reconstituted sesame enriched gari (‘sesame eba’) are shown in Table 2. There were significant differences between the ‘eba’ (stiff paste) made from un-enriched (Control) and the enriched gari samples ($P \leq 0.05$). On the basis of appearance, the control sample with no supplement was significantly scored better than the enriched gari ($P < 0.05$). Enrichment reduced the mean panel scores showing that they were less accepted than the control sample in term of appearance. The panel scores was reduced from a range of 6.56 - 7.43 in the control sample to a range of 3.00 to 5.80 in the samples enriched with sesame seed flour supplements. The sample enriched with 10% Full fat supplement had the lowest score of 3.00 for appearance, which was rejected by the panelist as being too dark. Similarly the texture of the eba from the sesame enriched gari was significantly different from the control ($P < 0.05$). When the reconstituted eba was finger tested to show how soft or thick, smooth or gritty the sample was, the texture of the enriched gari was found to be softer than the control. On the basis of taste, the control was also found to be the best closely followed by the sample enriched together with the 5% defatted supplement. There were significant differences ($P < 0.05$) between the control (un-enriched) and the enriched products. Sample with 10% defatted supplement was the closest to the control in terms of all the sensory parameters.

DISCUSSION

Chemical composition of sesame enriched gari

Enrichment significantly increased the protein content of the samples. The higher values of proteins in the “gari” with defatted supplements might have been due to the removal of the oil in the supplement thus increasing the values of the protein contents (Iwe and Onuh, 1992). The increase in protein content is attributable to the incorporation of sesame meal in the blend which served as a

plant protein supplement. Therefore enrichment of “gari” with sesame meal produced “gari” of higher nutritional value. The protein contents of the defatted blends were in the range of 11-14% recommended for growth by Beaton and Swiss (1974) and still within the range of PAG (1971). Therefore, samples from the “gari” from the defatted supplement may be inferred as capable of supporting growth in school age children who often consume “gari” as a convenience food. This increase in the fat content in “gari” enriched with full fat supplement might have been as a result of the contribution of the oil in the full fat sesame seed supplement which is more than 45% fat content (Nyotu *et al.*, 1996). This shows that the ash contents of “gari” with defatted residues were higher than those of “gari” enriched with full fat supplements. This is similar to the findings of Edem *et al.* (2002), who increased the ash content of “gari” to 5.17% and 5.58% by fortifying with 10% and 15% soy meal respectively. This is also true of some food products other than “gari”. Iwe and Onadipe (2001) increased the ash contents of sweet potato from 2.2% to 2.5% - 4% by supplementing it with soy meal up to 25% level. Enrichment also decreased the fibre content of gari. This showed that enrichment with sesame supplement reduced the fibre content of “gari”. This reduction of the fibre content might have been due to the dilution effect of the supplement on the fibre content of “gari”. The high crude fibre contents which range from 3.67% to 3.94% when compared with the control sample indicated that they are important dietary fibre which can be used to reduce the problem associated with the excess deposit of fats in the body tissues (Ezeike, 1995). This shows that enrichment reduced the carbohydrate contents of cassava products and gave protein enrichment to solve malnutrition problem such as kwashiorkor (Okezie and Kosikowski, 1992). . The increase and the higher values of energy in the “gari” with full fat supplement might have been due to its oil content since oil has twice the energy for the same quantities for both protein and carbohydrate (Osborne and Voogt, 1978). It could be inferred that “gari” enriched with defatted sesame meal was the richest in terms of the protein and ash contents, while “gari” enriched with full fat supplement was highest in fat content and total energy values while the

un-enriched (control) “gari” had the highest crude fibre and carbohydrate contents. This shows that “gari” enriched with defatted meal seemed to be the best sample in terms of the proximate composition.

The hydrocyanic acid contents were consistently lower in the enriched samples. The values were lower than the recommended values of 20.0 mg/kg (Ingram, 1975, CODEX STAN 151, 1995 and NIS 181, 2004) and the lethal dose of 40-60 mg/kg suggested for adult (Obioha, 1972). They were lower than the range in values of 0.00 – 32.00 mg/kg reported in earlier studies by Oke (1994), Aletor (1993a & b) and Adindu *et al.* (2003). The decrease in hydrocyanic acid values might have been due to the dilution effect of the sesame seed protein in the supplements as observed by earlier workers in soy enriched gari (Sanni and Sobamiwa, 1994; Oluwamukomi *et al.*, 2005). Sanni (1991) observed that after 3 days of fermenting cassava, “gari” had a total cyanide content of 20.0 and 7.0 mg/kg during the dry and wet seasons respectively. Sanni and Sobamiwa (1994) also observed that the cyanide content of soy-enriched “gari” was reduced with increasing protein content. However the type of supplement added whether full fat or defatted did not have any significant effect on the hydrocyanic acid content ($P > 0.05$).

There was a general increase in pH and decrease in acidity with enrichment. This showed that enrichment with sesame meal tended to make the “gari” less acidic by the dilution effect of the supplements. The general increase in pH and the corresponding decrease in the acidity with enrichment might have been due to the dilution effect of the sesame supplement which indirectly responsible for the reduced sourness in the enriched “gari” samples (Banjo and Ikenebomeh, 1996). This reduction made the acidity to be much lower than the recommended range values of 0.9 - 1.2% (Edwards *et al.*, 1977) and 0.6% - 1.0% (CODEX STAN 151, 1989, Rev. 1995). This was noticed in the reduction of the sour taste of the sesame “gari” which was an important parameter of sensory quality of “gari”. This reduction might have been due to the differences in the number of days of fermentation and the dilution effect of the sesame meal supplements. This had also been observed to be due to the production of ammonia from the sesame protein degradation

(Banjoh and Ikenebomeh, 1996; Reddy *et al.*, 1986). The pH and acidity values obtained indicated that the samples were in acidic range and may be stable against spoilage microbes.

Sensory properties of the reconstituted sesame enriched gari (“sesame eba”)

It was observed that there was a significant difference between the ‘eba’ made from un-enriched (control) and the enriched gari granules ($P < 0.05$). It has been observed that consumers usually judge gari quality based on its appearance, colour and particle size but with particle size being the mostly used attributes of quality (Blanchard *et al.*, 1994). In the case of reconstituted gari (“eba”), finger feel and mouth feel (texture) are its most important eating qualities (Oluwamukomi *et al.*, 2005). Eba should not be too soft or too sticky when tested by the finger and it should have a smooth feel in the mouth and be easily swallowed with soup usually without chewing when put in the mouth as a round ball (Almazan, 1992). The sensory characteristics of enriched eba however depend on the level of the enrichment. On the basis of appearance, the control sample with no supplement was significantly scored better than the enriched gari ($P < 0.05$). This is slightly different from the findings of Oluwamukomi *et al.* (2005) and Collins and Temalilwa (1981) who found out that there was no difference in the control and soy-enriched gari with soy flour up to 10% enrichment and Banjo and Ikenebomeh (1996) up to 15% enrichment level. Enrichment with sesame flour in this study reduced the mean panel scores, showing that they were less accepted than the control sample in term of appearance. The panel scores were reduced from a range of 6.56 - 7.43 in the control sample to a range of 3.00 to 5.8 in the enriched samples. The sample enriched with 10% Full fat supplement had the lowest score of 3.00 for appearance, which was rejected by the panelist as being too dark. This darkness in color might have been as a result of the toasting effect on the oil component. Toasting of the sesame seed could have led to Maillard reaction or lipid oxidation with attendant darkening of the colour (Ihekoronye and Ngoddy, 1985). Similarly the texture of the eba from the sesame gari was significantly different from the control ($P < 0.05$). When the reconstituted eba was finger tested it was found to be softer than the

control. The texture was a bit more fluffy and non cohesive. However at the 10% enrichment level it was still acceptable as the control sample for both the full fat and the defatted sesame enriched gari. On the basis of taste, the control was also the best closely followed by the sample enriched together with the 5% defatted supplement. The enriched samples were less sour than the control sample, but the sample enriched with defatted supplements both 5% and 10% still tasted as the control. The flavor of the enriched gari were significantly different from that of the control sample ($P < 0.05$). On the basis of overall acceptability, the control sample was found to be the best closely followed by the gari enriched with defatted supplement the sample with full fat supplement being the worst. Samples enriched with full fat sesame supplements were dark brown in colour, less sour when tasted and softer in texture when reconstituted into "eba". These are contrary to good qualities of gari that consumers usually look out for. These observations were consistent with previous findings of previous workers on soy-enriched gari samples (Oluwamukomi *et al.*, 2005; Oluwamukomi and Adeyemi, 2013; Banjo and Ikenebomeh, 1996 and Oshodi, 1985).

CONCLUSION

It can be concluded from this study that in terms of chemical composition, enriching gari with sesame seed protein meals increased the protein, fat contents and pH of gari significantly. However there was a corresponding decrease in carbohydrate, titratable acidity and fibre contents. Defatted samples have lower values of pH and higher values of protein, carbohydrate and HCN. In terms of sensory parameters, enrichment produced gari of comparable acceptability in terms of flavor and taste but less acceptable in terms of colour and texture. However using defatted supplements produce a better product than those of full fat supplement in terms of colour, taste and texture. Gari enriched with full fat sesame meal at 10% level was least accepted in term of colour. Therefore, enriching gari with defatted sesame seed meals produced the best acceptable gari up to 10% level in terms of the physicochemical and sensory properties.

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