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# Physicochemical Properties of 'Gari' Semolina Fortified with Full Fat Soy-Melon Blends

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**Abstract:** The physicochemical properties of 'gari', toasted, fermented cassava semolina, fortified with full fat soy-melon protein supplements at different processing stages were studied. The stages of processing were: Before fermentation (wet-mix method), After fermentation/before toasting (soak-mix method) and after toasting (dry-mix method). The samples were subjected to physicochemical tests. Results showed that supplementation increased the protein, fat and ash contents and the pH values, while the hydrocyanic acid content, titratable acidity reduced generally. Supplementation increased the protein content from 2.61 to 14.26-19.51%. The fat increased from 3.20 to 10.20-15.80%; while the ash content increased from 1.15 to 1.68-2.25%. Hydrocyanic acid was reduced from 1.345 mg $100g^{-1}$ to 0.672-1.248 mg $100g^{-1}$m in the supplemented products. The pH increased from 3.62 to 3.86-4.94 with the sample from the soak-mix method having the highest pH. The iron contents increased from 93.57 mg $kg^{-1}$ to 98.30-108.90 mg $kg^{-1}$. The phosphorus also increased from 16.25 mg $100g^{-1}$ to 17.81-49.41 mg $100g^{-1}$ sample while the calcium increased form 41.50 mg $100g^{-1}$ to 111.80-137.40 mg $100g^{-1}$. There was a decrease in the swelling capacities in all the supplemented samples. There were slight increases in the packed and loosed bulk densities. The reconstitution indices reduced in the samples supplemented before toasting but increased in samples supplemented after toasting. The wettability of the supplemented products reduced significantly from 30 sec delay period to 120-140 sec. This is the ability of the gari to soak water and rewet easily. From the result it could be concluded that fortification of 'gari' with soy-melon protein supplement improved its protein, fat, ash and some mineral contents and also reduced the HCN considerably. Using the 'soak-mix' method resulted in gari of better and improved physicochemical properties than gari from the 'wet-mix' and the 'dry-mix' methods.

**Key words:** Gari, soy-melon blends, soak mix, wet mix, dry mix

## INTRODUCTION

Gari, toasted, fermented cassava semolina, is one of the most popular products consumed in West Africa and the most important item in the diet of millions in Nigeria (Akinrele, 1964). However, Cassava from which this important item of food is produced is low in protein and deficient in essential amino acids. The crude protein content of locally produced gari could be as low as 1.03% and levels of cyanide are variable (0-32 mg HCN equivalent $kg^{-1}$) depending on the processing method, variety and locality (Oke 1994). Gari has been shown to be a rich source of energy but of poor protein content (1.03%) compared with soy bean (44.08%). It has low levels of Methionine, Tryptophan, Lysine and Phenylalanine (FAO, 1997). Some efforts have been made to improve the nutrient content of cassava products. Bassir (1963) supplemented gari with full-fat soy flour noting their effect on growth, reproduction and lactation in growing albino rats. Akinrele (1967) supplemented gari with a combination of defatted groundnut flour, full fat soy flour, sesame flour and dried yeast powder to determine their Essential Amino Index and the cost of supplementation. Collins and Temalilwa (1981) increased the PER of cassava flour to 1.55 by adding to it 20% soy flour. Oshodi (1985) supplemented gari with combination of soy grits and defatted melon to determine the effect of the enrichment on the sensory qualities of gari. The protein content was increased from 1.43-19.41% dry basis with 40% protein supplement and 60% gari. However, the color and the odor were scored lower than the control. The 'eba' made from the enriched gari was darker in color. Akinrele (1967) added the supplements both to the already fried gari and the sifted semolina before frying.

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He observed that the product from the gari enriched before frying was indistinguishable from the control gari. Also, the supplement was in form of grits which separated in gari soaked in water and in 'eba' reconstituted from the enriched gari. This is a problem is supplementing gari with oilseeds. While trying to improve the protein quality level of gari, it must not be done in such a way as to affect the physicochemical and sensory properties. Past efforts have shown that using Soybean, melon or groundnut alone was not sufficient in providing the necessary essential amino acids comparable to the reference protein. The reasons being that adequate amount of these flours cannot be added without strikingly altering the flavors, palatability and appearance of the gari product (Oshodi, 1985). Also, their biological values are not high enough to compensate for the small amounts in which they have to be added to gari and moreover they require further supplementation with Lysine and Methionine (Akinrele, 1967). In an attempt to cut down on the amount of legumes used for enriching gari at the same time improving the amino acid content of fortified gari, Oshodi (1985) enriched gari with soy grits and defatted melon flour at 25% replacement level, separately and 40% level collectively. The limiting amino acids Lysine and Histidine in Melon were provided by soybean while the Methionine lacking in soybean was supplied by Melon.

The protein content was increased from 1.43-19.4% in the enriched sample. The swelling capacity in cold water was retained but the color of the 'eba' was darker and the texture was rejected as too soft and lacked cohesiveness. The objective of this current study was to supplement cassava mash with full fat soy-melon blends at different stages of processing (before fermentation, after fermentation and after toasting). This is to improve the nutritional and the physicochemical qualities of gari by cutting down on the amount of soy flour used and substituting with melon flour.

## MATERIALS AND METHODS

**Source of materials:** Cassava roots harvested and used on the same day were obtained from the research farm of the Federal University of Technology, Akure, Ondo State, Nigeria. Soybean and melon seeds used to produce the protein supplements were purchased from the Oja Oba market, in Akure, Ondo State, Nigeria. They were sorted, cleaned, packed and kept under refrigeration until use.

**Sample preparation:** Full fat Soy-melon flour: Full fat soy-melon supplements were used to supplement three of the four portions of the cassava mash at three different stages of gari processing using 10% supplementation

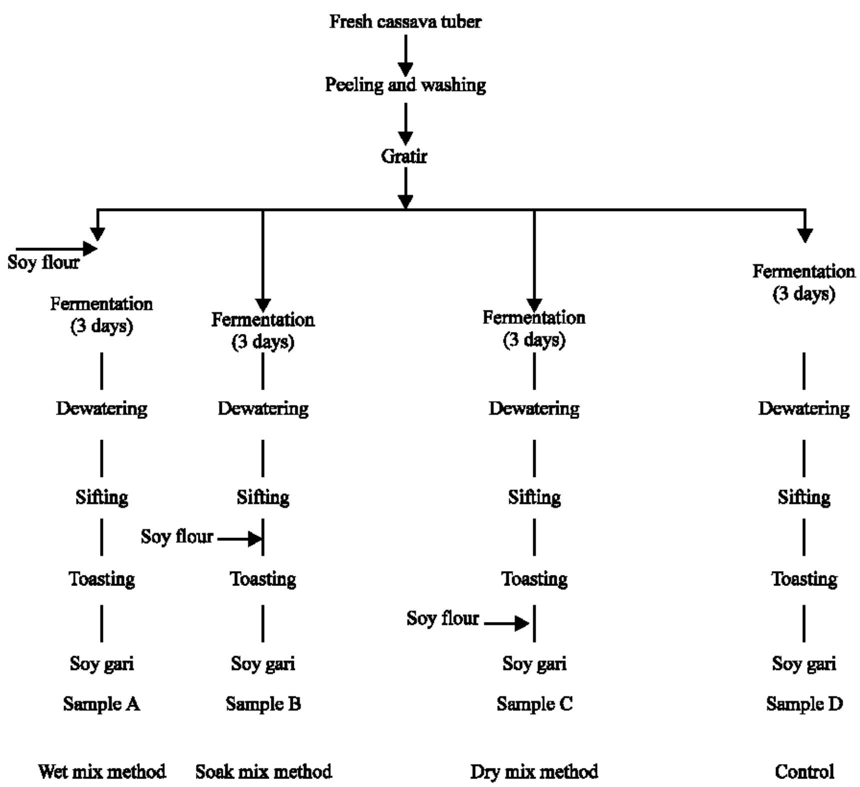


Fig. 1: Flow chart of the processing techniques for control and soy-gari samples source: Banjo and Ikenrebomeh (1996)

level. The three stages were: Before fermentation (wet mix method); after fermentation but before toasting (soak mix method); and after toasting (dry mix method). The remaining batch was used as the control, containing no supplement (Fig. 1).

**Chemical analysis:** The proximate compositions were determined according to the standard methods of AOAC (1990). The crude protein was determined by multiplying the total nitrogen by 6.25. The carbohydrate was obtained by difference. Phosphorus was estimated colorimeterically with Spectronic 20 using PhosphoVanandomolybdate method while the other mineral was determined using the Atomic Absorption Spectrophotometer (AOAC, 1990). The pH was measured with a pH meter. The total cyanide (mg $100g^{-1}$) was determined by the method of Rao and Hahn (1984). The Phpytic acid was determined by the method of Wheeler and Ferrel (1971).

**Physical analysis:** The Bulk density was determined by the method of AOAC (1990). The density calculated here was referred to as Loosed density. The same container was used to determine the packed density after compacting by tapping the cylinder gently unto the wooden surface by dropping it form a height of 1.2cm once per second, adding more flour until the cylinder was full and the top was scrapped off with a spatula to obtain uniform volumes. The swelling capacity was determined by the method of Ukpabi and Ndimele (1990). The Reconstitution Index was determined by the method of Banigo and Akpapunam, (1987). The wettability was determined by the method of Armstrong *et al.* (1979).

## RESULTS AND DISCUSSION

**Chemical composition:** Table 1 shows the results of the chemical analysis of soy-melon supplemented and Control gari samples. The supplemented samples are good sources of protein, fat and ash. This is similar to earlier studies by Oluwamukomi *et al.* (2005) and Oshodi (1985). The protein increased from 2.61% for the control to 14.26-19.51% for the supplemented samples while the fat increased from 3.20% for the control to 10.20-15.80% for the supplemented samples. The Ash content was raised from 1.15 to 1.68-2.24%. Supplementation produced gari of higher nutritional value. The protein content of the blends appeared adequate to supplement the requirement of growing children who are fond of soaking gari as a convenient food in their school boarding houses or at family levels. This is in the range of 11-14% recommended by Beaton and Swiss (1974). The iron contents of the supplemented samples increased in the supplemented samples from 93.57 mg $kg^{-1}$ to a range of 98.30-108.90 mg $kg^{-1}$. The phosphorus also increased from 16.25 mg $100g^{-1}$ to 17.81-49.41 mg $100g^{-1}$ sample. The sample toasted together with the supplement had the highest phosphorus content. This might have been due to the beneficial effect of toasting on the soy supplemented product. The phytic acid contents significantly increased in the supplemented gari samples from 169.2 mg $100g^{-1}$ to 197.4-223.49 mg $100g^{-1}$ sample. This must have been due to the contribution of the phytate content from the soy flour. The hydrocyanic acid content was significantly reduced from about 1.345 mg $100g^{-1}$ to 0.678-1.248 mg 100 $g^{-1}$ which is lower than the recommended standard level of 2.0 mg $100g^{-1}$ (Ingram, 1975). Sanni and Sobamiwa (1994) also made the similar observations. This was suggested to be due to the dilution effect of the soybean supplements. The pH increased from 3.62 to 3.70-4.94 for the samples but the increment was highest in the sample toasted together with the supplement. This shows that supplementation with soy flour tends to make the gari less acidic by the dilution effect of the supplements on the sourness of the gari samples. The increase in pH with supplementation

Table 1: Chemical composition of supplemented and control gari samples

| | Fullfat supplement | | | |
|---|---|---|---|---|
| Type of supplement | B.F | AFBT | A.T | Control (no supplement) |
| Moisture (%) | 5.76$^a$ | 2.07$^b$ | 6.24$^a$ | 7.02a |
| Protein (%) | 14.26$^b$ | 19.51$^a$ | 17.56$^a$ | 2.61$^c$ |
| Ash (%) | 2.25$^a$ | 1.90$^b$ | 1.68$^b$ | 1.15$^c$ |
| Fat (%) | 10.20$^b$ | 13.24$^a$ | 15.80$^a$ | 3.20$^c$ |
| Crude fibre (%) | 6.80$^a$ | 6.00$^a$ | 2.40$^c$ | 3.20$^b$ |
| Carbohydrate (%) | 60.73$^b$ | 57.28$^b$ | 56.32$^b$ | 83.82$^a$ |
| pH | 3.70$^b$ | 4.94$^a$ | 3.58$^b$ | 3.62$^b$ |
| HCN (mg $100g^{-1}$) | 1.01$^b$ | 0.672$^c$ | 1.248$^a$ | 1.345$^a$ |
| Acidity (%) | .456$^a$ | 0.413$^b$ | 0.424$^b$ | 0.465$^a$ |
| Iron (mg $kg^{-1}$) | 108.9$^a$ | 102.74$^a$ | 98.30$^b$ | 93.57$^b$ |
| Calcium (mg $100g^{-1}$) | 127.4$^a$ | 111.8$^b$ | 137.4$^a$ | 41.5$^c$ |
| Phosphorus (mg $100g^{-1}$) | 18.61$^b$ | 49.41$^a$ | 17.81$^b$ | 16.25$^b$ |
| Phytate (mg $100g^{-1}$) | 208.72$^a$ | 197.43$^b$ | 223.49$^a$ | 169.20$^c$ |

Values are means of triplicate readings, Means followed by different letters in a row are significantly different ($p<0.05$), Key: BF = Supplementation Before Fermentation (wet mix method); AFBT= Supplementation After Fermentation but Before Toasting (soak mix method); AT= Supplementation After Toasting (dry mix method)

Table 2: Physical properties of supplemented and control GARI samples

| | Fullfat supplement | | | |
|---|---|---|---|---|
| Parameters | BF | AFBT | AT | Control |
| Swelling Index (v $v^{-1}$) | 4.09$^c$ | 4.01$^c$ | 4.44$^b$ | 4.80$^a$ |
| Reconstitution Index (v $v^{-1}$) | 4.14$^c$ | 4.35$^c$ | 4.76$^a$ | 4.50$^b$ |
| Wettability (sec) | 120$^a$ | 120$^a$ | 140$^a$ | 30$^b$ |
| Bulk density (a) Packed | 0.73$^a$ | 0.67$^b$ | 0.67$^b$ | 0.61$^c$ |
| (g $dm^{-3}$) (b) Loosed | 0.62$^b$ | 0.52$^c$ | 0.69$^a$ | 0.53$^c$ |

Values are means of triplicate readings, Means followed by different letters in a row are significantly different ($p<0.05$), Key: BF = Supplementation Before Fermentation (wet mix method); AFBT= Supplementation After Fermentation but Before Toasting (soak mix method); AT= Supplementation After Toasting (dry mix method) might have been due to the production of ammonia from soybean protein degradation (Reddy *et al.*, 1986; Banjo and Ikenrebomeh, 1996). It could be observed that gari with Soy-melon flour also produced supplemented gari of better chemical properties than the one without any supplement.

**Physical properties:** Table 2 shows the physical properties of soy-melon gari after toasting. It can be observed that the Swelling Indices of the supplemented flours were lower than that of the control sample. They reduced from 4.8% v $v^{-1}$ to 4.01-4.44 for the supplemented samples. This is similar to the findings of Banjo and Ikenrebomeh (1996) and Oluwamukomi *et al.* (2005) who also confirmed a reduced swelling with supplementation. This they attributed to the reduced starch component in the supplemented products, which could have contributed to the absorption of water. However, the samples supplemented after toasting produced soy-gari of higher swelling power than that supplemented before toasting. High swelling index has been shown to give a greater volume and more feeling of satiety per unit weight of gari and a swelling index of at least 3.0 was recommended to be acceptable to consumers (Almazan, 1992). The Reconstitution Indices of the supplemented samples were lower for samples supplemented before toasting, but surprisingly it was higher in the sample supplemented after toasting. This might be due to the fact that the starch and the protein components were not mixed and both separately contributed to the absorption of water and swelling thus increasing the reconstitution index of the sample. This view was supported by the observation by Chauhan and Bains (1985) and Iweh and Onuh (1992) that sudden increase in water holding capacity with increase in soy supplementation must have been due to the protein system and that the higher the protein content of foods the more their capacity to hold or retain water (Oluwamukomi, 2004). The Wettability of the supplemented products increased significantly. It increased from 30 sec for the Control sample to 120-140 sec for the supplemented products. It was highest for the samples supplemented after toasting. This means that it will require more time for the supplemented gari samples to sink into water and will float for more time on the surface of the cold water that the Control sample. However this will be different for hot water. The Packed Densities for the supplemented products were higher than that of the control sample, increasing from 0.61 g $cm^{-3}$ for the control to 0.67-0.73 g $cm^{-3}$ for the supplemented products, while the Loosed Bulk densities also increased from 0.53 to 0.54-0.69 g $dm^{-3}$. The packed densities were consistently and significantly higher than the Loosed bulk densities ($p \leq 0.05$), which means that more quantity of Supplemented gari can be packed than the control gari for the same specific volume (Fagbemi, 1999). It was therefore generally observed that supplementation either improves or reduced the physical qualities of gari depending whether it was added before or after toasting. Supplementation after toasting produced gari of higher swelling and reconstitution indices, while supplementation before toasting produced gari of lower swelling and reconstitution indices.

## CONCLUSION AND RECOMMENDATIONS

From the results it could be concluded that supplementation improved the nutrient quality of gari especially the protein, fat, ash and the mineral contents. It also reduced the hydrocyanic acid content, thereby producing gari of higher quality and better safety. The acidity of the supplemented samples was reduced thus lowering the sourness of gari. This may be an advantage for people who are not interested in the sour taste of gari. However, supplementation reduced the Swelling and the reconstitution indices but increased the Wettability of gari. Supplementation by Soak mix method (supplementation before toasting) was found to be the best in terms of chemical and physical properties.

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