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Chemical and Sensory Qualities of Stored Gari Fortified with Soybean and Groundnut Flour

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ABSTRACT

Gari, a creamy white granular food product from cassava roots is a major staple consumed in both urban and rural areas due to its convenience. Gari was fortified with soybeans or groundnut at 10%, 20% and 30% respectively to produce "soy-gari" and groundnut-gari. The samples were analyzed at the initial stage of production and after eight months of storage. The proximate composition showed that moisture content, protein, fat, ash, crude fibre and carbohydrate were in range of 7.97 – 8.93%, 1.17 – 1.57%, 1.33 – 1.47%, 1.67 – 1.73%, 1.67 – 1.63% and 86.20% - 84.83 respectively at the initial production while results at eight months of storage ranged between 8.93 – 9.23%, 1.40 – 3.80%, 1.57– 3.73%, 1.20 – 2.50%, 2.80 – 1.90% and 79.50 – 84.10% respectively for soy-gari. Groundnut fortification increased the protein content from 1.17% to a range of 1.77% - 4.47%, the fat increased from 1.33% to 1.37% - 4.17%; while the carbohydrate content reduced from 86.20% to 84.33% - 78.45%. Sensory evaluation of flour and gari meal (Eba) was conducted. The result showed that gari fortified with 30% soybeans and groundnut preferred most in term of appearance, aroma, texture and mouth feel. The sensory evaluation for the soy and groundnut gari meal (Eba) showed that control samples were the most acceptable followed by the 10% of each legume. However, the increase in protein and other essential nutrients indicate that fortified gari have better nutritional qualities than control gari, therefore if globally accepted, it can prevent protein energy malnutrition.

Keywords: fortification; groundnut-gari; sensory qualities; soy-gari; storage

INTRODUCTION

Cassava (*Manihot esculenta* crantz) is an important vegetable crop that is grown throughout the tropics and sub-tropics, where it contributes a considerable proportion of the total caloric intake and ranks fourth after rice, wheat and corn on food energy production basis as a source of complex carbohydrates (Beleia *et al*.,2006). Cassava occupies a prominent position in foreign exchange earning following the Presidential Cassava Initiative of the federal government of Nigeria (FGN, 2006).

Gari (fried, fermented cassava flour) is the most popular cassava products consumed in West Africa and the most important component in the diet of millions of Nigerians providing about 11.835 kJ/person/day (Osho, 2003). However, cassava and its products are low in protein, deficient in essential amino acids and therefore have poor quantitative and qualitative protein content (Obatolu and Osho, 1992). Due to high cost of animal protein and ignorance about the importance of protein in diets, there is need to search for cheaper but good quality protein sources that are readily available for the fortification of "gari" and as this will increase the amount of protein in the diet of the consuming population (Oluwamukomi, 2008). Soybean is an excellent source of dietary protein for human food providing complete human requirement of almost all the amino acids (Liu, 1997). It is also an excellent source of minerals and vitamins (Aworh *et al*., 1987; Igyor *et al*., 2006). Recently, many functions of soybeans have been in the spotlight, for example, reducing the risk of heart disease, cancer and so on (Messina *et al*., 1994). Soybean is the concentrated source of vegetable protein with about 40% protein and 20% oil. Groundnut (*Arachis hypogaea* L.) is the 6th most important oil seed crop in the world. It contains 48-50% oil, 26-28% protein and 11-27 % carbohydrate, minerals and vitamin (Mukhtar, 2009). Groundnut is grown on 26.4 million hectare worldwide, with a total production of 37.1 million metric tons and an average productivity of 1.4 metric tons /ha. Developing countries constitute 97% of the global area and 94% of the global production of this crop (FAO, 2011).

In tropical and sub-tropical areas of the world, feeding of the fast growing population has continued to pose a serious problem. These areas are also characterized by a shortage of animal protein and incidences of protein energy malnutrition are higher because they are rich in starchy tubers, such as yam, cocoyam and cassava (Hernandez *et al*., 1996). Hence, continuous dependence on gari without fortification with protein-rich sources would result in protein deficiency. Soybean and groundnut are protein-rich legumes with good essential amino acids profiles are potentially useful for this purpose. This study aims to determine the chemical and sensory qualities of gari fortified with soybean and groundnut flour.

MATERIALS AND METHODS

Freshly harvested improved cassava cultivar (TMS 30572) sourced from IITA, Ibadan, Nigeria. Soybean seed (TGx536-02D) was obtained from the seed store of IAR&T, Ibadan. Groundnut and other ingredients were purchased from Bodija market in Ibadan, Oyo State, Nigeria.

Methods

Production of gari supplemented with soybean or groundnut

Freshly harvested non-infected cassava roots was washed using potable water and peeled using kitchen knives. The peeled roots was washed and grated in a cassava grater. Grated cassava was fermented for 3 days and the liquor squeezed out using hydraulic press. Drained grated cassava was sifted to remove fibre and roasted. Soybeans of white variety were cleaned by removing stones, sticks and damaged beans and washed using potable water. The soybeans seeds de-hulled by soaking in potable water for 12 hours, follow by hand –rubbing (within two palms) to remove the hulls. The floated hulls were removed by decanting until no hull was present. De-hulled soybean seeds were milled in slurry form (wet mill) and mixed with fermented cassava roots the second day. Matured and wholesome grains of groundnut were slightly roasted, de-coated and winnowed. This was washed with potable water and wet milled. The slurry was incorporated into the grated cassava and pressed to drain. The dewatered cassava mash were roasted, cooled and sieved before packaged inside the hessian bags. The proportions of soybean or groundnut added to cassava are; 100:0, 90:10, 80:20 and 70:30 respectively. The packaged fortified samples were stored for eight months under hermetic conditions at room temperature and were taken for analysis at the end of eight months storage.

Proximate Composition of Soy-gari and Groundnut-gari Samples

Moisture content, protein, fat, ash, crude fibre and carbohydrate were determined according to the method of AOAC (1990).

Sensory Evaluation

A preference test was carried out to determine the most acceptable sample. The samples were coded and presented to 10-member semi trained panelists who were familiar with cassava products. The samples were scored for the appearance, colour, aroma, texture, mouthfeel and overall acceptability using a nine point hedonic scale where 9 indicated `like extremely` and 1 indicated dislike extremely. Analysis of variance (ANOVA) was performed on the data gathered to determine differences, while the least significant test was used to detect significant differences among the means (Ihekoronye and Ngoddy, 1985).

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) using the Statistical Package for Social Statistics (SPSS version 20.0). Results were expressed as means and standard errors of the mean (SEM) while means were separated using The Duncan's New Multiple Range Test (Steel *et al*.,1997).

RESULTS AND DISCUSSION

The results of the initial and eight months proximate analyses of soy-gari, groundnut-gari and control "gari" samples are shown in (Tables 1 and 2). The moisture content of the products obtained was between 7.97% - 8.93%: 8.93 % - 9.23% for soy-gari; groundnut-gari ranged between 7.97%-8.77% : 8.93% - 9.23% respectively. This shows that gari was well roasted (dried) and all the samples were below the safe moisture level for gari (12.7%). The fortified samples are good sources of protein, fat and ash. The protein significantly increased from 1.17% for the control to 1.37% - 1.57%: 2.50% - 3.80% (soy-gari), 1.77% - 2.60%: 3.50% - 4.47% (groundnut-gari). This is similar to earlier studies by Oluwamukomi *et al*., 2014, Arisa *et al*., 2011 who increased the protein content of "gari" by supplementing with legume protein sources. The fat content increased from 1.33% for the control to 1.20% - 1.47%: 3.07% - 3.73% (soy-gari), 1.37% - 1.63% : 3.53% - 4.17% (groundnut-gari). This trend could have been due to the fact that groundnut has a high percentage of fat as it is an oil bearing seed (Srilakshmi, 2006); Okaka, 2005. The increase in ash contents of the samples show that fortified produced "gari" were of higher nutritional value. This confirms the beneficial effect of vegetable protein enrichment which was recommended as a means of providing high nutrient and energy density weaning foods (Fashakin *et al*., 1985). The crude fibre content reduced from 1.67% for the control to 1.63% - 1.55%: 1.90% - 1.63% (soy-gari), 1.80% - 1.60%: 1.67% - 1.47% (groundnut gari).

Table 1: Initial Proximate Analysis (%) of Soy-gari and Groundnut-gari samples.

Compositions (%)	Samples						
	201	202	203	204	205	206	207
Moisture	8.27±1.53^{d}	8.28±0.12^{d}	8.93±0.06^{a}	7.97±0.06^{e}	8.43 ±0.12^{cd}	8.77±0.10^{bc}	8.77±0.06^{ab}
Crude Protein	1.37±0.12^{e}	1.49±0.06^{de}	1.57±0.15^{d}	1.17±0.06^{f}	1.77±0.06^{c}	2.27±0.15^{b}	2.60±0.10^{a}
Crude fat	1.20±0.00^{d}	1.35±0.10^{bc}	1.47±0.06^{b}	1.33±0.06^{c}	1.37±0.06^{bc}	1.40±0.10^{bc}	1.63±0.06^{a}
Ash	1.70±0.10^{a}	1.73±0.06^{a}	1.57±0.06^{bc}	1.67±0.06^{ab}	1.53±0.06^{c}	1.63±0.06^{abc}	1.63±0.06^{abc}
Crude fibre	1.60±0.10^{b}	1.55±0.06^{b}	1.63±0.06^{b}	1.67±0.12^{ab}	1.60±2.72^{b}	1.63±0.12^{b}	1.80±0.00^{a}
Carbohydrates	85.87±0.31^{ab}	85.62±0.31^{abc}	84.83±0.29^{cd}	86.20±0.20^{a}	85.33±0.12^{abc}	85.10±1.15^{bcd}	84.33±0.15^{d}

Mean values followed by different alphabet within a row are significantly different ($p \leq 0.05$). where: 201 is 10% Soy-gari, 202 is 20% Soy-gari, 203 is 30% Soy-gari, 204 is Control, 205 is 10% Groundnut-gari, 206 is 20% Groundnut –gari and 207 is 30% Groundnut – gari.

Table 2: Proximate Analysis (%) of Soy-gari and Groundnut gari at eight months of storage.

Compositions (%)	Samples						
	201	202	203	204	205	206	207
Moisture	9.07±0.06^{ab}	9.23±0.15^{a}	8.67±0.15^{d}	8.93±0.06^{bc}	8.73±0.15^{cd}	8.83±0.06^{cd}	9.23±0.15^{a}
Crude Protein	2.50±0.10^{e}	3.60±0.10^{d}	3.80±0.10^{c}	1.40±0.10^{f}	3.50±0.10^{d}	4.10±0.10^{b}	4.47±0.15^{a}
Crude fat	3.07±0.06^{c}	3.57±0.15^{b}	3.73±0.12^{b}	1.57±0.15^{d}	3.53±0.06^{b}	3.97±0.12^{a}	4.17±0.12^{a}
Ash	2.33±0.06^{c}	2.23±0.06^{c}	2.50±0.10^{b}	1.20±0.00^{d}	2.27±0.15^{c}	2.77±0.12^{a}	2.53±0.06^{b}
Crude fibre	1.73±0.06^{bc}	1.90±0.10^{b}	1.63±0.12^{cd}	2.80±0.10^{a}	1.67±0.15^{c}	1.47±0.06^{d}	1.60±0.10^{cd}
Carbohydrates	81.10±0.30^{b}	79.83±0.12^{d}	79.50±0.26^{d}	84.10±0.17^{a}	80.23±0.15^{c}	78.45±0.21^{e}	78.60±0.17^{e}

Mean values followed by different alphabet within a row are significantly different ($p \leq 0.05$). where: 201 is 10% Soy-gari, 202 is 20% Soy-gari, 203 is 30% Soy-gari, 204 is Control, 205 is 10% Groundnut-gari, 206 is 20% Groundnut –gari and 207 is 30% Groundnut – gari.

Table 3: Sensory qualities of Soy-gari and Groundnut- gari.

Parameters	Samples						
	201	202	203	204	205	206	207
Appearance	2.14±1.61^{e}	4.85±1.83^{cd}	5.85±1.09^{bc}	2.35±1.44^{e}	4.42±1.65^{d}	6.35±1.54^{b}	8.92±0.26^{a}
Colour	2.64±2.13^{de}	5.28±1.85^{c}	5.00±1.79^{c}	2.07±1.14^{e}	3.78±1.36^{d}	6.57±1.39^{b}	8.85±0.36^{a}
Aroma	3.14±1.83^{cd}	4.78±1.92^{b}	4.57±2.06^{bc}	2.35±1.27^{d}	4.57±2.06^{bc}	5.92±1.97^{b}	8.35±1.86^{a}
Texture	4.00±2.74^{cd}	4.28±2.09^{cd}	5.35±1.78^{bc}	2.85±1.99^{d}	4.71±1.85^{c}	6.50±1.50^{ab}	7.85±2.10^{a}
Mouthfeel	3.42±2.37^{c}	4.78±2.00^{bc}	5.92±1.73^{b}	3.64±2.59^{c}	3.85±2.24^{c}	6.21±1.05^{b}	8.00±1.83^{a}
Overall appearance	2.71±2.43^{d}	4.78±1.84^{bc}	5.85±1.61^{b}	2.85±2.10^{d}	3.92±1.77^{cd}	6.14±1.95^{b}	8.00±2.32^{a}

Mean values followed by different alphabet within a row are significantly different ($p \leq 0.05$). where: 201 is 10% Soy-gari, 202 is 20% Soy-gari, 203 is 30% Soy-gari, 204 is Control, 205 is 10% Groundnut-gari, 206 is 20% Groundnut –gari and 207 is 30% Groundnut -gari.

Table 4: Sensory Qualities of Soy and Groundnut Eba

Parameters	Samples						
	201	202	203	204	205	206	207
Appearance	7.00^{c} ± 1.76	5.36^{b} ± 1.00	4.73^{b} ± 1.79	8.09^{c} ± 0.34	4.73^{b} ± 1.68	3.09^{a} ± 1.50	4.36^{ab} ± 2.20
Colour	6.27^{c} ± 2.28	5.82^{bc} ± 1.35	4.91^{bc} ± 1.66	8.27^{d} ± 1.35	4.82^{bc} ± 1.51	3.00^{a} ± 1.47	4.27^{ab} ± 1.95
Aroma	6.18^{bc} ± 2.15	5.64^{ab} ± 1.33	4.46^{ab} ± 1.90	7.46^{c} ± 1.92	5.73^{ab} ± 1.97	4.27^{a} ± 2.01	4.36^{a} ± 1.80
Texture	5.91^{b} ± 2.74	4.64^{ab} ± 1.64	4.27^{ab} ± 1.49	8.00^{c} ± 0.77	4.27^{ab} ± 1.85	4.09^{a} ± 1.08	4.55^{ab} ± 1.75
Mouthfeel	5.64^{b} ± 2.33	4.55^{ab} ± 1.75	3.82^{a} ± 1.79	7.46^{c} ± 1.21	4.27^{ab} ±1.66	4.27^{ab} ± 1.92	3.91^{ab} ± 2.12
Overall appearance	6.55^{cd} ± 2.23	5.18^{bc} ± 1.63	4.27^{ab} ± 1.92	7.91^{d} ± 1.14	4.55^{ab} ± 1.56	4.18^{ab} ± 1.33	3.46^{a} ± 1.13

Mean values followed by different alphabet within a row are significantly different ($p \leq 0.05$). where: 201 is 10% Soy-gari, 202 is 20% Soy-gari, 203 is 30% Soy-gari, 204 is Control, 205 is 10% Groundnut-gari, 206 is 20% Groundnut –gari and 207 is 30% Groundnut –gari

Fortification resulted in decrease in the crude fibre and carbohydrate content of the gari as the level of fortification increased. The carbohydrate content showed a gradual reduction as the level of substitution increased (86.20% to 78.50%).These reductions could have been due to the fact that as the cassava mash was reduced and replaced with groundnut and soy-bean mash (which had lower fibre and carbohydrate contents than the cassava mash), the percentage of these nutrients in the resultant product became lower. These reductions are in accordance with Uzopeters *et al*., (2008) who reported a reduction in the crude fibre and carbohydrate content of kokoro substituted with different levels of defatted groundnuts and soybean cake flours. A panel of tasters was composed to evaluate the organoleptic properties of the food blends prepared from the fortified gari and the non-fortified one. The panel found that in terms of appearance, colour, aroma, texture, mouth feel and overall acceptability; there was slight significant difference between the two blends. Although sample 207 with 30% groundnut was most acceptable while the least was 10% soy-gari.

Sensory evaluation conducted on the gari meal was based on the following parameters; appearance, color, aroma, texture, mouth feel and overall acceptability. As shown in Table 3 and 4, Sample 204 (unfortified meal) was the most preferred while 30% groundnut gari meal was the least may be because the meal was too brownish and cannot made dough easily compare to the conventional one.

CONCLUSION

From the results it could be concluded that fortification improved the nutrient quality of "gari" especially the protein, fat, ash and the mineral contents. The result revealed that protein contents in groundnut-gari was higher than soy-gari this may be due to groundnut roasted .The acidity of the fortified samples was reduced thus lowering the sourness of "gari". This may be an advantage for people who are not interested in sour taste of "gari". Based on the evaluation, groundnut-gari may be good only for drinking not for making meal'eba'. Also, during the processing, it took longer time to roast gari with groundnut especially at 30% level of substitution. However a further research work must be carried out to evaluate its nutritive value when consumed by humans and commercial production of the product may also be embarked on to further add to the variety of snack drinks available.

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