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Full Length Research Paper

Influence of addition and stage of inclusion of toasted African yam bean seed flour on the nutrient composition and sensory properties of 'gari'

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ABSTRACT

This work investigated the effect of the stage of inclusion of toasted African yam bean seed flour (TAYBSF) on the nutrient and acceptability of gari. Peeled and grated cassava mash was blended with TAYBSF in ratios of 95:5, 90:10, 85:15 and 80:20 w/w, respectively before (BF samples) and after (AF samples) fermentation. Gari without TAYBSF served as the control. Fermentation was done for 2 days after which the samples were dewatered, sieved, toasted and evaluated for chemical composition and sensory properties. Addition of TAYBSF increased the protein, crude fat and ash contents of BF samples from 2.60 to 13.74, 0.52 to 0.79 and 0.47 to 1.91%, respectively. Also, the crude protein, crude fat and ash contents of AF samples increased from 2.60 to 12.07, 0.52 to 1.25 and 0.47 to 1.67%, respectively. The total amino acid (TAA) content of BF and AF samples were significantly ($p<0.05$) higher than that of the control sample with values ranging from 59.83 to 78.74 g/100 g crude protein and 58.04 to 66.34 g/100 g crude protein for BF and AF samples, respectively and the control sample (55.83 g/100g crude protein). The control sample had significantly ($p<0.05$) higher score in the general acceptability than the fortified samples and was the most preferred by the panelists.

Keywords: African yam bean seeds, Amino acid profile, Cassava, Flour, Gari, Nutrient composition, Sensory properties

INTRODUCTION

The search for a solution to the problem of malnutrition in its various forms particularly in developing countries necessitated the enhancement of nutritive quality of staple foods through improved processing, enrichment, and fortification. "Gari" (toasted cassava meal) is one of such basic staples that demand attention considering its position in the dietary regime of a developing country like Nigeria, providing about 11.835 kJ/person/day (Okafor, 1992; Osho, 2003). Gari is a free-flowing creamy white or yellow granular partially gelatinized flour produced from cassava (Cardoso et al., 1998). It is produced through the process of peeling, washing, grating, bagging and pressing or dewatering (by the use of hydraulic press), fermentation (2-5 days), sieving, garification (frying), cooling and packaging. It is widely consumed because of its shelf stability as well as its ease of preparation when compared to other foods products from cassava (Sanni et al., 2008).

Cassava from which this important staple is produced is low in protein and deficient in essential amino acids. The crude protein content of locally produced gari vary between 1.03-2% and the level of cyanide vary from 0 to 32 mg HCN equivalent Kg^{-1} depending on the cassava variety and processing method (Oke, 1994; Ojo and Deane, 2002). High protein foods of animal origin such as meat, fish, milk, and eggs are very expensive especially for the low-income earners who are in the majority among the population of West African sub-region. Although efforts to increase the local production of these animal protein sources to make prices affordable are still ongoing, fortification of gari with plant protein may be another alternative. It is, therefore, logical to source protein fortificants from plant sources like African yam bean, soybeans, cowpea, and bambara nuts among others.

African yam bean [Sphenostylis stenocarpa (Hochst. Ex A. Rich) Harms] is one of the lesser-known legumes (Apata and Ologhobo, 1990) and widely cultivated in the southern parts of Nigeria. It is rich in protein (19.5%), carbohydrates (62.6%), fat (2.5%), vitamins and minerals (Iwuoha and Eke, 1996). The protein is made up of over 32% essential amino acids, with lysine and leucine being predominant (Onyenekwe et al., 2000). It is consumed worldwide as a major source of cheap protein especially in developing countries where consumption of animal protein may be limited as a result of economic, social, cultural or religious-factors (Olayide, 1982). This work, therefore, was done to improve the protein content of gari by the inclusion of toasted African yam bean seed flour at different stages or period and to assess the effects of the bean flour inclusion on the nutrient and acceptability of the gari.

MATERIALS

Procurement of Raw Materials

Cassava (*Manihot esculenta* Crantz) (NR 8082) was procured from the research farm of the Department of Crop Science, University of Nigeria, Nsukka. African yam bean seeds (Sphenostylis stenocarpa) (red variety) was procured from Obollo-a for market, near Nsukka, Enugu State.

Sample Preparations

Preparation of African yam bean seed flour: The African yam bean seeds (13 kg) were thoroughly cleaned, toasted (at 160°C in an open iron pan with constant stirring for 5 min to aid dehulling), dehulled manually, winnowed, milled (locally fabricated hammer mill) into flour, sieved (using a raffia woven sieve, 0.3 x 0.3 cm pore size) and then packaged in a polyethylene bag until used for analyses.

Processing of cassava: The cassava tubers (NR 8082) (37 kg) were peeled manually with a knife, washed and grated using a mechanical grater to obtain the cassava mash as shown in Figure 1. The cassava mash was divided into four (4) lots (95, 90, 85 and 80%) and graded levels (5, 10, 15 and 20%) of toasted African yam bean seed flour (TAYBSF) were mixed with the different portions of the mash to get 95:5, 90:10, 85:15 and 80:20% w/w blends of cassava mash: TAYBSF designated as BF samples. Each sample blend was thoroughly mixed, bagged and allowed to ferment for 48 hours (2 days). Following fermentation each sample was dewatered in a hydraulic press and the cake sifted (to remove fibrous materials from the cassava cakes), using a raffia woven sieve (0.3 x 0.3 cm pore size) and toasted in a large frying pan for 5 min with constant stirring to prevent lumping and scorching and ensure even heating of the granules. Another batch of cassava mash was also prepared, divided into four (4) lots (95, 90, 85, and 80%), bagged and allowed to ferment for 48 hours (2 days). Following fermentation, each sample was dewatered in a hydraulic press and the cake sifted (to remove fibrous materials from the cassava cakes), using a raffia woven sieve (0.3 x 0.3 cm pore size). After sifting, graded levels (5, 10, 15, 20%) of TAYBSF were added to each portion of the mash and mixed thoroughly to get 95:5, 90:10, 85:15 and 80:20% w/w blends of cassava mash: TAYBSF designated as AF samples. Each blend of the sample was toasted in a large frying pan for 5 min with constant stirring as was done for the first batch of samples (BF). Another lot of cassava mash (100%) without TAYBSF which served as the control was also bagged and allowed to ferment for 48 hours (2 days), followed by dewatering in a hydraulic press and the cake sifted and toasted as done for other samples. All the toasted gari samples were cooled and packaged as shown in Figure 1 until used for analyses.

Formulation of Toasted African Yam Bean Seed (TAYBS)-Gari Samples

The blending ratios of gari and TAYBSF are as shown in Table 1.

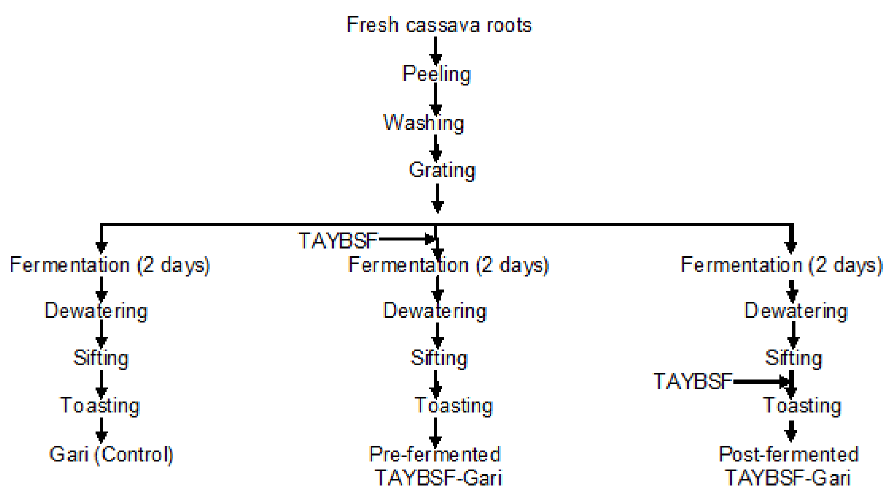

Figure 1: Processing of pre- and post-fermented TAYBS-gari.

Table 1: Blending ratios of moist cassava mash and TAYBSF.

Sample codes	Moist Cassava mash (%)	TAYBSF (%)
BF1	95	5
BF2	90	10
BF3	85	15
BF4	80	20
AF1	95	5
AF2	90	10
AF3	85	15
AF4	80	20
Control	100	0

TAYBSF: Toasted African yam bean seed flour; BF: Gari sample with TAYBSF addition pre-fermentation; AF: Gari sample with TAYBSF addition post-fermentation; BF1: Gari fortified with 5% TAYBSF before fermentation; BF2: Gari fortified with 10% TAYBSF before fermentation; BF3: Gari fortified with 15% TAYBSF before fermentation; BF4: Gari fortified with 20% TAYBSF before fermentation; AF1: Gari fortified with 5% TAYBSF after fermentation AF2Gari fortified with 10% TAYBSF after fermentation; AF3: Gari fortified with 15% TAYBSF after fermentation; AF4: Gari fortified with 20% TAYBSF after fermentation; Control: Gari with no TAYBSF fortification

METHODS

Sample Analysis

The following analyses were carried out on the samples.

Proximate analyses of the samples: The moisture (by hot-air oven method), crude fiber, crude protein (Kjeldahl method), ash and fat (Soxhlet extraction) contents of the samples were determined according to the method of AOAC (2010), while the carbohydrate content was determined by difference. Sum of all the proximate components was subtracted from hundred (100). The balance was assumed to be carbohydrate.

%Carbohydrate=100 - (% protein, fat, fiber, ash, and moisture).

Determination of the Amino Acid Profile of the Samples

The Amino acid profile of the sample was determined using methods described by Benitez (1989). Each sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid Analyzer (TSM), model: DNA 0209.

Sensory Evaluation of the Samples

Sensory evaluation of the samples was conducted using thirty students as panelists. A 9-point Hedonic scale ranging from 9=like extremely and 1=dislike extremely were used to evaluate the samples for color, flavor, taste, texture, mouldability and overall acceptability. Table water was used for mouth rinsing intermittently.

Statistical Analysis

The experiment adopted was complete randomization design (CRD). The data generated from all analyses and sensory evaluation were subjected to statistical analysis of variance (ANOVA) using the Statistical Product for Special Services (SPSS) version 20. Means were separated using the Duncan's Multiple Range Test and significance was accepted at p<0.05 (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Effect of TAYBSF Fortification on the Proximate Composition of the Samples

Table 2 shows the results of the effect of level of the toasted African yam bean seed flour (TAYBSF) fortification on the proximate composition of gari samples. Both the stage and the level of the toasted African yam bean seed flour (TAYBSF) fortification had significant (p<0.05) effect on the proximate composition of the samples.

There was a significant (p<0.05) difference between the protein content of the control sample and the fortified samples. The protein content of the fortified samples was higher (ranged from 7.42-13.74%) than that of the control sample (2.60%) due to the presence of the fortificant- TAYBSF. The post-fermented fortified sample (AF1) with the lowest content of protein (7.42%) had 3 times more protein content than the control sample (2.60%). This attests to the efficacy of African yam bean seed (AYBS) as a protein source to improve the protein level of gari. Increase in the level of TAYBSF in the gari significantly (p<0.05) influenced the protein content of the fortified samples. Samples blended with toasted African yam bean seed flour (TAYBSF) before fermentation (BF) had higher range of protein content (7.68-13.74%) than the samples that were blended with TAYBSF after fermentation (AF). The progressive increase was observed among the BF samples as the level of TAYBSF inclusion increased. BF4 had the highest level of TAYBSF and the highest protein content (13.74%) while BF1 had the lowest level of TAYBSF and the lowest protein content (7.68%) among the samples fortified with TAYBSF before fermentation. Such an increase in protein content was also observed among the AF samples where AF4 had the highest protein level (12.07%). The higher protein values of the BF samples than the AF samples may be due to the co-fermentation of cassava mash blended with TAYBSF. Other possible reasons that may have contributed to the observed increase in protein include fermentation process which is known to improve the nutritional value of foods and hydrolysis of the protein molecules by microbial mass during fermentation to amino acids and other simple peptides. Also, some proteins which may have been tied up by the dry heat treatment applied during toasting were probably released during fermentation by the fermenting organisms. Structural proteins of the microbial cells involved in the fermentation which became part of the fermented product may also have contributed to the observed significant increase in protein (Tortora et al., 2002).

The crude fiber content of the fortified samples ranged from 2.37 to 2.93% for the BF samples and 2.31 to 3.67% for the AF samples. There was a significant difference ($p<0.05$) in the crude fiber content between BF1 and AF1. Among the fortified samples, it was observed that an increase in the level of TAYBSF and stage of fortification caused a decrease in the crude fiber content of the samples. Samples that were blended with TAYBSF before fermentation (BF) had higher crude fiber content than the samples blended with TAYBSF after fermentation (AF). Among the BF samples, the highest crude fiber content was observed in BF1 (2.93%) containing 5% of TAYBSF while the lowest was BF4 (2.37%) which contained 20% of TAYBSF. In the AF samples, AF1 had the highest crude fiber content (3.67%) while AF4 had the lowest (2.39%). This reduction in crude fiber with an increase in TAYBSF fortification agree closely with the observation of Uzo-Peters et al. (2008) who reported a reduction in the crude fiber content of kokoro substituted with different levels of defatted groundnut and soybean cake flours. The range of values observed in this study is however below the value (6.13%) reported for gari by Oluwamukomi and Adeyemi (2013). This disparity may be attributed to maturity and varietal differences of the raw material (cassava) used.

A significant ($p<0.05$) increase was observed in the fat content of the fortified samples (0.61 to 1.25%) when compared with the control sample (0.52%). Evidently, the inclusion of toasted African yam bean seed flour (TAYBSF) to gari increased the fat content of the samples due to the contribution of fat from the TAYBSF. Stage of inclusion of TAYBSF to gari also influenced the fat content of the fortified samples. Samples blended with TAYBSF after fermentation (AF) had a higher percentage of crude fat than samples blended with TAYBSF before fermentation (BF). Apparently, the TAYBSF added to the fermented cassava just before toasting was not broken down by fermentation while in BF samples the blends (cassava mash and TAYBSF) were fermented and most of the fat may have been hydrolyzed during fermentation while some may have been expelled with the gari milk especially during dewatering. Among all the fortified samples, AF4 containing 20% of TAYBSF had the highest crude fat (1.25%) while AF1 containing 5% of TAYBSF had the lowest percentage of crude fat (0.55%).

The moisture content of the fortified samples decreased significantly ($p<0.05$) from 11.63-7.69% as the level of TAYBSF fortification increased when compared with the control sample (11.76%). The high moisture content observed in the control sample was expected. In the fortified samples, the low moisture content observed may be due to the increase in their dry matter content as a result of the TAYBSF added. The presence of dry matter in TAYBSF high in hydrophilic constituents especially carbohydrate and protein might have caused the absorption of water from the cassava during blending and consequently reducing the moisture content of the samples. The water imbibed by the TAYBSF may not be easily released as free water that can be determined during moisture content determination. Although the control sample had higher moisture content than the fortified samples the value (11.76%), all the samples compare well with the maximum 12% recommended for shelf stable gari by CODEX Alimentarius. Irtwanga and Achimba (2009) reported that good quality gari should be well dried and of low moisture content for good storability. The moisture content observed in the control sample in this study agrees with the values reported by Ukpabi and Ndimele (1990). This suggests that the TAYBSF-gari and the control can keep for a reasonable length of time when stored in packaging materials that have low moisture permeability and under low relative humidity environment since gari is hygroscopic in nature. There was no significant ($p>0.05$) difference between the moisture content of BF and AF samples except for sample AF4. Samples that were blended with TAYBSF before fermentation (BF) had higher moisture content compared to the samples blended with TAYBSF after fermentation (AF). Among the BF samples, a decrease in the moisture content was observed. Similar result was observed among AF samples. The protein content of African yam bean

Table 2: Blending ratios of moist cassava mash and TAYBSF.

Samples	Protein	Crudefiber	Fat	Moisture	Ash	Carbohydrate
BF1	$7.68^{b} \pm 0.55$	$2.93^{b} \pm 0.02$	$0.61^{abc} \pm 0.02$	$11.63^{b} \pm 0.98$	$0.60^{bc} \pm 0.02$	$76.55^{c} \pm 1.00$
BF2	$10.51^{d} \pm 0.79$	$2.61^{a} \pm 0.02$	$0.69^{abc} \pm 0.01$	$11.16^{b} \pm 2.72$	$0.80^{d} \pm 0.02$	$74.23^{b} \pm 1.23$
BF3	$11.93^{e} \pm 2.26$	$2.53^{a} \pm 0.02$	$0.72^{bcd} \pm 0.04$	$11.01^{b} \pm 1.09$	$1.28^{f} \pm 0.02$	$75.53^{b} \pm 1.51$
BF4	$13.74^{f} \pm 1.19$	$2.37^{a} \pm 0.07$	$0.79^{cd} \pm 0.07$	$9.61^{ab} \pm 1.35$	$1.91^{h} \pm 0.02$	$71.58^{a} \pm 1.69$
AF1	$7.42^{b} \pm 0.45$	$3.67^{c} \pm 0.04$	$0.55^{ab} \pm 0.03$	$10.70^{b} \pm 0.60$	$0.58^{b} \pm 0.02$	$77.08^{c} \pm 1.72$
AF2	$9.41^{c} \pm 0.04$	$2.43^{a} \pm 0.02$	$0.89^{d} \pm 0.02$	$9.57^{ab} \pm 0.50$	$0.62^{c} \pm 0.02$	$77.08^{c} \pm 1.70$
AF3	$10.87^{d} \pm 0.03$	$2.34^{a} \pm 0.03$	$1.11^{e} \pm 0.18$	$9.40^{ab} \pm 2.19$	$1.24^{e} \pm 0.02$	$75.04^{b} \pm 1.72$
AF4	$12.07^{e} \pm 0.77$	$2.31^{a} \pm 0.02$	$1.25^{e} \pm 0.24$	$7.69^{a} \pm 1.00$	$1.67^{g} \pm 0.02$	$75.01^{b} \pm 1.01$
Control	$2.60^{a} \pm 0.16$	$2.94^{b} \pm 0.07$	$0.52^{a} \pm 0.02$	$11.76^{b} \pm 0.30$	$0.47^{a} \pm 0.02$	$81.71^{d} \pm 2.56$

Values are means of triplicate determination ± SD. Mean with the same superscript within the same column are not significantly ($p>0.05$) different. BF: Gari sample with TAYBSF addition pre-fermentation; AF: Gari sample with TAYBSF addition post-fermentation; BF1: Gari fortified with 5% TAYBSF before fermentation; BF2: Gari fortified with 10% TAYBSF before fermentation; BF3: Gari fortifed with 15% TAYBSF before fermentation; BF4: Gari fortified with 20% TAYBSF before fermentation; AF1: Gari fortified with 5% TAYBSF after fermentation; AF2: Gari fortified with 10% TAYBSF after fermentation; AF3: Gari fortified with 15% TAYBSF after fermentation; AF4: Gari fortified with 20% TAYBSF after fermentation; Control: Gari with no TAYBSF fortification seeds is appreciably high and is characteristically known to be spongy and may have imbibed more water molecules during the fermentation process and this may have contributed to the higher moisture observed in BF samples relative to AF samples. The inclusion of TAYBSF before fermentation also caused increased particle size of BF samples (especially BF 3 and 4), this might also have contributed to the increased moisture content in BF samples because the lumps in the samples may have trapped some amount of water which may have been difficult to release during the dewatering process of the blends. The AF samples, in contrast, had only the cassava mash fermented alone and so during dewatering, may have been more thoroughly drained of free water than the BF samples. Besides, the inclusion of TAYBSF into AF samples after fermentation may have encouraged mopping up of residual moisture in the dewatered fermented cassava granules by the TAYBSF thus contributing to the observed lower moisture content of AF samples.

There was a significant (p<0.05) difference between the ash content of the control sample and that of the fortified samples. Fortification of gari with TAYBSF increased the total solid contents of gari thereby increasing the ash content. Stage of inclusion also influenced ash content significantly (p<0.05), BF samples had higher ash content than AF samples. The highest ash content was observed in BF4 containing 20% of TAYBSF while the lowest ash content (0.58%) was observed in AF1 containing 5% of TAYBSF. The higher ash content observed in BF samples than AF samples indicates that the mineral contents of BF samples are higher than that of the AF samples since ash content depicts the presence of mineral elements in food samples (Baryeh, 2001; Edem et al., 2001). This may be attributed to the co-fermentation of cassava mash and toasted African yam bean seed flour (TAYBSF). Edem et al. (2001) reported that the ash content of gari was increased to 5.17% and 5.58% by fortifying with 10% and 15% soy meal, respectively. Iwe and Onadipe (2001) reported an increase in the ash contents of sweet potato from 2.2% to between 2.5% and 4% by supplementing with soy meal up to 25% level.

There was a significant (p<0.05) difference between the carbohydrate content of the control and the fortified samples. Increase in the level of TAYBSF fortification caused a decrease in the total carbohydrate content of the fortified samples (77.14-71.64%) when compared with the control sample (82.12%) and the level of reduction increased with increase in the level of TAYBSF inclusion. The control sample expectedly had the highest content of carbohydrate due to low content of other constituents (such as protein, ash, fat etc.) and carbohydrate was determined by difference. Stage of TAYBSF inclusion also had a significant (p<0.05) effect in the carbohydrate content of the fortified samples. Among the BF samples, the highest carbohydrate content was observed in sample BF1 (77.14%) and the lowest in BF4 (71.64%) while sample AF1 had the highest carbohydrate content (77.10%) and sample AF4 had the lowest carbohydrate content (74.47%) among AF samples. Uzor-Peters et al. (2008) reported that increase levels of defatted groundnuts and soybean cake flours supplementation to kokoro decreased the carbohydrate content of kokoro.

Effect of TAYBSF Fortification on the Amino Acid Content of the Samples

Table 3 shows the amino acid content of TAYBSF fortified gari. Addition of TAYBSF to gari and stage of addition significantly (p<0.05) influenced the amino acid content of the fortified samples.

AThe total amino acid (TAA) of the control sample was 55.83 g/100 g crude protein while that of the fortified samples ranged from 58.04 to 78.74 g/100 g crude protein. Expectedly, the TAA of the fortified samples was higher than that of the control sample because of the addition of TAYBSF to the gari samples. Increase in the level of inclusion of TAYBSF caused a progressive increase in the TAA of the fortified samples with the highest value exhibited by sample BF4 (78.74 g/100 g crude protein) and the least value by AF1 (58.04 g/100 g crude protein). Sample BF4 also had highest content of essential amino acid (EAA) like lysine (4.43), valine (2.69), leucine (3.58), isoleucine (2.38), arginine (12.00) and threonine (3.09 g/100 g crude protein). BF samples had higher (total amino acid) TAA than AF samples and this may probably be because of co-fermentation of the blended samples. The predominant amino acids in control and fortified samples were glutamic acid (11.29 and 11.51-14.62), arginine (10.18 and 10.79-12.00), aspartic acid (8.10 and 8.56-11.04), respectively. The amino acids that occurred at the lowest level in both the control and the fortified samples were cystine (0.93 and 0.99-1.32) and methionine (0.89-0.99-1.33 g/100 g crude protein). Co-fermentation of cassava mash and TAYBSF may have contributed to this disparity. The total essential amino acid (TEAA) of the control samples was lower than that of the fortified samples. Increase in the level of inclusion of TAYBSF also increased the TEAA of the fortified samples and they all contain the essential amino acids in good proportion when compared with FAO/WHO requirement for adults (11%) and above 26% recommended for infants (FAO/WHO/UNU, 1985). The stage of TAYBSF addition also influenced the TAA content of the samples. BF samples showed a higher level of TEAA than the AF samples.

Effect of TAYBSF Fortification on the Sensory Qualities of the Samples

The mean sensory scores of the fortified and unfortified (control) samples are shown in Table IV. Addition of toasted of African yam bean seed flour (TAYBSF) to gari and stage of addition significantly (p<0.05) influenced the sensory properties of the fortified samples.

Table 3: Effect of TAYBSF fortification on the amino acid contents (g/100g crude protein) of the samples.

P/m	BF1	BF2	BF3	BF4	AF1	AF2	AF3	AF4	Control
Lysine	3.27	4	4.24	4.43	3.13	3.3	3.35	3.81	3
Histidine	1.61	2.02	2.08	2.24	1.58	1.7	1.77	1.8	1.51
Arginine	10.62	11.56	11.57	12	10.53	10.79	10.96	11.22	10.18
Asp/acid	9	10.48	10.7	11.04	8.56	9.31	9.55	9.99	8.1
Threonine	2.32	2.59	2.7	3.09	2.26	2.37	2.46	2.79	2.18
Serine	1.57	1.98	2.22	2.97	1.41	1.63	1.79	1.84	1.3
Glu/acid	11.74	12.57	13.33	14.62	11.51	11.82	11.89	12.19	11.29
Proline	1.63	2.24	2.34	2.95	1.63	1.83	1.93	2.03	1.53
Glycine	2.45	3	3.17	3.36	2.31	2.55	2.67	2.79	2.19
Alanine	3.57	4.25	4.29	4.48	3.49	3.65	3.8	4.1	3.42
Cystine	1.06	1.19	1.26	1.32	0.99	1.06	1.13	1.19	0.93
Valine	1.68	2	2.2	2.69	1.65	1.77	1.77	1.91	1.56
Meth	0.99	1.15	1.2	1.33	0.89	0.99	1.02	1.09	0.89
Isoleuine	1.4	2.09	2.19	2.38	1.33	1.46	1.52	1.71	1.27
Leucine	2.29	3	3.33	3.58	2.31	2.46	2.51	2.76	2.18
Tyrosine	1.59	2.22	2.22	2.38	1.59	1.59	1.75	1.91	1.43
Tryptophan	ND	ND	ND	ND	ND	ND	ND	ND	ND
P/alanine	3.04	3.29	3.37	3.88	2.87	3.12	3.21	3.21	2.87
TEAA	27.22	31.7	32.88	35.62	26.55	27.96	28.57	30.3	25.64
TAA	59.83	63.63	72.41	78.74	58.04	61.41	63.08	66.34	55.83

P/m: Parameters; Asp/acid: Aspartic acid; Glu/acid: Glutamic acid; P/alanine: Phenylalanine; ND: Not determined; TEAA: Total Essential Amino Acid; TAA: Total Amino Acid; BF: Gari sample with TAYBSF addition pre-fermentation; AF: Gari sample with TAYBSF addition post-fermentation; BF1: Gari fortified with 5% TAYBSF before fermentation; BF2: Gari fortified with 10% TAYBSF before fermentation; BF3: Gari fortifed with 15% TAYBSF before fermentation; BF4: Gari fortified with 20% TAYBSF before fermentation; AF1: Gari fortified with 5% TAYBSF after fermentation; AF2: Gari fortified with 10% TAYBSF after fermentation; AF3: Gari fortified with 15% TAYBSF after fermentation; AF4: Gari fortified with 20% TAYBSF after fermentation; Control: Gari with no TAYBSF fortification

Increase in the level of inclusion of TAYBSF to the samples caused a progressive decrease in the sensory qualities of the fortified samples with the lowest values exhibited by samples BF4 and AF1, which had the highest (20%) level of the TAYBSF.

The stage of inclusion of TAYBSF to the samples also caused a decrease in the appearance, taste, flavor, texture as well as the mouldability of the BF samples, hence, impaired the organoleptic properties of the fortified samples. The AF samples also followed the same trend as the BF samples. However, All the AF samples (except sample AF4) had higher sensory scores in all the sensory qualities compared to the BF samples. The impairment of the sensory qualities of the fortified samples when compared to the control sample may probably be attributed to the TAYBSF added to the samples.

The control sample was most preferred and had significantly (p<0.05) higher scores for appearance (8.03), taste (7.17), flavor (7.20), texture (7.43) and mouldability (7.00) than the fortified samples. However, AF1 which had the lowest level (5%) of TAYBSF didn't differ significantly (p>0.05) from the control in terms of the flavor and overall acceptability. Sanni et al. (2007) made similar observations between gari from

Table 4: Sensory scores of reconstituted fortified and the control samples.

Parameter	Appearance	Taste	Flavor	Texture	Mouldability	OA
BF1	$6.83^{e} \pm 1.12$	$6.23^{e} \pm 1.28$	$6.17^{de} \pm 1.44$	$6.37^{cd} \pm 1.61$	$6.27^{de} \pm 2.00$	$6.17^{d} \pm 1.53$
BF2	$4.87^{cd} \pm 1.38$	$5.53^{d} \pm 1.50$	$5.13^{c} \pm 1.41$	$5.40^{b} \pm 1.28$	$5.53^{cd} \pm 1.66$	$4.83^{c} \pm 1.46$
BF3	$4.43^{bc} \pm 1.79$	$4.50^{abc} \pm 1.78$	$4.63^{abc} \pm 1.67$	$4.87^{b} \pm 1.66$	$4.67^{bc} \pm 2.09$	$4.23^{bc} \pm 1.72$
BF4	$3.73^{b} \pm 1.87$	$3.93^{a} \pm 1.91$	$3.90^{a} \pm 1.81$	$4.03^{a} \pm 1.88$	$3.60^{a} \pm 2.11$	$3.43^{ab} \pm 2.13$
AF1	$7.33^{ef} \pm 1.09$	$5.83^{de} \pm 1.66$	$6.70^{ef} \pm 1.21$	$7.03^{de} \pm 1.19$	$6.97^{e} \pm 1.03$	$7.10^{e} \pm 1.37$
AF2	$5.23^{cd} \pm 1.57$	$5.23^{cd} \pm 1.36$	$5.47^{cd} \pm 1.25$	$5.57^{bc} \pm 1.63$	$5.27^{c} \pm 1.74$	$5.00^{c} \pm 1.76$
AF3	$5.33^{d} \pm 1.35$	$5.00^{bcd} \pm 1.60$	$4.87^{bc} \pm 1.68$	$5.00^{b} \pm 1.60$	$5.00^{c} \pm 1.98$	$4.90^{c} \pm 1.52$
AF4	$2.83^{a} \pm 2.00$	$4.13^{ab} \pm 2.18$	$4.23^{ab} \pm 1.83$	$3.57^{a} \pm 2.03$	$4.00^{ab} \pm 2.02$	$3.27^{a} \pm 1.84$
Control	$8.03^{f} \pm 1.19$	$7.17^{f} \pm 1.72$	$7.20^{f} \pm 1.54$	$7.43^{e} \pm 1.38$	$7.00^{e} \pm 1.68$	$7.60^{e} \pm 1.43$

Values are means of thirty replications ± SD. Mean values with different superscripts in the same column are significantly (p<0.05) different. OA: Overall Acceptability; BF: Gari sample with TAYBSF addition pre-fermentation; AF: Gari sample with TAYBSF addition post-fermentation; BF1: Gari fortified with 5% TAYBSF before fermentation; BF2: Gari fortified with 10% TAYBSF before fermentation; BF3: Gari fortified with 15% TAYBSF before fermentation, BF4: Gari fortified with 20% TAYBSF before fermentation; AF1: Gari fortified with 5% TAYBSF after fermentation; AF2: Gari fortified with 10% TAYBSF after fermentation; AF3:Gari fortifed with 15% TAYBSF after fermentation; AF4: Gari fortified with 20% TAYBSF after fermentation; Control: Gari with no TAYBSF fortification pure cassava and gari from a blend of cassava and sweet potato. Familiarity and conversance of the panelists with unfortified gari may have contributed some level of bias that led to the observed scores. The sensory scores of the fortified samples decreased with increase in the level of inclusion of the TAYBSF from 6.17 to 3.90 and 6.70 to 4.23 for BF and AF samples, respectively. This could be attributed to the increase in beany flavor associated with legumes (Eke, 2002). It could be deduced from the results that the flavor of the AF samples was preferred to that of the BF samples due probably to the fermentation effect. Fermentation of the blends of BF samples may have led to the development of flavor compounds characteristics of legume but foreign to cassava hence the low flavor score. Expectedly, AF1 of all the fortified samples did not differ significantly ($p<0.05$) from the control sample except in taste.

In terms of the overall acceptability, the control (unfortified) sample was preferred in all the parameters followed by the AF1.

CONCLUSION AND RECOMMENDATION

Conclusion

The inclusion of toasted African yam bean seed flour (TAYBSF) before and after fermentation increased the protein, fat and ash contents of the fortified samples, but the increase was slightly higher in the samples where the TAYBSF was added before fermentation. Increase in the TAYBSF incorporation into gari also caused a progressive increase in the total amino acid of the fortified samples than the control sample. Although the inclusion of TAYBSF to gari and stage of inclusion significantly increased the nutrient contents of the fortified samples basically the protein content, the sensory properties were impaired. Thus, the acceptability of the fortified samples decreased with an increase in the level of addition of TAYBSF. Sample AF1 (sample with 5% TAYBSF) had the lowest nutrient content but was the most acceptable by the panelists and had sensory scores that compared favorably with the control sample.

Recommendation

Further studies are required to determine the storage stability and the digestibility of protein of the fortified gari. The organoleptic properties that were impaired due to the incorporation of a high level of TAYBSF should be looked into and corrected.

ETHICAL REVIEW

This study does not involve any human or animal testing.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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