PAT December, 2024; 20(2): 65-73 ISSN: 0794-5213

Online copy available at www.patnsukjournal.org

Publication of Nasarawa State University, Keffi

ORIGINAL ARTICLE

NUTRIENTS COMPOSITION, FUNCTIONAL PROPERTIES AND ACCEPTABILITY OF SOYBEAN ENRICHED GARI

*Awogbenja Makanju Dehinde and Isah Munirat Eleojo
Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Nasarawa State University, Keffi, Nigeria
* Corresponding Author's email: dendus12@gmail.com

Abstract

Gari is a dried granular starch product made from cassava roots. It is a major component of everyday diet in Nigeria providing about 283kcalories/person/day. The amount of protein in daily diet of an average Nigerian is very limited thus, gari enriched with soybean offers the chance to supply a relatively cheap improved starch staple that can improve family nutrition. This study was carried out to investigate the proximate, mineral, functional and sensory properties of gari enriched with soybeans flour Cassava roots were processed into gari using the conventional processing practice and blended with soybeans flour. Five samples were derived in the ratio (100:0; 95:5; 90:10; 85:15; 80:20). The proximate composition, mineral content, functional property and sensory evaluation of cassava-soybean were determined. The results of proximate composition showed that the moisture content ranged from 7.39% - 8.93%, protein ranged from 6.58% - 24.52% and crude fibre ranged from 1.21% - 2.39%. All the samples were below the recommended value of 12% for moisture and it is capable of having a long shelf life. Functional properties results indicated that bulk density values ranged between 0.57 - 076g/ml, least gelation index ranged from 2.00 - 3.00%, solubility index ranged from 2.94 - 2.07%, swelling capacity ranged from 2.54 - 10.0% and water absorption capacity 3.00 - 1.32g/ml. Calcium was the most abundant mineral in the samples (197 - 210mg/Kg) followed by phosphorus 131 - 150mg/Kg. Other mineral elements observed in least amount were iron and zinc and the values ranged from 4.12 - 4.72mg/Kg and 0.02 - 0.10mg/Kg, respectively. The sensory evaluation results showed no significant difference (p>0.05%) in all the samples although sample D (85% cassava: 15% soybean) ranked best in terms of appearance, aroma, texture, mouthfeel and overall acceptability. From the findings, it was established that the incorporation of soybean in gari production, significantly improved the nutritional quality, functional and sensory properties of the products.
Keyword: Cassava, Protein, Calcium, Least gelation, minerals.

Introduction

Cassava (*Manihot esculenta)* is an important vegetable crop that is grown throughout the tropics and sub tropics where it contributes 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 (Belecia *et al.*, 2019). Gari is a granular food product processed from peeled, grated, fermented, sieved and toasted cassava tuber (*M. esculenta*). It is the most commonly consumed cassava product across Nigeria and many African countries and makes up a greater part of the food consumed by greater proportion of the population (Osho, 2017; Messina, 2017).

Gari can be made with cold water to obtain a free flowing mixture usually taken with added salt, sugar, groundnut and fish. The problem with frequent consumption of gari, stems from its poor nutritional value common with all cassava products. Gari is known for its high caloric value, low protein, fat and micronutrients contents. Low protein gari based diets can predispose consumers to protein-energy malnutrition with compromised renal functions (Ijarotimi *et al*., 2019). Moreover, protein energy malnutrition and micronutrient deficiencies constitute the most dreaded nutritional problems faced in developing countries (Alade *et al.*, 2016). Food enrichment is a viable strategy in improving nutritional quality of foods and consequently enhance adequate nutritional intake among people. Enrichment of gari with protein-rich plant foods such as sesame seed, soybeans, melon seed and groundnut) usually result in an improved nutrient quality and acceptable sensory properties (Laurent, 2019). Soybeans *(Glycine max)* belongs to the family of leguminous and sub-family papilionnideae. Soybeans is a leading constituents of the food for animals and is progressively important in the human diet (Ijarotimi *et al.,* 2019).

Soybeans is a rich source of protein, essential amino and fatty acids, minerals and vitamins (Laurent, 2019). It has been expressed that, owing to the protein and amino acids contents in Soybeans, soy foods can replace animal protein foods without requiring major adjustments in the diet (Arisa *et al.,* 2011). Lately, several functions of soybeans has been enumerated for example reducing the risk of heart disease, helps in the reduction of hot flash as experienced by women mainly in their menopausal and pre-menopausal stage (Arisa *et al.,* 2011). There is a need to explore the potentials of this food as enrichment material in gari production. This study was carried out to investigate the proximate, mineral, functional and sensory properties of gari enriched with soybeans flour.

Materials and Methods

Samples Collection, Preparation and processing

Freshly harvested cassava roots (*Manihot esculenta)* and soybeans (*Glycine Max)* were obtained from a local market within Lafia metropolis in Nasarawa state, Nigeria. Fresh cassava tubers were washed before peeling to remove soil and reduce microbial load. The washed tubers were peeled manually with kitchen knife to remove thick peel and reduce cyanide content and reduce microbial load. The peeled cassava tubers were grated into mash and bagged with sack bag for 3 days to ferment and dewater. The dewatered mash was disintegrated with sieve to get granules of close to equal size for easy toasting and removal of large lumps and fibre. The sieved mash was toasted in a large but shallow cast iron pan over generated fire from wood paddles until the granules were dried through hand feeling. The toasted gari was allowed to cool on a stainless tray and sieved with gauze to get granules of equal or close to equal sizes. Samples were packaged in polythene bags and stored at room temperature for further use.

The soybean was processed according to the modified method described by Ijarotimi and Owoeye, (2017). The soybeans seed were cleaned by removing broken grains, pebbles, and pre matured seeds and washed. The cleaned Soybeans was soaked in water for 12hours and dehuled by rubbing between palms. The hulls were removed by floatation in water and allowed to dry in the sun for 8hours. The dried seeds were milled into flour packed in plastic container sealed and stored at room temperature until analysis as shown in figure 1.

The sieved food samples; gari and soybeans flour were measured, formulated as presented in table 1 and blended together for 60 seconds for homogeneity.

Table 1: Blending ratio for formulation of soybean enriched gari

Sample	Cassava Flour(g)	Soybean flour (g)
A	100	0
B	95	5
C	90	10
D	85	15
E	80	20

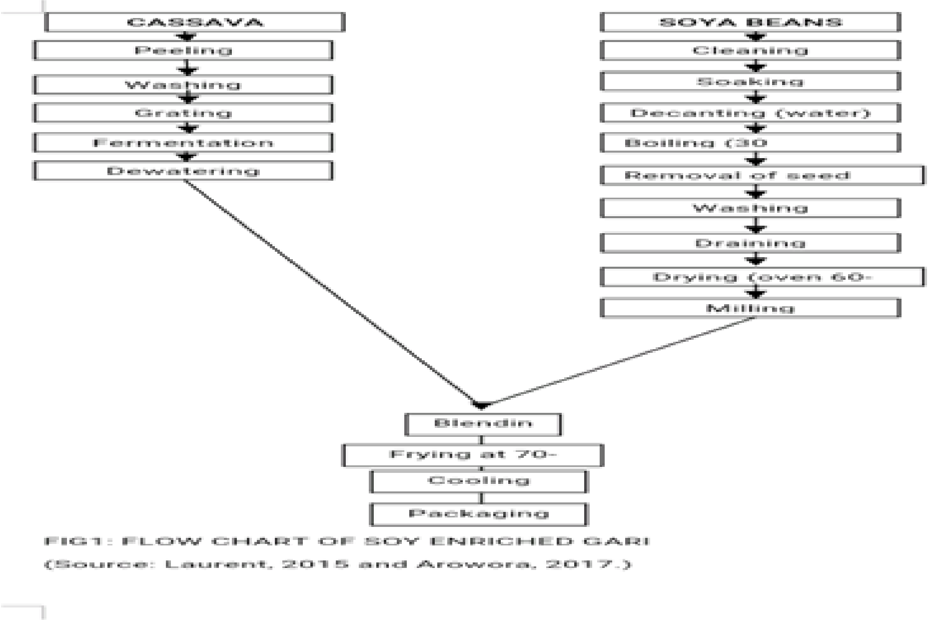

Figure 1: **Formulation of complementary foods**

Data collection

Proximate determination of soybean enriched gari

The proximate composition of samples for moisture, ash, fibre, fat, Protein was analysed by the standard methods described in AOAC (2012), the carbohydrate content was calculated by subtracting the sum of the value of the nutrient from 100. The energy value was determined by using the Atwater's conversion factors.

1 kcal/ 100 g = [(4 × carbohydrate) + (4 × protein) + (9 × fat)]

Determination of mineral composition of soybean enriched gari

The mineral (iron, zinc and calcium) compositions of the samples were determined using the methods described by Adeoti and Osundahunsi (2017) while phosphorus determination was carried out by Vanodo-molybdate method (AOAC, 2012).

Determination of functional properties of soybean enriched gari

Bulk density was determined according to the method of Asoegwu *et al.*, (2006). The Water absorption capacity an index of the amount of water retained within a food matrix under certain conditions was determined using a modified method described by Adebowale *et al.*, (2005). Water absorption was examined as per cent water bound per gram flour. The swelling capacity and Solubility index of each sample was calculated as a multiple of the original volume as done by Ukpabi and Ndimele (1990) while the least Gelation properties of the samples were determined by employing the method of Adebowale *et al.* (2005).

Sensory evaluation of soybean enriched gari

Sensory (colour, taste, odour, texture, mouth feel) as described by Ayo *et al.* (2023). Sensory evaluations of the-gari were determined using fifteen-member panellist consisting of staff and students of Faculty of Agriculture, Nasarawa State University Keffi, and Nigeria. The panellists were neither regular nor occasionally consumers of gari and were not allergic to any food. Gari samples were presented in coded white microwavable plastic container. The order of presentation of samples to the panellists was randomized. The panellists were instructed to evaluate the coded samples for appearance, taste, colour, aroma, mouth feel, after taste, and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale (for taste, aroma and 1 = disliked extremely, 5 = neither like nor dislike, while 9 = liked extremely

Statistical analysis

All measurements were done in three replicates, and the results were subject to one factor analysis of variance, applying software package SPSS 16.0. The significance of differences was evaluated by Duncan's test, at $P<0.05$. The results are represented as mean value ± standard deviation.

Results and Discussion

Proximate composition

The proximate and energy compositions of gari and soybeans are presented in table 2, moisture content of the samples from ranged 7.39 - 8.93%, with sample C having the highest moisture value. However, the moisture content was considerably low and is capable of having a long shelf life. This is in agreement with the recommendation that for good storability the moisture content of gari should be below 12% (Okwulehie *et al.,* 2021). The variation between moisture content in this study and other reported gari based food products could be attributed to the processing procedures and composition of blended food materials (Ijarotimi *et al.,* 2019). Scientific study has shown that high moisture content in the flour sample enhances microbial activities, spoilage and thereby reduces the shelf life of the product (Oluwole *et al*., 2019).

The crude protein content of the sample ranged from 6.58 - 24.52% with sample A (100% cassava flour) having the lowest value. The crude protein content of the product was observed to improve with soybeans flour substitution. Sample A (100% cassava) was observed to have lowest content of crude protein (6.58%) and Sample D (85% cassava flour: 15% soybeans flour) highest protein content (24.52%) with the protein content of cassava which has being said to be as low as 1% raised to 24.52% by enrichment. This method of gari production could go a long way to fight protein energy malnutrition among the poor who make up the bulk of the population. This is similar to earlier report by Arisa *et al*. (2016) who observed increased protein content of gari by supplementing with groundnut and soybean.

The ash content of the sample ranged from 1.41 - 2.39% with sample A (100% gari) having the lowest ash value (1.41%), followed by sample B (95% gari 5% soybeans flour). A significant increase was observed in sample E (80% gari: 20% soybeans flour) The increase in the ash content of the samples shows that the enrichment produce gari with higher nutritive value, this is in accordance with earlier studies by Arisa *et al.,* (2016) who increased the protein content of gari by substituting with groundnut and soybeans. This confirms the beneficial effect of vegetable protein enrichment which was recommended as a means of providing nutrient and energy dense food (Arisa *et al.,* 2016).

The crude fat content ranged from 1. 21%, 1.27%, 1.46%, 1.58%, 1.86% in sample A, B, C, D and E respectively. Sample A (100% gari) and sample E (80% gari: 20% soybeans flour) was observed to have the lowest and highest crude fat value respectively. This trend could be due to the fact that soybeans has a higher percentage of fat as it is an oil bearing seed (Okwulehie *et al.,* 2021). Soybeans has a total fat content of 19.9g/100g higher than cassava. The enriched samples have advantage over the control in its oil content, because soybeans contains omega-3 and omega-6 fatty acid at the ratio of 3:1 respectively. The product has the advantage of having a long shelf life since the oil contents were not very high and so cannot go rancid easily.

The crude fibre content ranged from 2.13 - 2.59% with sample A (100% gari) having the lowest value (2.13%) and sample E (80% gari: 20% soybeans) having the highest value (2.59%). No significant increase was observed for the crude fibre of each sample ($p<0.5\%$). If the nutritive value of fibre is to be considered, the treated samples are recommended to provide fibre in the diet than the control which was not treated with soybeans flour. This is in accordance with earlier studies by Arisa *et al.* (2016) for gari-based enriched with soybeans and groundnut. Epidemiological studies have shown that dietary fibre intake promote food health. For instance, dietary fibre was beneficial in treating Type 2 diabetes mellitus by delaying digestion and absorption of carbohydrates in gastro-intestinal tract (American Diabetes Association, 2013).

The carbohydrate content ranged from 76.30 - 47.43% with sample E (80% gari: 20% soybeans flour) having the lowest value (47.43%). The gradual reduction as the level of substitution increases, may be due to the fact that as the cassava flour was reduced and replaced with Soybeans flour (which had lower fibre and carbohydrate than the cassava) the percentage of these nutrients in the resultant product became lower. The decrease in the carbohydrate level is expected to boost the nutritional value of the product.

The energy content ranged from 342kcal-289kcal with sample A (100%) having the highest value 342kcal, lowest value was recorded in sample E (80%:20%). Energy content is an important property of food. The energy the body needs for running, talking, and thinking comes from the food we eat. Energy content is the amount of heat produced by the burning of 1 gram of a substance, and is measured in joules per gram (J/g). The present study suggest that the enriched gari samples provides considerable amount of energy, the observed energy value of these experimental flour blend could be attributed to high fat and protein content of soybeans, carbohydrates of gari, which agrees with other studies, that legumes like soybeans are inexpensive sources of energy (Arisa *et al*., 2016; Alalade *et al.,* 2016)

Table 2: Proximate (g/100g) and energy (kcal) compositions of gari and soybeans

Sample	Moisture	Total Ash	Crude Fibre	Crude Fat	Protein	Carbohydrate	Energy Kcal
A	7.39±0.55^{e}	1.41±0.04^{e}	2.13±0.03^{e}	1.21±0.07^{e}	6.52±0.14^{e}	81.36±0.45^{a}	342.25^{a}
B	7.69±0.71^{c}	1.52±0.06^{d}	2.36±0.81^{d}	1.27±0.19^{d}	18.41±0.12^{c}	68.75±0.36^{b}	341.13^{a}
C	8.93±0.52^{a}	1.89±0.03^{c}	2.43±0.38^{c}	1.46±0.15^{c}	20.08±0.31^{b}	65.21±0.27^{c}	320.94^{b}
D	8.90±0.21^{a}	1.93±0.07^{b}	2.51±0.23^{b}	1.58±0.12^{b}	24.52±0.60^{a}	60.56.76±0.18^{d}	315.34^{b}
E	7.99±0.32^{b}	2.39±0.41^{a}	2.59±0.02^{a}	1.86±0.08^{a}	20.85±0.02^{b}	47.43±0.09^{e}	289.86^{d}

a,b,c,d: Means with the same alphabet on the same column are significantly (p<0.05%) different. Sample A: 100% cassava; Sample B: 95% cassava: 5% soybeans; Sample C: 90%cassava: 10 soybeans; Sample D: 85% cassava: 15% soybeans; Sample E: 80% cassava: 20% soybeans.

Minerals Composition

The results of the mineral content of the soybeans enriched gari are presented in table 3. Calcium ranged from 197.24 - 208.06mg with the lowest and highest value recorded in sample E (80%gari: 20%soybeans) and sample C (90%gari: 15% soybeans) respectively. The calcium content of the enriched sample was observed to improve with soybeans flour substitution, no significant difference (p<0.05%) was observed in the sample although sample E has the lowest value 197.24mg while, sample D has the highest value (210.00mg). Calcium is important for bone health throughout life, although, diet is the best way to get calcium, calcium supplements maybe an option if diet falls short. This method of gari production provide the needed calcium at no extra cost. Therefore, increasing the content of soybeans flour invariably had additional effect as it increase the calcium content of the product.

The range value of iron was between 41.06 and 51.01mg with the lowest (41.06mg) in sample E (80% gari: 20% soybeans). The iron values of the enriched samples were raised above the control and no significant difference (p<0.05%) was observed. Sample D has the highest value (51.01mg) followed by sample C (47.07mg) increasing the soybeans content lead to decrease in iron content in sample E (41.06mg). Iron is a mineral that the body needs for growth and development. It is needed by the body to make haemoglobin, a protein in red blood cells that carries oxygen from the lungs to all parts of the body. Iron also helps fight against anaemia, therefore this enrichment process is a viable method to fight against micro nutrient deficiency.

The result for the zinc composition of soy enriched gari showed that iron levels were 0.020mg, 0.042mg, 0.067mg, 0.078mg 0.0104mg in sample A, B, C, D and E respectively. The result from the study showed that as the level of substitution of soybean flours increases, the level of zinc increases. The lowest zinc value (0.020%) and highest value of zinc (0.104mg) was recorded in sample A (100% gari) and sample E (80%gari: 20% soybeans) respectively. Zinc is a nutrient found throughout the body which helps with the immune system and metabolism function, zinc is also important to wound healing and enhances sense of taste and smell with varied diets, the body usually gets enough zinc. (Mayo clinic.org). The enrichment of soybeans flour with gari at different level of soybeans substitution (5%, 10%, 15% and 20%) shows no significant increase in the phosphorus content from 131.86mg in sample A which is the control to 142.37mg in sample B, 146.08mg in sample C, 150.11mg in sample D with the highest value and 148.06mg in sample E. According to Ijarotimi *et al.*, (2022) phosphorus is a mineral that makes up 1% of a person's total body weight. It is considered the second most abundant minerals in the body as it is useful in the formation of bones and teeth. Enrichment of gari increase minerals content through the incorporation of soybeans, provides a cheaper and affordable means of curbing micronutrient deficiency in young children and adult.

Table 3: Mineral composition (mg/g) of soybean enriched gari

Samples	Ca	Fe	Zn	P
A	198.10±0.02^{d}	42.00±0.03^{c}	0.02±0.02^{e}	131.86±0.03^{e}
B	201.68±0.03^{c}	46.53±0.02^{b}	0.04±0.03^{d}	143.37±0.05^{d}
C	208.06±0.01^{b}	47.07±0.03^{b}	0.07±0.02^{c}	146.08±0.03^{c}
D	210.00±0.03^{a}	51.01±0.02^{a}	0.08±0.03^{b}	150.11±0.02^{a}
E	197.24±0.03^{e}	41.06±0.03^{d}	0.10±0.03^{a}	148.07±0.05^{a}

a,b,c,d: Means with the same alphabet on the same column are significantly (p<0.05%) different.
Sample A: 100% cassava; Sample B: 95% cassava: 5% soybeans; Sample C: 90%cassava: 10 soybeans; Sample D: 85% cassava: 15% soybeans; Sample E: 80% cassava: 20% soybeans.

Functional properties

The functional properties of the soybeans enriched samples are presented in table 4. Bulk density ranged from 0.57 - 0.76g/ml and no significant differences (p<0.05) were observed. The highest bulk density (0.76g/ml) was observed in sample A (100%) followed by sample B (95% gari: 5% soybeans) and the lowest bulk density (0.57g/ml) for sample D (80% gari: 20% Soybeans). The low bulk density observed in this study implies that less quantity of the flour samples would be required in packaging (Ijarotimi *et al.*, 2019). The bulk densities of the soy enriched samples were higher than that of the control, the higher the loose pack density (LPD), the higher the bulk density. Loose pack density indicates the free space between the foods when packed. A large free space is undesirable in packaging of foods because it constitute a large oxygen reservoir while a low LPD and lower bulk density result in greater oxygen transmission in the packed food. (Alalade *et al.,* 2019).

The water absorption capacity (WAC) of the soybeans enriched gari sample ranged from 3.00%-1.32% with sample E (80%gari :20% soybeans flour) having the lowest value 1.32% The water absorption capacity for the soy enriched gari showed that water absorption was lowest (1.32%) and highest (3.00%) sample E (80% gari: 20% soybeans) and sample A (3.00%) respectively. Samples C and D (with a ratio of 90:10% and 85%:15% of soybeans substitution) has the same water absorption value of 2.03g/ml. The results suggest that addition of soybeans to gari affected the amount of water absorption at different level. Water absorption capacity (WAC) is the ability of a product to associate with water under a condition where water is limiting. The WAC in this present study is lower and is desirable for making thinner food that will enhance more intake of nutrients (Ijarotimi *et al.,* 2019) and lowering the microbial activities of the food products thereby prolonging the shelf life of the food product (Alalade *et al.,* 2016.)
Solubility index ranged from 2.94%-2.07%, the least value was observed in sample E (80%:20%) A significant difference (p<0.05%) was observed between the control A (100% cassava) and sample E

(80%:20%). Sample A (100%) was observed to have the highest value 2.94% followed closely by sample B (95%:5%) at 2.33%, the least value was recorded for sample E (80%:20%) at 2.07%. Solubility index decrease with increase in soy flour substitution. Solubility index is used to determine the reduction noticed in solvent. Solubility index according to Ijarotimi *et al*., (2022) causes changes in the food samples such as thickness, plasticity and viscosity of the food. SI was the weight of dry solids in the supernatant from the water absorption index test (Alalade *et al.,* 2017*).*

The swelling index ranged from 20.54%-10% with sample E (80:20%) having the lowest value (10%). Swelling capacity is an important factor used in determining the expansion accompanied in solvent. According to (Ijarotimi *et al*., 2019) swelling causes changes in hydrodynamic properties of the food samples, thus imparting characteristics such as body, thickness and reduced viscosity of food, plasticity and electricity. These properties are desirable for a good dough meal. The higher swelling capacity of sample A compared to the other samples is expected since it has higher starch content compared to the other samples. The lower swelling power of the soy-enriched samples may be due to formation of protein-amylose complex (Alalade, 2016) which can also contribute to reduction in the swelling. The result of the least gelation index ranged from 2.00 - 3.00%. Sample A, B and C (5%,10% soybeans substitution) least gelation index while, sample D and E (15% and 20%) has the highest gelation index, the higher gelation index may be as a result of competition for water between the protein of the soy flour and starch component from the gari. The lower the gelation index the better the gelating ability of the protein ingredients (Alalade *et al.,* 2016*).* The least gelation is the ability of a food product to form gel at a higher concentration. This implies that the soybeans enriched samples have poor gelating ability hence it will not form a good gel.

Table 4: Functional properties of soybean enriched gari

Samples	**A**	**B**	**C**	**D**	**E**
Bulk density (g/ml)	0.76±0.02[c]	0.71±0.02[d]	0.68±0.03[c]	0.66±0.02[b]	0.57±0.02[a]
Water absorption capacity (g/ml)	3.00±0.03[a]	2.22±0.02[b]	2.03±0.03[c]	2.03±0.02[c]	1.32±0.03[e]
Solubility index (%)	2.94±0.0[a]	2.33±0.04[a]	2.17±0.03[c]	2.10±0.03[d]	2.07±0.07[e]
Swelling capacity (%)	20.54±0.04[a]	18.06±0.03[a]	15.07±0.04[c]	13.09±0.03[d]	10.00±0.03[e]
Least gelation concentration (%)	3.00±0.00[a]	3.00±0.00[a]	3.00±0.00[a]	2.00±0.00[b]	2.00±0.00[b]

a,b,c,d: Means with the same alphabet on the same column are significantly (p<0.05%) different. Sample A: 100% cassava; Sample B: 95% cassava: 5% soybeans; Sample C: 90%cassava: 10 soybeans; Sample D: 85% cassava: 15% soybeans; Sample E: 80% cassava: 20% soybeans.

Table 5: Sensory evaluation of soy enriched gari

Samples	Appearance	Colour	Mouth feel	Texture	Overall Acceptability
A	6.71±0.92[b]	7.33±0.03[e]	5.44±1.07[c]	7.66±1.00[d]	6.79±1.00[d]
B	6.53±0.09[c]	7.55±0.97[b]	5.52±0.94[b]	7.68±0.81[c]	6.82±08[c]
C	6.52±0.94[a]	7.53±1.04[a]	5.70±0.91[a]	7.74±0.08[a]	6.87±0.80[a]
D	6.74±1.00[a]	7.66±1.08[a]	5.70±0.98[a]	7.25±0.93[e]	6.84±0.85[b]
E	6.33±1.28[e]	7.45±1.19[d]	5.33±1.14[d]	7.78±1.18[a]	6.72±0.01[e]

a,b,c,d: Means with the same alphabet on the same column are significantly (p<0.05%) different. Sample A: 100% cassava; Sample B: 95% cassava: 5% soybeans; Sample C: 90%cassava: 10 soybeans; Sample D: 85% cassava: 15% soybeans; Sample E: 80% cassava: 20% soybeans.

Sensory evaluation of the soybeans enriched gari is presented in table 5. The appearance, colour and mouthfeel of the enriched samples were significantly higher in sample D (85:15) than other samples. The result further showed that all sample did well for appearance and there was significant difference (p<0.05%) although sample D had the highest value 6.74 which was followed closely by the control sample A (100:0) with value of 7.71.There was no significant colour change in the enriched sample since there were no significant difference (p<0.05) between sample A (control) and the enriched samples although sample D scored high for colour. This could be attributed to the fact that the soybeans was not fermented. The taste of the soybeans enriched gari was accepted. Sample C and D has the highest value 3.70%, this may be due to the fact that the cassava was fermented for three days and the strong acid taste preferred by most people was not affected. The texture of the soy enriched gari was preferred, the improved soybeans gari product had a fluffy texture. Sample D was most preferred this could be as a result of the enrichment ratio 85% gari: 15% soybeans which resulted in a well-blended product. The soy enriched gari was generally accepted and desired over the control sample. Sample D has the highest value 4.01%, followed closely by the control sample A 3.97%.

Conclusion

The enrichment of gari which is a food choice in the face of alternative food in most home in Nigeria has become a trend. Findings from this study aimed at assessing the mineral content, Proximate, functional and sensory properties of gari incorporated with indigenous legume, soybeans. This enrichment process advances nutritional value by increasing mineral levels which are important in improving healthy bones and tooth and improving haemoglobin level. The process influenced functional properties; enrichment produce a product that can compete favourably with 100% gari. All the samples performed well in sensory evaluation. Enrichment of this product can thus present a sustainable and viable means of tackling nutrient deficiencies especially protein energy malnutrition in population. In light of the findings from the current study, the researcher recommends that the use and commercialization of indigenous legume crops should be encouraged for use in the production of confectionery as it is cheap and provide adequate nutrients needed for growth and development and also help fight protein energy malnutrition among children.

References

Adebowale, Y. A., Adeyemi, I. A. and Oshodi, A. A. (2005). Functional and physico-chemical properties of flour of six mucuna species. *African Journal of Biotechnology*, 4(12): 1461-1468.

Adeoti O.A., and Osundahunsi O.F. (2017). Nutritional Characteristics of Maize-based Complementary Food Enriched with Fermented and Germinated *Moringa oleifera* Seed Flour. *Int'l J Food Sci. Nutri Diet. 6(2), 350-357.*

Arisa, N. U., Omosaiye, O. B., Adelekan, A. O. and Alabi Mac Foy, A. (2011). Chemical and sensory qualities of gari fortified with groundnut flour. African Journal of Food Science and Technology; Vol. 2(5) pp. 116-119.

Alade, O.A, Adegbite J.A and Omoloa A.O, (2016), Chemical and Physiochemical Properties of Moringa Flour and Oil. *Global Journals of Food Science Frontier Research (c). XII. V., 1, 13-14.*

Alalade M. A. (2016). Performance of three groundnut (*Arachis hypogaea* L.) varieties as affected by basin size and plant population at Kaduna. Ph.D. Dissertation Submitted to post graduate school, Ahmadu Bello University, Zaria pp 173.

AOAC. (2012). Association of Official Analytical Chemist. Official Methods of Analysis of the Analytical Chemist International, 18th ed. Gathersburg, MD USA.

Asoegwu S. N., Ohanyere, S. O., Kanu, O. P. and Iwueke, C. N. (2006). Physical properties of African oil bean seed (*Pentonclethra nacrophylla*). *Agricultural Engineering International Journal, 44(1): 1-6.*

Ayo, J.A, Awogbenja M.D and Ibrahim, S (2023). Nutritional Evaluation of Acha (*Digitaria exilis*) and Lima Bean (*Phaseolus lunatus*) based Biscuit. *FUW Trends in Science & Technology Journal;* Vol. 8 No. 3 pp. 166 – 172. www.ftstjournal.com. e-ISSN: 24085162; p-ISSN: 20485170.

Belecia, A., Butarelo, S.S. and Silva, R.S.F. (2019).Modelling of starch gelatinization during cooking of cassava (*Manihot esculenta* Crantz) LWT – *Food Technology, 39,399 – 404.*

Ijarotimi O. S., and Owoeye O. R. (2017). Study on energy nutrient density, functional and organoleptic properties of complementary foods from indigenous plant Based food materials. *Journal of Advances in Food Science and Technology,* 4(2): 73-83.

Ijarotimi O.S., Oluwajuyitan T.D. and Ogunmola G.T. (2019) Nutritional, functional and sensory properties of gluten-free composite four produced from plantain (Musa AAB), tigernut tubers (*Cyperus esculentus*) and defatted soybean cake (Glycine max). *Croat J Food Science and Technology* 11(1):1131–1251

Ijarotimi O. S., Monisola R. F. and Timilehin D. O. (2022). Nutritional, antioxidant and organoleptic properties of therapeutic-complementary-food formulated from locally available food materials for severe acute malnutrition management. Bulletin of the National Research Centre (2022) 46:39 https://doi.org/10.1186/s42269-022-00725-z

Laurent, A., Koubala, B. B., Kouninki, H., and Nukenine, E. N. (2019). Effect of harvest period on the proximate composition and functional and sensory properties of gari produced from local and improved Cassava (Manihot esculenta) varieties. *International Journal of Food Science, 2019, 115.9*

Messina, M. J. Persky, V. Setchell, K. D. R. and Barness, S. (2017). Soy intake and cancer Risk: A review of the In vitro and In vivo Data. Nutr. Cancer 212: 112 – 131.9

Okwulehie, S.O and Sobamiwa, A.O, (2021). Processing and Characteristics of Soybean Fortified gari. *World Journal of Microbiology and Biotechnology, 10, 268- 270.*9

Osho, S.M. (2017). The processing and acceptability of a fortified cassava-based product (gari) with soybean. *Nutrition and Food Science; 33(6), 268-272.*

Ukpabi, U. J and Ndimele, C. (1990). Evaluation of gari production in Imo State Nigeria. *Nigeria Food Journal, 8(1): 105-110*