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Shelf Stability Studies on the Chemical Composition of Malted Soy-garri as affected by Moisture Variation

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Abstract

The effect of moisture variation on the chemical composition of malted soy-garri was investigated through ten weeks storage. Malted soy-garri made from TME 419 cassava variety had its moisture levels varied to 8%, 10% and 12%, then stored for ten (10) weeks at ambient temperature in Ziploc bags. Proximate and hydrogen cyanide (HCN) composition of the garri samples were determined fortnightly during the storage period. Results showed that fortification resulted to an increase in the nutritional profile of the study samples. While moisture variation had an insignificant effect ($p<0.05$) on the chemical composition of the malted soy-garri samples, the storage duration showed significant differences on the chemical composition of the samples. The result of this study indicated a favourable shelf stability of malted soy-garri at the moisture variations (8% 10% and 12%) studied when compared with the control garri (unfortified garri) samples.

Keywords: Malted Soy-garri, Moisture variation, Malted Soy flour, Fortification, unfortified garri, Shelf stability.

1. INTRODUCTION

Garri, which is a by-product of cassava (*Manihot esculenta* Crantz) is rich in carbohydrate and serves a major source of energy when

consumed. Cassava tubers are deficient in protein, fat, vitamins and some minerals. Garri has a caloric value of 334 – 360 KJ per 100g serving and is a low protein food about 1.12%. The proximate and physical properties of garri is a function of the cassava variety, age of cassava, time of harvesting, processing methods, packaging methods, storage conditions and durations of storage (Oduro *et al.,* 2000; Chuzel and Zakhia, 1991).

Although cassava is a staple food, it is poisonous in its raw state as the plant contains cyanogenic glucosides. These glucosides are converted to hydrogen cyanide (HCN) by an enzyme called linamarase, which is also present in cassava and acts on the glucosides when the plant cells are ruptured either when it is eaten or during processing (Neil, 2006).

The amount of cyanide present in cassava depends on the variety. There are two main types of cassava, bitter and sweet. While, in general, bitter varieties have higher levels of cyanide, it must not be assumed that all sweet varieties have low cyanide levels. The cyanide levels range from 10 to 450 mg/Kg of fresh root (Neil, 2006). Cyanide in cassava is readily removed during processing, resulting in a safe and versatile product of which garri is one of the major by-products of cassava.

The process of preparation involves peeling, washing, grating, fermentation of the mash and dewatering in jute bag for at least seventy two (72) hours. The fermented pulp is subsequently fried at high temperatures during which any associated micro-organisms would have been killed (Adeniji, 1976).

Soybean, a member of the family *leguminoceae*, subfamily *papiplonaceae*, and the genus *Glycine max* (L) Merril, has been receiving attention as a source of food capable of increasing the available protein supplies. Consequently, interest in the production, processing and utilization of the crop has been growing (Osho, 1991). Soybean entered Nigerian diets in an attempt to improve nutrient intake, especially the protein intake of the low-income populace (Obatolu *et. al.,* 2006).

According to Ahaotu *et. al.,* (2017), the very low protein content of garri led to the production of malted soy-garri which is a high protein garri made from co-fermentation of cassava mash with malted soy flour. Moisture content of garri determines its shelf stability, therefore

it is important to study the influence of moisture variation in the chemical and nutritional composition of malted soy-garri during storage.

2. MATERIALS AND METHODS

2.1 Raw Material Procurement

Fifty (50) kg of matured TME 419 cassava root variety utilized, was obtained from the National Root Crop Research Institute, Umudike, Abia State of Nigeria, while Soybeans used was purchased from a local market in Owerri, Imo State, Nigeria.

2.2 Production of Malted Soy Flour

Malted soy flour (MSF) was produced by steeping 5.0 kg wholesome soybeans in water at ambient temperature (28°C) for 10 h, the steep water drained, the soybeans spread out on a moistened, sterile Hessian sack at ambient temperature and allowed to germinate for 24 h, while being sprinkled with water at 6 h interval. The germinated seeds were oven dried (GENLAB MINO/50 England United Kingdom) at 60°C for 24 h. Thereafter the dried seeds were milled using KENWOOD FP 950 series England UK to obtain malted soy flour.

2.3 Preparation of Malted Soy-garri

Cassava roots were manually peeled, washed and grated through the aid of a mechanical grater to obtain the cassava mash. The malted soy-garri was prepared according to the method described by Ahaotu *et al*., (2017). Twenty kilograms (20kg) of cassava mash was thoroughly mixed with 1.75 kg of malted soy flour, transferred into polyethylene woven sacks, fermented at ambient temperature for 48 h, dewatered using hydraulic press, sifted and garrified using the method of Akingbala *et al.,* (2005). The resultant product, malted soy-garri were spread out and left to cool at ambient temperature. The moisture content of the garri was varied by sprinkling sterile distilled water on the garri, then oven dried to the specific moisture levels using the AOAC (2000) method of moisture determination to derive the specific samples SG1 (8%), SG2(10%) and SG3 (12%). The control samples (without malted soy flour) CG1 (8%), CG2 (10%) and CG3 (12%) were also produced using the same method. All the garri samples (malted

soy garri and control) were all packed in Ziploc storage bag and stored at ambient temperature. Samples were drawn for analysis forth nightly.

2.4 Chemical Analysis and Shelf Stability Studies

The packaged samples were stored for ten (10) weeks and samples drawn fortnightly for the following analysis.

2.4.1 Hydrogen Cyanide Content

The residual cyanide level of flours of the cassava varieties was determined using the alkaline picrate method (Onwuka, 2005) with modifications.

Five grams (5g) of each sample was dissolved in 50ml distilled water and allowed to stay overnight. The sample was filtered and the filtrate was used for the cyanide determination. To 1 ml of the extract, 4 ml of alkaline picrate (obtained by dissolving 1g of picrate and 5g of sodium carbonate (Na_2CO_3) in 200 ml of distilled water) was added and incubated in a water bath at a temperature of 50°C for 5 minutes. The formation of a dark red colour was read spectrophotometrically at 490 nm against a reagent blank which contained 1 ml of distilled water and 4 ml of alkaline picrate solution.

A series of serial dilutions were from potassium cyanide (KCN) (in water, acidified with HCl) corresponding to the concentrations of 0.1, 0.2, 0.3, 0.4 and 0.5 µg/ml. The resulting solution was further diluted with 10 ml of water to give a final concentration of 0.01, 0.02, 0.03, 0.04 and 0.05µg/ml and the cyanide content of the flours was extrapolated from the standard.

The cyanide content was calculated from the equation:

$$Y = 3.23x + 0.217 \times 10$$

Where; x = Slope of the graph, 0.217 = Intercept, 10 = Dilution factor.

2.4.2 pH determination

The pH was determined using the method described by Ogiehor and Ikenebomeh (2005). Ten grams of the sample was mixed with 10 ml distilled water. The pH was determined with glass electrode pH meter (Jenway, 3510, England) which was standardized.

2.4.3 Determination of Moisture Content

Moisture content was determined gravimetrically as described by AOAC (2000) and Onwuka (2005). A measured weight of each sample (5.0g) was put in a previously weighed can and dried in the oven at 105°C for 3 hours in the first instance. It was cooled in a desiccator and reweighed. It was then returned to the oven for further drying at the same temperature, cooling and re-weighing of the drying samples was repeated at hourly interval until no further reduction was recorded in the weigh (i.e. Constant weight was attained).

The weight of lost moisture was calculated by weight difference and expressed as a percentage of the samples weight. The formula below was used:

$$MC = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1}$$

Where; MC = Moisture Content, W_1 = Weight of empty can, W_2 = Weight of can + sample before drying, W_3 = Weight of moisture can + sample dried to constant weight.

2.4.4 Determination of Protein Content

The semi micro Khejdahl method described by Chang (2003) was used to determine the protein content. The total Nitrogen content and protein value were obtained. A measured weight of the sample (1.0g) was mixed with 10 ml of concentrated H_2SO_4 in a Khejdahl digestion stand. One tablet of Selenium catalyst was added to the mixture and then heated strongly under a fume cupboard until the mixture becomes a clear solution. (This process is digestion). A reagent blank was also digested but without any sample. The digest was carefully diluted with distilled water and transferred quantitatively to a 100 ml volumetric flask and made to mark with distilled water. 10 ml of the digest was mixed with equal volume of 45% NaOH solution in a Khejdahl distillation apparatus. The mixture was distilled and the distillate was collected into 10 ml of 4% boric acid solution containing three drops of mixed indicator solution (methyl red & bromocressol green).

A total of 50 ml of distillate was collected and titrated against 0.02A H_2SO_4 solution. The end point was marked by a colour change from green to a deep red colour. Both the samples and the blank reagent were distilled and titrated.

The formula below was used to calculate the Nitrogen and Protein content;

$$\% \text{ Protein} = \% N_2 \times 6.25$$

$$\% N_2 = \frac{100}{W} \times \frac{14 \times N}{1000} \times \frac{Vd}{Va} \times T - B$$

Where; 1ml of W H_2SO_4 = 14mg H_2, W = Weight of the sample analysed, W = Normality (Conc.) of titrant, Vd = Total volume of digest, Va = Volume of digest analysed, T = Titre value of sample, B = Titre value of reagent blanks.

2.4.5 Determination of Crude Fat

Fat content was determined by the continuous solvent gravimetrical method using soxhlet apparatus, the method was described by AOAC (2000). A measured weight of each sample (5.0g) was wrapped in a previously weighed porous paper (Whatman No. 1 filter paper) and placed inside a soxhlet reflux, the flask contain 300 ml solvent (petroleum ether). The upper end of the soxhlet apparatus, reflux on heating the solvent in the flask through an electric heating mantle. The solvent boiled, vapourised and condensed into the reflux flask with the solvent (Immersed) unto the flask and siphoned over thus, carrying its extracted oil down to the boiling solvent.

The cycle of boiling, vapourising and reflux condensation was allowed to go on repeatedly for about 2 – 3 hours, allowing up to fourteen (14) refluxes, and at the end, the soxhlet was recovered and the defatted wrapped sample was carefully retrieved with the aid of a pair of forceps. It was then dried in the oven at 80°C for 30 minutes, cooled in a desiccator and reweighed. The new weight of oil extracted (fat) was obtained and expressed using the formula below:

$$\% \text{ Fat} = \frac{W_1 - W_2}{W_3} \times \frac{100}{1}$$

Where; W_1= Weight of porous paper, W_2 = Weight of the paper and sample (wrapped) before defatting, W_3 = Weight of proper sample after drying.

2.4.6 Determination of Crude Fibre

The crude fibre content was done using the Weende method described by James (1995). A measured weight of each sample (5.0g) was defatted (as in fat analysis). The defatted sample was boiled under reflux for 30 minutes in 150 ml of 1.25% H_2SO_4 solution, care was taken to avoid loss of particles during the whole process. After boiling for 30 minutes in acid solution, the samples were washed with repeated portions of hot

distilled water until the wash water was free of acid (through litmus test). Meanwhile, during the washing, a two-fold muslin cloth was used to retain the particles of the sample which was carefully transferred back to the flask and boiled again.

This time, in 150 ml of 1.25%NaOH solution, it was washed as before and then transferred quantitatively into a weighed crucible in which it was dried in the oven at 105°C for an hour; it was then cooled in a desiccator and reweighed. The crucible fibre was calculated as follows:

$$\% \text{ Fibre} = \frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where; W_1 = Weight of sample analysed, W_2 = Sample after boiling + weight of crucible drying, W_3= Weight of crucible + sample after ashing.

2.4.7 Determination of Total Ash

The ash content of the samples was determined by furnace incineration methods as described by (Pearson, 1976). A measured weight of the sample was put in a previously weighed porcelain crucible and allowed to incinerate in a muffle furnace at 550°C until only ash was left of it. The crucible and the ash content was cooled in a desiccator and then weighed. The ash content was calculated as shown below:

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where; W_1 = Weight of empty crucible, W_2 = Weight of sample analysed, W_3 = Weight of crucible and ash.

2.4.8 Determination of Carbohydrate Content

The carbohydrate content was calculated by Nitrogen free extract using the method described by Udoh and Ogunwale (1986). It was given as the difference 100 and a sum total of the other proximate components. Hence the formula below was used, the carbohydrate (NFE) was given by:

$$\% \text{ CHO} = 100 - \% (A + B + C + D + E)$$

Where; NFE = Nitrogen free extract, CHO = Carbohydrate, A = Moisture content, B = Ash content, C = Fat content, D = Crude fibre content, E = Protein content.

2.4 Statistical Analysis

The data obtained were analysed using two-factor (Moisture variation × Storage time) analysis of variance (ANOVA) method by Microsoft

Excel program (2013). Where the variance ratio was found significant, the Fisher's LSD (0.05) test was used to separate the means. Significant difference is considered at 5% probability.

3. RESULTS AND DISCUSSION

Table 1: Effect of Moisture variation on the Hydrogen cyanide (mg/100g) content of the garri samples under storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	1.31 ± 0.01^{c}	1.36 ± 0.01^{b}	1.41 ± 0.01^{a}	0.51 ± 0.01^{f}	0.54 ± 0.01^{e}	0.58 ± 0.01^{d}	**0.02**
2	1.30 ± 0.01^{c}	1.33 ± 0.01^{b}	1.37 ± 0.01^{a}	0.48 ± 0.01^{f}	0.51 ± 0.00^{e}	0.55 ± 0.01^{d}	**0.02**
4	1.10 ± 0.01^{c}	1.13 ± 0.01^{b}	1.21 ± 0.01^{a}	0.41 ± 0.01^{f}	0.45 ± 0.01^{e}	0.50 ± 0.01^{d}	**0.02**
6	0.84 ± 0.01^{b}	0.86 ± 0.01^{b}	0.91 ± 0.01^{a}	0.31 ± 0.01^{d}	0.35 ± 0.01^{c}	0.37 ± 0.01^{c}	**0.02**
8	0.80 ± 0.00^{b}	0.82 ± 0.01^{ab}	0.84 ± 0.01^{a}	0.27 ± 0.01^{d}	0.29 ± 0.01^{d}	0.32 ± 0.01^{c}	**0.02**
10	0.61 ± 0.01^{b}	0.61 ± 0.00^{b}	0.64 ± 0.01^{a}	0.11 ± 0.01^{c}	0.13 ± 0.01^{c}	0.12 ± 0.01^{c}	**0.02**
LSD	**2.03**	**2.03**	**2.03**	**2.03**	**2.03**	**2.03**	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

The total cyanide level of the samples was very low which is primarily attributed to the cassava variety (TME 419) used in this study. The SG samples had less than 1% total cyanide while the CG samples had less than 2% total cyanide. Moisture variation had no significant effect on the sample studied however, the method of processing employed and fortification with malted soy flour may be responsible for the massive decrease in the cyanide level of the malted soy-garri samples from the first week of processing. There was also a decrease in the cyanide level of the samples as storage duration increased. This study is not in agreement with the work of Ukpabi and Ndimele (1990) who reported that garri should have total hydrogen cyanide level of 1.7 to 8.5 mg/kg. Therefore, the malted soy-garri with an impressively increased protein content and reduced cyanide level can be consumed without deleterious effects.

Table 2: pH of Malted Soy-garri at varying moisture contents as affected by storage time

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	4.73 ±0.01^{e}	4.71 ±0.01^{cd}	4.70 ±0.01^{d}	5.12 ±0.01^{ab}	5.10 ±0.00^{b}	5.13 ±0.01^{a}	0.02
2	4.71 ±0.01^{e}	4.68 ±0.01^{d}	4.65 ±0.01^{e}	5.10 ±0.00^{ab}	5.08 ±0.01^{b}	5.12 ±0.01^{a}	0.02
4	4.69 ±0.00^{e}	4.63 ±0.01^{d}	4.61 ±0.00^{e}	5.07 ±0.01^{ab}	5.06 ±0.01^{b}	5.09 ±0.01^{a}	0.02
6	4.61 ±0.01^{e}	4.58 ±0.01^{d}	4.57 ±0.01^{d}	5.09 ±0.01^{a}	5.04 ±0.01^{b}	5.10 ±0.01^{a}	0.02
8	4.60 ±0.00^{b}	4.56 ±0.01^{c}	4.56 ±0.01^{c}	5.02 ±0.01^{a}	5.03 ±0.00^{a}	5.03 ±0.01^{a}	0.02
10	4.51 ±0.01^{c}	4.28 ±0.01^{d}	4.28 ±0.01^{d}	4.88 ±0.01^{b}	4.89 ±0.00^{b}	4.92 ±0.01^{a}	0.02
LSD	0.83	0.83	0.83	0.83	0.83	0.83	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

Generally, moisture variation had no significant effect on the pH of each sample during storage nonetheless, the pH of the SG samples was increased by fortification with malted soy-flour thus, causing a significant difference between the CG and SG samples throughout the storage period. The significant effect of storage time on the samples can be seen from the variant means on the rows of table 2. Also, there was a significant decrease (towards acidity) in the pH of all samples as the storage time increased. This general increase in pH might have been due to the dilution effect of the soy flour supplement which indirectly is responsible for the reduced sourness in the fortified garri samples (Banjo and Ikenebomeh, 1996).

Table 3: Effect of moisture variation on the protein content of garri samples during storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	1.18 ±0.01^{e}	1.27 ±0.00^{d}	1.29 ±0.00^{d}	10.17 ±0.01^{c}	10.24 ±0.00^{b}	10.40 ±0.00^{a}	0.03
2	1.17 ±0.01^{f}	1.22 ±0.00^{e}	1.26 ±0.00^{d}	10.13 ±0.01^{c}	10.22 ±0.00^{b}	10.33 ±0.00^{a}	0.03
4	1.11 ±0.01^{e}	1.22 ±0.00^{d}	1.24 ±0.00^{d}	10.07 ±0.01^{c}	10.14 ±0.00^{b}	10.29 ±0.00^{a}	0.03
6	1.08 ±0.01^{e}	1.17 ±0.00^{d}	1.20 ±0.00^{d}	9.93 ±0.01^{c}	9.99 ±0.00^{b}	10.12 ±0.00^{a}	0.03
8	1.02 ±0.01^{e}	1.12 ±0.00^{d}	1.11 ±0.00^{d}	9.73 ±0.01^{c}	9.88 ±0.00^{b}	10.02 ±0.01^{a}	0.03
10	0.92 ±0.01^{e}	0.95 ±0.00^{de}	0.96 ±0.00^{d}	8.12 ±0.01^{c}	8.17 ±0.00^{b}	8.25 ±0.00^{a}	0.03
LSD	4.03	4.03	4.03	4.03	4.03	4.03	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

From table 3, it is observed that moisture variation had no significant effect on the protein content of all the samples throughout the storage duration. However, there was a significant difference in the protein content between the CG and SG samples per week of analysis as represented in the rows of table 3. The impressive increase in the protein content of the malted soy-garri is as a result of the malted soy-flour added. Also, the protein content consistently decreased during the

storage period. This decrease could be attributed to the microbial utilization of available protein, considering the very low moisture difference between the samples studied.

According to Obatolu and Osho (1992), garri contains 0.7 to 1.2% protein. Therefore, this study justifies the need for fortification of garri to improve its basic protein level for the well-being of consumers.

Table 4: Effect of moisture variations on the fat content of garri samples during storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	2.02 ±0.01^{d}	2.01 ±0.01^{d}	1.94 ±0.01^{e}	5.16 ±0.02^{a}	5.11 ±0.01^{b}	5.02 ±0.03^{c}	**0.03**
2	2.01 ±0.01^{d}	1.98 ±0.01^{d}	1.92 ±0.01^{e}	5.15 ±0.02^{a}	5.09 ±0.01^{b}	5.02 ±0.01^{c}	**0.03**
4	1.96 ±0.01^{d}	1.94 ±0.01^{d}	1.87 ±0.01^{e}	5.13 ±0.01^{a}	5.00 ±0.00^{b}	4.95 ±0.01^{c}	**0.03**
6	1.95 ±0.01^{d}	1.90 ±0.00^{e}	1.85 ±0.01^{f}	5.09 ±0.01^{a}	4.95 ±0.01^{b}	4.89 ±0.00^{c}	**0.03**
8	1.89 ±0.01^{d}	1.88 ±0.01^{d}	1.82 ±0.01^{e}	5.01 ±0.01^{a}	4.93 ±0.01^{b}	4.87 ±0.02^{c}	**0.03**
10	1.83 ±0.01^{c}	1.81 ±0.01^{c}	1.74 ±0.01^{d}	4.83 ±0.01^{a}	4.77 ±0.01^{b}	4.76 ±0.01^{b}	**0.03**
LSD	**0.83**	**0.83**	**0.83**	**0.83**	**0.83**	**0.83**	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

Fortification of cassava mash with malted soy flour resulted to a significant increase in fat content of the garri samples. Moisture variation made an insignificant effect on the fat content of the samples but, storage duration showed significant differences between the samples' fat content as seen by the mean differences on the rows of table 4. The decrease observed in the fat content of the garri samples during storage may be as a result of possible high proteolytic and lipolytic activities of the corresponding microbes associated with these activities. This is in accordance with Amadi and Adebola (2008) who reported a decrease in nutrients of stored garri (three months) due to the activities of microbes/enzymes invading the stored produce.

Table 5: Effect of moisture variation on the percentage crude fibre of garri samples during storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	2.15 ±0.01^{c}	2.08 ±0.01^{d}	2.01 ±0.01^{e}	2.30 ±0.01^{a}	2.28 ±0.01^{a}	2.25 ±0.03^{b}	**0.02**
2	2.12 ±0.01^{c}	2.06 ±0.01^{d}	2.00 ±0.00^{e}	2.28 ±0.01^{a}	2.27 ±0.01^{a}	2.20 ±0.00^{b}	**0.02**
4	2.11 ±0.01^{c}	2.03 ±0.01^{d}	1.96 ±0.01^{e}	2.22 ±0.01^{a}	2.20 ±0.01^{a}	2.14 ±0.01^{b}	**0.02**
6	2.09 ±0.02^{c}	1.99 ±0.01^{d}	1.92 ±0.01^{e}	2.17 ±0.01^{a}	2.12 ±0.01^{b}	2.11 ±0.01^{bc}	**0.02**
8	2.04 ±0.01^{c}	1.81 ±0.01^{d}	1.73 ±0.00^{e}	2.11 ±0.01^{a}	2.07 ±0.01^{b}	2.03 ±0.01^{c}	**0.02**
10	1.95 ±0.01^{a}	1.75 ±0.01^{c}	1.62 ±0.01^{e}	1.97 ±0.01^{a}	1.81 ±0.01^{b}	1.70 ±0.01^{d}	**0.02**
LSD	**1.26**	**1.26**	**1.26**	**1.26**	**1.26**	**1.26**	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

From the table 5 above, it was observed that moisture variations had a negligible effect on the percentage crude fibre while storage time showed minimal differences between the samples as analysed fortnightly and the SG samples slightly contained a higher percentage fibre. Although Sanni *et al.,* (2005) reported recommendations from the Nigerian Industrial Standard that garri should have crude fibres not more than 2.0%, the decimal increase in fibre content of the SG samples maybe due to the indigestible matter from the malted soy-flour added. However, this decimal increase may be deemed negligible as Ukpabi and Ndimele (1990) found that most market garri had a crude fibre range of 0.5 – 3.0%. Also, Almazan *et al.,* (1987) reported that, the less fibrous a garri sample is, the better its quality thus, all samples are of good quality because of their low fibre content throughout the storage duration.

Table 6: Effect of Moisture variation on the percentage ash of garri samples during storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	1.22 ±0.01^{f}	1.25 ±0.01^{e}	1.29 ±0.01^{d}	1.41 ±0.01^{c}	1.48 ±0.01^{b}	1.56 ±0.01^{a}	**0.02**
2	1.25 ±0.01^{f}	1.28 ±0.01^{e}	1.31 ±0.00^{d}	1.42 ±0.01^{c}	1.52 ±0.01^{b}	1.58 ±0.01^{a}	**0.02**
4	1.27 ±0.01^{e}	1.29 ±0.01^{e}	1.35 ±0.01^{d}	1.46 ±0.01^{c}	1.53 ±0.01^{b}	1.62 ±0.01^{a}	**0.02**
6	1.29 ±0.00^{f}	1.32 ±0.01^{e}	1.36 ±0.02^{d}	1.49 ±0.01^{c}	1.59 ±0.02^{b}	1.65 ±0.01^{a}	**0.02**
8	1.32 ±0.01^{d}	1.31 ±0.01^{d}	1.33 ±0.02^{d}	1.48 ±0.01^{c}	1.61 ±0.01^{b}	1.65 ±0.01^{a}	**0.02**
10	1.31 ±0.01^{d}	1.28 ±0.01^{e}	1.29 ±0.01^{de}	1.43 ±0.01^{c}	1.56 ±0.01^{b}	1.59 ±0.01^{a}	**0.02**
LSD	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

While variations in moisture had no significant effect on the percentage ash content of the samples, storage time showed significant differences on the ash content between the samples as seen from the mean values on the rows of table 6. Also, the ash levels of the garri samples studied, increased with fortification. The CG samples had its cumulative ash content in a range of 1.22 ± 0.01 – 1.36 ± 0.02%, while the malted soy-garri samples had 1.41 ± 0.01 – 1.65 ± 0.01% respectively. This is similar to the findings of Edem *et al.,* (2001), who increased the ash content of garri to 5.17% and 5.58% by fortifying it with 10% and 15% soy meal respectively. This is also true of some food products other than garri. Study by Iwe and Onadipe (2002) increased the ash content of sweet potato from 2.2% to 2.5% and to 4% by supplementing it with soy meal up to 25% level.

Table 7: Effect of moisture variations on the percentage carbohydrate of garri samples during storage.

Time (Week)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	85.43 ± 0.01^{a}	83.26 ± 0.01^{b}	81.10 ± 0.01^{c}	72.83 ± 0.01^{d}	70.59 ± 0.00^{e}	68.71 ± 0.01^{f}	**0.25**
2	85.33 ± 0.01^{a}	83.13 ± 0.00^{b}	80.63 ± 0.01^{c}	72.55 ± 0.01^{d}	70.33 ± 0.01^{e}	68.39 ± 0.00^{f}	**0.25**
4	85.65 ± 0.00^{a}	83.51 ± 0.00^{b}	81.64 ± 0.00^{c}	72.81 ± 0.73^{d}	71.05 ± 0.03^{e}	69.00 ± 0.01^{f}	**0.25**
6	85.79 ± 0.02^{a}	83.77 ± 0.01^{b}	81.98 ± 0.00^{c}	73.71 ± 0.02^{d}	71.35 ± 0.00^{e}	69.35 ± 0.03^{f}	**0.25**
8	85.96 ± 0.01^{a}	84.06 ± 0.01^{b}	82.48 ± 0.01^{c}	74.57 ± 0.04^{d}	71.80 ± 0.00^{e}	70.00 ± 0.01^{f}	**0.25**
10	86.37 ± 0.01^{a}	85.01 ± 0.00^{b}	83.36 ± 0.00^{c}	76.63 ± 0.02^{d}	74.55 ± 0.01^{e}	72.58 ± 0.01^{f}	**0.25**
LSD	**2.76**	**2.76**	**2.76**	**2.76**	**2.76**	**2.76**	

The values are means of duplicate determination ± standard deviation. Means with the same superscript letters in the rows are not significantly different *($p < 0.05$)*.

Moisture variation had no significant effect on the percentage carbohydrate within each sample throughout the ten (10) weeks of storage. However, there was a significant difference in the carbohydrate content between the samples throughout the storage duration as seen in the mean values on the rows of table 7.

The garri samples maintained a significantly high carbohydrate level throughout the storage period of ten (10) weeks. It was also observed that fortification reduced the carbohydrate content of SG samples significantly. Generally, there was an increase in the carbohydrate content of all samples due to the decrease of other proximate parameters that may have been as a result of microbial/enzymatic activities. This result indicates that storage time does affect the percentage carbohydrate content of both unfortified and the malted soy-garri.

4. CONCLUSION

This study provides information on the effect of moisture variation on the chemical composition of malted soy-garri and unfortified garri during storage. Results revealed that for the entire duration of storage, moisture variation had a negligible effect on the chemical parameters studied. This study further revealed that garri samples studied maintained a high percentage of nutrients which minimally decreased over the duration of storage. Conclusively, malted soy-garri showed a very good stability in its chemical composition when compared to the control (unfortified garri) throughout the storage period.

REFERENCES

1. Adeniji, M. O. (1976). Fungi associated with the deterioration of Garri. *Niger. J. plant. Prot.* 2: 74 – 77.
2. Ahaotu, N.N., Anyogu, A., Obioha, P., Aririatu, L, Ibekwe, V. I., Oranusi, S., Sutherland, J. P and Ouoba, L. I. I. (2017). Influence of soy fortification on microbial diversity during cassava fermentation and subsequent physicochemical characteristics of *garri. Food Microbiology 66: 165- 172.* **DOI:** 10.1016/j.fm.2017.04.019
3. Akingbala, J. O., Oyewole, O. B., Uzo-Peters, P. I., Karim, R. O. and Baccus-Taylor, G. S. H. (2005). Evaluating stored cassava quality in gari production. *Journal of Food, Agric. and Environment*. Vol. 3 (1): 75-80. **DOI:** https://doi.org/10.1234/4.2005.522
4. Almazan, A. M; Hahn, S. k., Mahanga, N. M. and Yamachi, Y. (1987). Production of Cyanide during processing of Cassava into some Traditional African Food. *Journal of Science Food Agric.* 11 – 15.
5. Amadi, J. E., and Adebola, M. O. (2008). Effect of Moisture Content and Storage Conditions on the Storability of Garri. *African Journal of Biotechnology*. 7(24): 4591 – 4594. **DOI:** 10.5897/AJB08.839
6. AOAC International. (2000). Official Methods of Analysis. 17th Edn. Gaithersburg, MD, Method 985.14.
7. Banjo, N. O. and Ikenebomeh, M. J. (1996) Comparison of methods for the Preparation of Soy "garri" from Cassava and Soybean mash. *J. Food Sci. & Tech.* **33(4):** 440 – 442.
8. Chang, S. K. C. (2003). Protein Analysis. In: Food Analysis, Nielsen, S. S. (Ed). Kluwer Academic Plenum Publisher, New York.
9. Chuzel, G. and Zakhia, N. (1991). Adsorption Isotherms of garri for estimation of packaged shelf-life. *Intl. J. of Food Science and Technology*. 26: 583 – 593. **DOI: https://doi.org/10.1111/j.1365-2621.1991.tb02004.x**
10. Edem, D. O., Ayatse, J. O. I. and Itam, E. H. (2001). Effect of Soy Protein Enrichment on the Nutritive value of Garri (farina) from *Manihot esculenta.* Food Chemistry. 75: 57 – 62. **DOI:** 10.1016/S0308-8146(01)00183-2
11. Iwe, M. O. and Onadipe, O. O. (2002). Proximate, Physical and Sensory Properties of Soy-Sweet potato flour Cookie. *Global J. Pure and Applied Sciences*. 8(2): 187 – 192. **DOI:** 10.4314/gjpas.v8i2.16030
12. James, C. S. (1995). The Analytical Chemistry of Foods. Chapman and Hall Press, New York. Pp. 86.
13. Neil, N. (2006). Cassava Processing. Practical Action Publishing. **URL:** https://core.ac.uk/download/pdf/48027481.pdf
14. Obatolu, V. A. and Osho, S. M. (1992). Nutritional Evaluation of Staple food in Lagos State (New project). In Second year Technical Report. April 1, 1991 – April 30, 1992. IDRC/IITA Soybean Utilisation Project Phase. Osho, S. M and Dashiel, K. E. (eds) IITA, Ibadan Nigeria. Pp. 194 – 207.
15. Oduro, W. O., Ellis, N. T., and Nimako, T. K. (2000). 'Quality of Garri from selected Procession Zones in Ghana Food Control'. *Food Control J*. 11 (4): 297 – 303. **URL:** http://hdl.handle.net/123456789/10830

16. Ogiehor, I. S. and Ikenebomeh, M. J. (2005). Extension of Shelf life of Garri by hygienic handling and Sodium Benzoate treatment. *Afr. J. Biotechnol.* **4(7):** 744 - 748. **DOI:** 10.5897/AJB2005.000-3135
17. Onwuka, G. I. (2005). 'Food Analysis and Instrumentation: Theory and Practice'. 1st Edn. Napthali Print, Lagos. pp. 1 – 219.
18. Osho, S. M. (1991). "Soya Processing and Utilization Research: Why Rapid Rural Appraisal", Soyabean Utilization in Nigeria and Ghana, IDRC/IITA Soyabean Utilization Project Phase 11, 1st Year Technical Report.
19. Pearson, D. (1976). Chemical Analysis of Foods. 7th Edn. Church Hill Livingstone, London, Uk. Pp.72 – 73, 138 – 143.
20. Sanni, L. & Maziya-Dixon, Busie & Akanya, J. & Okoro, C. & Alaya, Yosri & Egwuonwu, C. & Okechukwu, R. & Ezedinma, Chuma & Akoroda, M. & Lemchi, L. & Ogbe, F. & Okoro, E. & Tarawali, G. & Mkumbira, J. & Ospina-Patino, Marco & Ssemakula, Gorrettie & Dixon, A.. (2005). Standards for Cassava Products and Guidelines for Export. **URL:** http://biblio1.iita.org/handle/20.500.12478/3177?show=full
21. Udoh, E. J. and Ogunawale, A. J. (1986). Laboratory Manual for the Analysis of Soil, Plant and Water Samples. University Press, Ibadan, Nigeria. Pp. 66 – 70.
22. Ukpabi, U. J. and Ndimele, C. (1990). Evaluation of the quality of Garri Produced in Imo State. *Nig. Food Jn.* Volume 8, 1990. Pp. 105 – 110.