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Studies on the Functional Properties of Malted Soy-*garri* as affected by Moisture Variation during Storage

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Abstract

The study evaluated the effect of moisture variation on the functional properties of malted soy-garri through ten (10) weeks storage period. Malted soy-garri made from co-fermentation of TME 419 cassava mash variety and malted soy-flour having varying moisture levels (8%, 10% and 12%) were packed in ziplock polyethylene bags and stored at ambient temperature for ten weeks. Samples were drawn fortnightly and analysed for functional properties through the storage period. Results showed that moisture variation had an insignificant ($p<0.05$) effect on the water absorption capacity, swelling index, wettability and bulk density while the storage time showed significant differences between the samples studied. Generally, the malted soy-garri samples compared favourably with the unfortified garri samples on all parameters studied.

Keywords: Malted Soy-garri, Moisture variation, Malted Soy flour, Co-fermentation, Storage.

1. INTRODUCTION

Garri is a gelatinized, granular dry coarse product obtained from the *garrification* (continuous turning of fermented, dewatered, sifted cassava mash on a large heated iron pan). *Garri* is a by-product of Cassava (*Manihot esculenta* Crantz*)* which is a major food crop that yield high calories to millions of people living in the tropics (Oyewole and Odunfa, 1989).This gritty, starchy staple derived from cassava has high energy and fibre content but very low protein content of 0.7 to 1.2% according to Obatolu and Osho (1992). It also contains other nutrients although in marginally nutritional significance (Ikegwu *et al.*, 2009).

Garri is by far the most popular form in which cassava is sold and consumed in Nigeria and in many other African countries (Ikediobi *et al.,* 1980; Oluwole *et al.,* 2008). This important by-product of cassava serves as a staple and an important item in the menu of most Nigerians as it is conveniently stored and marketed in ready-to-eat form. It could be consumed in different forms; as a snack when mixed with cold water, sugar, salt or groundnut as desired. It could also be prepared by sprinkling into hot water (80 – 100^{0}C) to form dough (eba) and be eaten with choice soup as a complete meal (Nweke *et al.,* 2002; Adindu and Aprioku, 2006).

The low protein content of *garri* has led to the fortification of cassava mash with malted soy flour to help improve the protein content of the diet, thereby improving the nutrient content of *garri* (Ahaotu *et al.,* 2017). *Garri* being a major staple food consumed in Nigeria, improving its protein content by incorporation of malted soy flour will go a long way to increase the protein intake of Nigeria thus improving their nutritional status. According to Ahaotu *et al.*, (2017), incorporation of malted soy flour in cassava mash during malted *soy-garri* production insignificantly affected the general acceptability of malted *soy-garri*, it improved the proximate composition and reduced the cyanogenic glycosides.

Moisture content of *garri* is a major challenge to *garri* storage because of the peculiar features of the tropics (high humidity and temperature) which makes *garri* to lose its desirable qualities. Moisture content of *garri* is the bane of its shelf stability, hence it is therefore pertinent to study the influence of moisture variations on the shelf stability of malted *soy-garri*.

2. MATERIALS AND METHODS

2.1 Raw Material Procurement

Fifty (50) kg cassava roots of TME 419 variety utilized, was sourced 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 using 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 Determination of Functional Properties

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

2.4.1 Water Absorption Capacity

The water absorption capacity was determined by the method described by Abbey and Ibeh (1988).

Each sample (1g db.) was weighed separately and placed into clean centrifuge tubes of known weights. Distilled water was mixed with the flour to make – up to 10 ml dispersion. The tubes were then centrifuged at 3500 rpm for 15 minutes. The supernatant was decanted and each tube together with its content was reweighed. The grain in mass is the water absorption capacity of the garri samples.

$$\text{WAC} = \frac{\text{Initial volume} - \text{Final Volume}}{\text{Weight of sample}}$$

2.4.2 Swelling Index

The swelling index was determined according to the method described by Ukpabi and Ndimele (1990).

Three (3) gram weight of the garri were transferred into clean dry graduated (50 ml) cylinder. The garri samples were gently filled and the volume noted. Distilled water (30 ml) was added to each sample. The swirled cylinder was allowed to stand for 60 minutes, while the change in volume recorded every 15 minutes.

The swelling index of each garri sample was calculated as multiple of the original volume as done by Ukpabi and Ndimele (1990).

2.4.3 Wettability

The method of Armstrong *et al.,* (1979) was adapted. Wettability was estimated by measuring the wetting time (sec.) of 1 g of garri sample dropped from a height of 15 cm on the surface of 200 cm^3 distilled water contained in 250 cm^3 beaker at ambient temperature (30 ± 1 ^{o}C). The wetting time was regarded as the time required for all the flour to become wetted and penetrate the surface of still water.

2.4.4 Bulk Density

The method described by (Onwuka, 2005) was adopted. A graduated cylinder (10 ml) was weighed dry and gently filled with the garri sample. The bottom of the cylinder was then tapped gently on a laboratory bench several times. This continues until no further diminution of the test garri in the cylinder after filling to mark was observed.

Weight of the cylinder plus garri was weighed and recorded.

$$\text{Bulk Density (g/ml)} = \frac{\text{Weight of Sample (g)}}{\text{Volume of Sample (ml)}}$$

2.5 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: Percentage swelling index 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	1.18 ± 0.01^{c}	1.21 ± 0.01^{b}	1.25 ± 0.01^{a}	1.08 ± 0.01^{e}	1.13 ± 0.01^{d}	1.18 ± 0.01^{c}	**0.01**
2	1.18 ± 0.00^{c}	1.22 ± 0.01^{b}	1.25 ± 0.01^{a}	1.09 ± 0.01^{e}	1.15 ± 0.01^{d}	1.19 ± 0.00^{c}	**0.01**
4	1.17 ± 0.01^{c}	1.21 ± 0.01^{b}	1.23 ± 0.01^{a}	1.05 ± 0.01^{e}	1.13 ± 0.01^{d}	1.17 ± 0.00^{c}	**0.01**
6	1.22 ± 0.01^{c}	1.24 ± 0.01^{b}	1.27 ± 0.01^{a}	1.09 ± 0.00^{e}	1.18 ± 0.00^{d}	1.21 ± 0.01^{c}	**0.01**
8	1.22 ± 0.01^{c}	1.24 ± 0.00^{b}	1.28 ± 0.01^{a}	1.11 ± 0.01^{e}	1.19 ± 0.01^{d}	1.22 ± 0.01^{c}	**0.01**
10	1.25 ± 0.01^{b}	1.26 ± 0.01^{b}	1.31 ± 0.01^{a}	1.13 ± 0.01^{d}	1.21 ± 0.01^{c}	1.25 ± 0.01^{b}	**0.01**
LSD	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	**0.23**	

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

According to Ayerno (1979), swelling index is a function of the starch content and it is dependent on the weak internal bonding of amylose and amylopectin content of the starch. The CG samples had a higher swelling capacity compared to the SG sample. This may be due to the higher percentage of carbohydrates in them. Moisture variation made no significant difference but storage time showed significant differences in the swelling capacities of the samples studied. It was reported that a good quality *garri* should have a swelling capacity of 3.0 – 5.0 volume increase (Ingram, 1975; Almazan *et al.,* 1987). Although the mean values were significantly low, there was a significant increase in the swelling index of the samples as the storage time increased. The low swelling capacity of the SG samples maybe due to the fortification and the method of processing employed. Also, this result may potentially not have negated the general acceptability and diverse utilization of *garri* for consumption.

Table 2: Water absorption capacity (g/g) 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	3.61 ± 0.01^a	3.54 ± 0.00^b	3.21 ± 0.01^c	3.02 ± 0.01^d	2.97 ± 0.01^e	2.91 ± 0.01^f	**0.01**
2	3.60 ± 0.00^a	3.55 ± 0.01^b	3.21 ± 0.00^c	3.01 ± 0.00^d	2.97 ± 0.00^e	2.90 ± 0.00^f	**0.01**
4	3.62 ± 0.01^a	3.56 ± 0.00^b	3.24 ± 0.00^c	3.03 ± 0.01^d	2.99 ± 0.00^e	2.92 ± 0.00^f	**0.01**
6	3.65 ± 0.00^a	3.58 ± 0.01^b	3.31 ± 0.01^c	3.08 ± 0.00^d	2.98 ± 0.01^e	2.95 ± 0.01^f	**0.01**
8	3.68 ± 0.00^a	3.59 ± 0.01^b	3.33 ± 0.01^c	3.11 ± 0.01^d	2.98 ± 0.01^e	2.97 ± 0.01^f	**0.01**
10	3.70 ± 0.00^a	3.61 ± 0.01^b	3.37 ± 0.01^c	3.18 ± 0.01^d	3.11 ± 0.01^e	3.03 ± 0.01^f	**0.01**
LSD	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	

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

Table 2 presents the results of the effect of storage time on water absorption capacity of malted soy-*garri* at different moisture levels. The water absorption capacity between the samples during storage were significantly different *($p<0.05$)* as represented by the means (on the rows of table 2) determined per week of analysis but moisture variation made no significant difference on each sample throughout the storage duration. A well dried *garri* should be able to absorb water adequately when soaked in water. The results obtained are similar to those reported by Ukpabi and Ndimele (1990). The CG1 sample had highest water absorption capacity, followed by CG2 and finally CG3. Although the CG samples were found to absorb more water than the fortified SG samples, this result indicates that moisture variations and fortification with malted soy flour significantly led to the difference and decrease in the water absorption capacity of the samples.

Table 3: Wettability (sec) of malted soy-*garri* at varying moisture contents as affected by storage time

Time (Wk)	CG1 (8%)	CG2 (10%)	CG3 (12%)	SG1 (8%)	SG2 (10%)	SG3 (12%)	LSD
0	30.09 ± 0.02^{d}	27.31 ± 0.01^{e}	25.11 ± 0.01^{f}	116.19 ± 0.01^{a}	112.41 ± 0.01^{b}	110.06 ± 0.01^{c}	**0.04**
2	30.15 ± 0.01^{d}	27.39 ± 0.01^{e}	25.14 ± 0.01^{f}	116.42 ± 0.01^{a}	112.58 ± 0.01^{b}	110.62 ± 0.01^{c}	**0.04**
4	30.93 ± 0.01^{d}	27.66 ± 0.01^{e}	25.82 ± 0.01^{f}	117.09 ± 0.01^{a}	113.13 ± 0.01^{b}	111.11 ± 0.01^{c}	**0.04**
6	31.19 ± 0.01^{d}	28.30 ± 0.01^{e}	25.71 ± 0.01^{f}	116.95 ± 0.01^{a}	113.66 ± 0.01^{b}	111.76 ± 0.03^{c}	**0.04**
8	32.45 ± 0.02^{d}	29.14 ± 0.03^{e}	26.36 ± 0.01^{f}	117.27 ± 0.02^{a}	114.08 ± 0.01^{b}	112.10 ± 0.01^{c}	**0.04**
10	34.71 ± 0.01^{d}	29.92 ± 0.01^{e}	28.05 ± 0.01^{f}	120.17 ± 0.01^{a}	118.53 ± 0.01^{b}	114.14 ± 0.04^{c}	**0.04**
LSD	**13.24**	**13.24**	**13.24**	**13.24**	**13.24**	**13.24**	

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 above, the result shows that moisture variation had no significant effect *($p<0.05$)* on the wettability of the samples while storage duration showed significant differences between the samples. There was a noticeable increase in the wettability of the samples during storage, by increasing from 30.09 ± 0.02 to 34.71 ± 0.01 seconds for CG1; 27.31 ± 0.01 – 29.92 ± 0.01 seconds for CG2; 25.11 ± 0.01 – 28.05 ± 0.01 seconds for CG3; 116.19 ± 0.01 – 120.17 ± 0.01 seconds for SG1; 112.41 ± 0.01 – 118.53 ± 0.01 seconds for SG2 and 110.06 ± 0.01 – 114.14 ± 0.04 seconds for SG3. High wettability mean values indicates that it requires more time for the malted soy-*garri* samples to sink in water and will float for more time on the surface of the cold water than the control sample. This may have been due to fortification of cassava mash with protein rich malted soy flour resulting to longer wetting time for the *garri* giving rise to higher wettability values. Comparing this result with previous reports, it was found that the wettability values ranging from 120 – 150 (seconds) for soy-melon enriched *garri* were higher than those of 27 – 35 (seconds) reported for unenriched *D. alata* yam flour (Cheftel, 1977) and 42.5 (seconds) reported for un-enriched *D. rotundata* yam flour (Fagbemi, 1999). There is an indication that the un-enriched yam flours had similar wettability values with un-fortified *garri* but where denser, will sink faster than soy-melon enriched *garri* granules.

Table 4: Bulk Density (g/ml) 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	0.62 ± 0.00^{c}	0.61 ± 0.01^{c}	0.61 ± 0.01^{c}	0.71 ± 0.00^{a}	0.70 ± 0.00^{a}	0.68 ± 0.01^{b}	**0.01**
2	0.62 ± 0.00^{c}	0.61 ± 0.01^{c}	0.62 ± 0.01^{c}	0.72 ± 0.00^{a}	0.71 ± 0.01^{a}	0.68 ± 0.00^{b}	**0.01**
4	0.61 ± 0.01^{d}	0.61 ± 0.01^{d}	0.61 ± 0.01^{c}	0.71 ± 0.00^{a}	0.72 ± 0.01^{a}	0.69 ± 0.00^{b}	**0.01**
6	0.61 ± 0.01^{b}	0.57 ± 0.00^{d}	0.59 ± 0.00^{c}	0.69 ± 0.01^{a}	0.68 ± 0.00^{a}	0.69 ± 0.00^{a}	**0.01**
8	0.62 ± 0.01^{b}	0.58 ± 0.01^{c}	0.59 ± 0.00^{c}	0.68 ± 0.01^{a}	0.68 ± 0.01^{a}	0.69 ± 0.00^{a}	**0.01**
10	0.61 ± 0.01^{b}	0.57 ± 0.00^{c}	0.57 ± 0.00^{c}	0.67 ± 0.01^{a}	0.67 ± 0.00^{a}	0.68 ± 0.00^{a}	**0.01**
LSD	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	

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 4, moisture variation had no significant effect on the bulk densities of the samples however, fortification and method of processing may have resulted in the higher mean values for the malted soy-*garri*. The values of the bulk density for the malted soy-*garri* samples were higher than 0.67 g/ml reported for cassava garri by Koubala *et al.,* (2014) and were also within the range of 0.568 – 0.908 g/ml for garri in the Eastern States of Nigeria as reported by Ukpabi and Ndimele (1990). According to Arinola *et al.,* (2016), bulk density has an implication in the packaging and transportation of food materials; high bulk density products are known to exhibit better packaging property than those with low bulk density because higher quantity could be packaged in a given volume thus reducing storage space, packaging and transportation cost. Thus, the malted soy-*garri* samples presents better packaging and transportation advantages.

4. CONCLUSION

This study revealed that; malted *soy-garri* has good shelf stability when kept at 8%, 10% and 12% moisture level when compared with the unfortified *garri* samples. Moisture variation made no significant effect on the functional properties of the samples studied. Although there were slight significant increase/reduction in the functional properties studied as the storage time increased, the results are still within the safe and acceptable limits.

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