

## Comparative Study on Quality Attributes of Gari Obtained from Some Processing Centres in South West, Nigeria

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**Abstract:** Gari is one of the most popular fermented food made from cassava and eaten in Nigeria and other parts of West Africa. However, acceptability relies on the conformity with the major quality attributes demanded for in gari. The present study therefore, is aimed at generating data that can produce useful information on the quality attributes of different gari samples produced in South West, Nigeria and to compare the results with standards as stipulated by Gari Regulation (1980). Gari samples obtained from eight major processing centres spread across South-West, Nigeria were analysed for desired chemical, physical and sensory attributes. The gari samples were coded AA, BB, CC, DD, EE, FF, GG and HH representing processing centres 1, 2, 3, 4, 5, 6, 7 and 8, respectively. The moisture content for all samples varied between 10.3 and 12.4% which enhanced water absorption capacities varying from 68.36-72.11%. However, fat contents of between 0.33 and 0.44% were generally low in spite of the addition of palm oil during roasting operation, which indicated that addition of palm oil did not have direct impact on the gari samples. The acidity, calculated as lactic acid indicated 0.03, 0.03, 0.04, 0.03, 0.04, 0.04, 0.03 and 0.03%, respectively were below the recommended maximum value of 1.0%. The swelling index recorded for all the gari samples were generally good since it was three times the original volume. The hydrocyanic acid which varied from 0.008 to 0.011% was low for all the samples when compared with 0.6% stipulated by the Gari Regulation (1980). The particle size distribution varied between the eight samples, suggesting that none of the samples was graded and was found to be acceptable grain size distribution irrespective of what was stipulated. The sensory evaluation ratings showed significant difference in terms of colour, taste, odour and overall acceptability and was due to differences in the processing methods employed for the production of the gari samples.

**Keywords:** Chemical composition, gari, physical properties, sensory evaluation

### INTRODUCTION

Cassava (*Manihot esculenta* crantz) variously designated manio, mandioc, tapioca is a perennial woody shrub of euphorbiaceae family. It is grown principally for its swollen roots and its leaves are also eaten in some parts of Africa. The roots are rich in starch (25 to 30%) but poor in other nutrients like protein, vitamins and minerals (Ayankunbi *et al.*, 1991). Cassava is the fourth most important staple food in the world after rice, wheat and maize (IFAD/FAO, 2000) and an essential part of the diet of more than half a billion people in the tropical region of Africa, Latin America and Asia (Hahn, 1989).

Cassava popularity is due largely to its usage in the production foods like gari, fufu, chips, Lafun, Industrial starch etc. The cassava root spoils quickly after harvesting as evidenced by discolouration and deterioration of the roots and in order to avoid this losses, it must be processed within 24 h after harvesting (Hahn, 1989).

Gari, a fermented gelatinous granular flour is a major source of dietary energy for low-income consumers in many parts of Tropical Africa, including major urban areas (Ihekoronye and Ngoddy, 1985). The occurrence of toxic materials in form of glucosides in cassava makes the raw tuber poisonous and its removed to a large extent during gari processing. The processing method that brings

about the reduction in cyanogenic glucosides includes peeling, grating, fermentation, pressing and frying (Cook and Maduagwu, 1978; Ogunsua, 1980). These processes have vigorous effect on the elimination of the toxins and affect the properties of the final product. Gari is a free flowing particulate product consisting of cassava particles which has been gelatinized and dried (Oni *et al.*, 2010). Gari is probably the most important single traditional food in Nigeria (Oluwole *et al.*, 2004) and development of real significance in cassava processing as been concentrated on its production (Njoku and Banigo, 2006).

Gari is usually consumed by mixing with boiling water to form a stiff paste and eaten with stews, soups as accompaniment. It may also be eaten with fried or roasted fish, coconuts, palm kernel, groundnuts when mixed with cold water, with or without the addition of sugar. Sometimes, gari is eaten dry as snack by children (Arisa *et al.*, 2011). The wide consumption of gari has been attributed to its relatively long shelf life compared to other food products from cassava as well as its ease of preparation for eating (Omueti *et al.*, 1993; Sanni *et al.*, 2005). It has also been reported that gari of acceptable quality can be produced from dried cassava chips (Ekwu and Ehirim, 2008) and when properly stored, it has a shelf life of 6 months or more (Sanni *et al.*, 2008).

To many consumers of gari, acceptability relies on the conformity with the major quality attributes demanded for in gari. However, due to the breakdown of the hydrocyanic acid, the gari is imparted with ketone and aldehyde flavor. The breaking down of the toxins is responsible for the gari flavor as well as sourness which is also desirable due to the formation of ethanol during fermentation.

South West is one of the major gari producing and consuming areas of Nigeria, with more than 95% of the gari still being produced by unhygienic village methods on a small scale, thereby, giving rooms for the quality of the gari to be constantly reviewed. The present study aims at generating data that can produce useful information on the quality attributes of different gari samples produced in South West, Nigeria and to compare the result with standard as stipulated by Gari regulation (1980).

## MATERIALS AND METHODS

**Collection of samples:** Gari samples were collected from 8 different processing centers spread across South West, Nigeria. They were collected in cellophane bags, neatly sealed to prevent absorption of moisture before analysis. The research work was conducted for a period of 8 months (January-August 2011) in the laboratories of the department of Food Technology and Science Laboratory Technology of The Federal Polytechnic, Ilaro, Ogun State, Nigeria.

**Chemical analysis of gari samples:** The gari samples obtained from each of the processing centers was analysed for moisture content, ash, crude fibre, total titrable acidity, pH and Hydrocyanic content using standard methods. The moisture content was determined on a 5 g sample of gari using hot air oven method at 105°C. Ash content was determined by the method described by AOAC (1990). Five grams of each sample were measured into the crucible, placed in the muffle furnace and maintained at 600°C for 6 h. Fat content was by soxhlet extraction method on a 5 g sample. Crude fibre content of the gari sample from each processing centre was determined using method described by Pearson. Total Titrable Acidity (TTA) was determined using AOAC (1990) method on a 10 g sample and Total titrable acidity was calculated as lactic acid. pH was determined on a 5 g sample of gari dispersed into 50 mL of distilled water for 10 min. The pH of the clear filtrate was measured using digital pH meter (model pHs-25 pit m) after necessary calibrations with buffer solutions of 4.0 and 7.0. The hydrocyanic acid was determined using method described by Nwabueze and Anoruoh (2009). (5.0 g) of each gari sample was prepared into a paste and dissolved in 50 mL distilled water in a corked conical flask. It was allowed to stay overnight. The solution was later transferred into a conical flask. About 4.0 mL of alkaline picrate solution was added and incubated in a water bath for 5 min. Colour development (reddish brown) and absorbance was taken at 490 nm (6405 UV/VIS Spectrophotometer, Jenway, UK, England). A blank preparation using 1ml distilled water was made. The cyanide content was extrapolated using cyanide standard curve and reported as mean of triplicate determinations.

### Methods of physical properties determination:

**Grain Size Determination (GSD):** Three hundred grams of each gari samples were placed in the uppermost sieve of a gyroshaker (Endocotts Model BS410/196 Test Sieve Shaker, London, England). The shaker was fitted with four sieves, with mesh sizes 2.00 and 1.00 mm, 600 and 300 µm respectively. The sieving was done for 30 min. Gari samples retained on each mesh were weighed and calculated as percentage retention.

**Swelling index:** The swelling index were measured using the method of Ukpabi and Ndimele (1990). Fifty grams of each gari samples were put into a 500 mL measuring cylinders. Three hundred mL of cold water were added and allowed to stand for 4 h before observing the level of swelling. The swelling index were then calculated as the multiple of the original volume.

**Relative Bulk Density (RBD):** The relative bulk densities of the gari samples were determined by taking 5.0 g of

Table 1: Selected chemical properties of gari samples

Sample code	M.C (%)	Ash (%)	Fat (%)	Crude fibre (%)	HCN (%)	TTA (%)	pH
AA	11.7	0.78	0.37	0.48	0.008	0.03	4.5
BB	12.4	0.71	0.33	0.56	0.010	0.03	4.5
CC	10.7	0.70	0.43	0.66	0.011	0.04	4.3
DD	11.0	0.74	0.36	0.58	0.008	0.03	4.5
EE	10.3	0.71	0.44	0.56	0.010	0.04	4.3
FF	11.5	0.76	0.35	0.49	0.009	0.04	4.3
GG	11.0	0.72	0.36	0.62	0.007	0.03	4.4
HH	11.0	0.69	0.36	0.55	0.009	0.03	4.5

Values are not significantly different ( $p < 0.05$ ) from each other; AA: represent centre 1; FF: represent centre 6; BB represent centre 2; GG: represent centre 7; CC: represent centre 3; HH: represent centre 8; DD: represent centre 4; EE: represent centre 5

Table 2: Selected physical properties of gari samples

Sample code	Aggregate size (%)				Swelling index	Relative bulk density (g/mL)	Water absorption capacity (%)
	2.00 mm	1.00 mm	600 $\mu$ m	300 $\mu$ m			
AA	18.06 <sup>a</sup>	55.32 <sup>c</sup>	25.54 <sup>a</sup>	1.08 <sup>a</sup>	3.51 <sup>a</sup>	0.842 <sup>a</sup>	72.11 <sup>a</sup>
BB	15.78 <sup>b</sup>	57.12 <sup>b</sup>	26.01 <sup>a</sup>	1.04 <sup>a</sup>	3.23 <sup>a</sup>	0.821 <sup>a</sup>	68.82 <sup>b</sup>
CC	17.99 <sup>a</sup>	55.34 <sup>c</sup>	25.52 <sup>a</sup>	1.15 <sup>a</sup>	3.31 <sup>a</sup>	0.832 <sup>a</sup>	70.15 <sup>a</sup>
DD	16.06 <sup>b</sup>	58.10 <sup>a</sup>	25.35 <sup>a</sup>	0.50 <sup>c</sup>	3.21 <sup>a</sup>	0.839 <sup>a</sup>	70.02 <sup>a</sup>
EE	15.30 <sup>c</sup>	58.98 <sup>a</sup>	25.09 <sup>a</sup>	0.63 <sup>b</sup>	3.43 <sup>a</sup>	0.823 <sup>a</sup>	68.36 <sup>b</sup>
FF	16.78 <sup>b</sup>	56.26 <sup>b</sup>	25.11 <sup>a</sup>	0.52 <sup>c</sup>	3.16 <sup>a</sup>	0.836 <sup>a</sup>	70.97 <sup>a</sup>
GG	17.75 <sup>a</sup>	55.77 <sup>c</sup>	25.95 <sup>a</sup>	0.53 <sup>c</sup>	3.22 <sup>a</sup>	0.830 <sup>a</sup>	70.06 <sup>a</sup>
HH	14.97 <sup>c</sup>	59.28 <sup>a</sup>	24.93 <sup>a</sup>	0.83 <sup>a</sup>	3.24 <sup>a</sup>	0.827 <sup>a</sup>	71.02 <sup>a</sup>

Values in column with same superscript are not significantly different at  $\leq 0.05$ ; AA: represent centre 1; FF: represent centre 6; BB: represent centre 2; GG: represent centre 7; CC: represent centre 3; HH: represent centre 8; DD: represent centre 4; EE: represent centre 5

Table 3: Sensory evaluation rating of gari samples

Sample code	Sensory evaluation of gari sample			
	Colour	Taste	Odour	Overall acceptability
AA	5.43 <sup>de</sup> ±1.83	4.57 <sup>e</sup> ±1.75	5.17 <sup>e</sup> ±1.58	5.40 <sup>cd</sup> ±1.48
BB	6.50 <sup>bc</sup> ±1.87	5.83 <sup>cd</sup> ±1.02	5.67 <sup>bc</sup> ±1.48	5.93 <sup>bc</sup> ±1.28
CC	4.90 <sup>e</sup> ±1.48	5.03 <sup>de</sup> ±1.58	4.83 <sup>e</sup> ±1.53	4.80 <sup>d</sup> ±1.84
DD	6.45 <sup>bc</sup> ±1.24	6.37 <sup>bc</sup> ±1.81	6.27 <sup>b</sup> ±1.88	6.23 <sup>b</sup> ±1.44
EE	5.37 <sup>de</sup> ±1.85	5.08 <sup>de</sup> ±1.88	5.17 <sup>e</sup> ±1.78	5.07 <sup>d</sup> ±1.98
FF	7.13 <sup>b</sup> ±1.45	7.13 <sup>b</sup> ±1.38	7.18 <sup>a</sup> ±1.58	7.38 <sup>a</sup> ±1.56
GG	6.00 <sup>cd</sup> ±1.88	5.72 <sup>cd</sup> ±1.64	5.50 <sup>bc</sup> ±1.74	5.92 <sup>bc</sup> ±1.74
HH	8.00 <sup>a</sup> ±0.98	7.93 <sup>a</sup> ±1.74	7.70 <sup>a</sup> ±1.33	8.10 <sup>a</sup> ±0.93

Values represent means of triplicate. Values in column with the same superscript are not significantly different at  $p \leq 0.05$ ; AA: represent centre 1; EE: represent centre 5; BB: represent centre 2; FF: represent centre 6; CC: represent centre 3; GG: represent centre 7; DD: represent centre 4; HH: represent centre 8

each sample and measuring equivalent weight of 5 mL of water. Relative bulk densities were then calculated as mass of gari over the volume using a 5 mL plastic container as described by Ukpabi and Ndimele (1990).

**Water Absorption Capacity (WAC):** The water absorption capacities were determined using the method of Beuchat (1977). (1.0 g) of each gari sample was mixed with 10 mL of water for 30 sec in a mixer. The samples were then allowed to stand at room temperature for 30 min, then centrifuged at 3,500 rpm for 30 min. The volumes of the supernatant were noted in a 10 mL measuring cylinder. The mass of water absorbed were calculated and expressed as percentages.

**Method of sensory evaluation:** Sensory evaluation was carried out in the gari samples using a 30 member semi trained taste panel, where evaluation was done based on ratings on the basis of colour, taste, odour and overall acceptability. The ratings of samples was done using a 9-

point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike, respectively).

Statistical analysis of data generated was performed by subjecting the data to analysis of variance (ANOVA) to calculate significant difference in treatment means and Duncan was used to separate the means.

## RESULTS AND DISCUSSION

### Results:

**Chemical properties of gari samples:** Table 1 presents the results of chemical properties of gari samples obtained from eight processing centres spread across South West, Nigeria. The moisture contents for all the gari samples varied between 10.3 and 12.4%. The gari sample from BB (processing centre 2) had the highest moisture content of 12.4% while gari samples from EE (processing centre 5)

had the lowest moisture content of 10.3%. The ash contents for the gari samples ranged 0.69 to 0.78%. Gari sample from HH (processing centre 8) had the lowest ash value while sample AA (processing centre 1) had the highest ash content. The fat contents for all the gari samples varied between 0.33 and 0.44%. Crude fibre contents of 0.48, 0.56, 0.66, 0.58, 0.56, 0.49, 0.62 and 0.55%, respectively were obtained for all the eight samples investigated. Gari sample CC (processing centre 3) had the highest cyanide content of 0.011% while sample GG (processing centre 7) had the lowest cyanide content of 0.007%. Total titrable acidity, calculated as lactic acid ranged from 0.03 to 0.04 for all the samples while the pH values ranged from 4.3 to 4.5.

**Physical properties of gari samples:** The results of physical properties of gari samples are shown in Table 2. On mesh size 2.00 mm, the percentage retention varied between 14.97 and 18.06%, i.e., 14.97% of gari from processing centre 8 (HH) was retained on mesh size 2.00 mm while 18.06% of gari from processing centre 1(AA) was retained on mesh size 2.00 mm. Also, on mesh size 1.00 mm, the percentage retention was between 55.32 and 59.28%. Mesh sizes 600 and 300  $\mu\text{m}$  have percentage retention varying from 25.09 to 26.01% and 0.50 to 1.08% respectively. Mesh size 1.00 mm had the highest percentage retention for all the eight samples evaluated. The swelling index recorded for all the gari samples are 3.51, 3.23, 3.31, 3.21, 3.43, 3.16, 3.22 and 3.24, respectively. Sample AA (processing centre 1) had the highest swelling index while sample FF (processing centre 6) had the lowest swelling index. The relative bulk density varied between 0.821 to 0.842 g/mL for all the samples. Sample AA (processing centre 1) had the highest bulk density of 0.842 g/mL while samples BB (processing centre 2) had the least bulk density of 0.821 g/mL. The water absorption capacity for all the eight samples varied between 68.36 and 72.11% with samples from AA (processing centre 1) having the highest water absorption capacity and samples from EE (processing centre 5) having least water absorption capacity.

**Sensory evaluation of gari sample:** Table 3 showed the results of sensory evaluation ratings of the gari samples obtained from eight processing centres spread across South West, Nigeria. In terms of colour, sample HH (processing centre 8) was most preferred while sample CC (processing centre 3) was least preferred. For the taste, sample HH (processing centre 8) was also most preferred (highly ranked) while sample AA (processing centre 1) was least preferred (lowly ranked). The odour of the gari samples revealed that sample HH (processing centre 8) was most preferred while sample CC (processing centre 3) was least preferred. The trends in the overall ranking showed that sample HH and FF

(processing centres 8 and 6) were generally acceptable to the consumers in terms of colour, taste, odour and overall acceptability while sample CC (processing centre 3) was the least preferred sample.

## DISCUSSION

There is no significant difference ( $p < 0.05$ ) in the moisture contents of all the gari samples obtained from eight processing centres in South West, Nigeria. The figures are still within a tolerable level. (Geoffrey Campbell-Platt, 1987). Gari regulation (1980) stipulated 12.0% moisture content. This also confirms 12.13% moisture level recommended by Okpugo *et al.* (1979) for locally produced gari. However, it can be deduced from the study that all the gari samples would be able to store for 6 months without mould infection as reported by Ukpabi and Ndimele (1990). For ash content, all the gari samples analysed have low values in contrast 2.8% stipulated by Gari regulation (1980). However, Uzomah *et al.* (2001) had earlier reported a similar result. The fat contents obtained from all gari samples were not significantly different from each other ( $p < 0.05$ ). The fat contents revealed low values. Addition of palm oil during processing of gari in most cases served as additive, thereby enhancing the flavor and colour but does not show any significant increase in the fat content. Ekwu and Ehirim (2008) reported a similar result. The crude fibre contents for all gari samples are low and are within the nutritional maximum level of 3.0% recommended by Ibe (1981). Gari regulation (1980) had recommended not more than 2.0% crude fibre for gari samples. The result obtained is similar to those reported by Ekwu and Ehirim (2008). Almost all the gari samples analysed for cyanide contents have low values compared with 0.6% stipulated by Gari Regulation (1980). The low cyanide contents are probably due to the rigorous processing methods of gari production such as peeling, grating, fermenting, dewatering/pressing and frying which invariably brings about the reduction in cyanogenic glucosides (Cook and Maduagwu, 1978; Ogunsua, 1980). Hence, the gari samples investigated in this research work falls within the same level. There is no significant difference ( $p < 0.05$ ) in the total titrable acidity (lactic acid). Gari Regulation (1980) stipulated 1.0% total acidity in gari samples. However, the results obtained are similar to those reported by National Root Crops Research Institute (NRCRI, 1983). All the gari samples investigated revealed a slightly acidic nature and this might be due to the fermentation period which may not have been extended for more than two days before frying. Uzomah *et al.* (2001) and Sanni *et al.* (2008) reported a similar result. There is significant difference in particle size distribution of all gari samples evaluated ( $p \leq 0.05$ ). The variation in particle size distribution might be due to the grating

procedure, i.e., garification process and the extent of fermentation of the mash (Oduro *et al.*, 2000). However, there is generally acceptable grain size distribution irrespective of what was stipulated. All the gari samples evaluated are not significantly different from each other in terms of swelling index. A good quality gari has been described as that which can swell to at least 3 times its original volume. (Ukpabi and Ndimele, 1990; Sanni *et al.*, 2008). Sanni *et al.* (2005) reported that the swelling index of granules reflect the extent of associative forces within the granules, therefore the higher the swelling index, the lower the associative forces. The samples did not differ in terms of relative bulk density. Plaami (1997) reported that bulk density is influenced by the structure of starch polymers and loose structure of starch polymers result in low bulk density. The lower the bulk density, the higher the floatation of gari samples on top of water and as a result may not soak properly in water which may lead to rejection by consumers (Sanni *et al.*, 2008). Also, the samples differs significantly ( $p \leq 0.05$ ) in water absorption capacity. A well dried gari sample should be able to absorb water adequately when soaked in water. The results obtained are similar to those reported by Ukpabi and Ndimele (1990).

From the statistical analysis carried out, the gari samples differs significantly in terms of colour, taste, odour and overall acceptability. Sample HH from processing centre 8 was highly rated, closely followed by sample FF from processing centre 6 while sample CC from processing centre 3 was least preferred. The significant difference in terms of colour observed in the samples might be due probably to the rate of heating during frying operation. The observed difference in terms of taste might be due to the high level of cyanogenic glucoside in cassava tubers producing a more desirable attribute on hydrolysis which consumers prefers, while differences in the aroma observed might be due to the fact that different processing methods were used during the production of gari, most especially the fermentation period which might differ from one processing centre to the other.

### CONCLUSION

The result of the study showed a positive relationship between the particle size of the grated, dewatered, fermented and sieved cassava roots and moisture content of the roasted gari. Gari samples with large aggregate sizes generally tended to have high moisture content after roasting which may affect storability of the samples while gari with smaller aggregate size displayed lower moisture contents and therefore displayed better storability. The fat contents were generally low even with the addition of palm oil during roasting while other quality parameters such as fibre, ash, total titrable acidity, pH and hydrocyanic acid were found to be within the general acceptable limit.

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