Applied Tropical Agriculture
Volume 21, No.2 (Special Issue), 14-19, 2016.

Chemical, Anti-Nutritional and Sensory Attributes of Melon Enriched Gari

Abiodun, O.A.[1]*, Adepeju, A.B.[2], Odedeji, J.O.[3] and Amanyunose, A.A.[3]

[1]Department of Home Economics and Food Science, University of Ilorin, Kwara State, Nigeria.
[2]Department of Food Science and Technology, Joseph Ayo Babalola University, PMB 5006 Ikeji Arakeji Osun State.
[3]Department of Food Science and Technology, Osun State Polytechnic, Iree, Osun State, Nigeria.
*Corresponding author: Email: funmiabiodun2003@yahoo.com

ABSTRACT

This study was carried out to determine the chemical, anti-nutritional and sensory quality attributes of melon enriched gari. Freshly harvested cassava was peeled, washed and grated into pulp. Cassava pulp and melon flour were mixed together in ratio 90:10 and 80:20 respectively. The fermented mixture was packaged in a sack and fermented for five days. The fermented mixture was dewatered and samples taken each day, pulverized and toasted. Proximate, mineral, anti-nutritional factors and sensory quality attributes of the gari were determined. Protein content ranged from 0.83-8.86 % in the gari with 20% melon. Fat and crude fibre increased with melon substitution. Carbohydrate contents of the control were higher than melon substituted gari. The pH ranged from 5.5 in control day 5 to 6.6 in enriched gari at 20 % level. Higher potassium and sodium were observed in the control gari while the melon substituted gari had higher values in the calcium, magnesium and phosphorus. Oxalate, tannin and hydrogen cyanide contents ranged from 0.27-1.35 mg/g, 0.24-0.69 mg/g and 0.05-0.18 mg/g respectively in the gari. Sensory evaluation conducted showed no significant differences ($p<0.05$) in the texture of the control gari from day one to five but there were significant differences ($p>0.05$) in the texture, aroma and appearance of melon fortified gari. The longer the fermentation of gari fortified with melon, the better it becomes in term of the sensory quality attributes. Enrichment of gari with 10 % melon in day 3 to 5 was more acceptable in terms of texture, appearance and overall acceptability. The protein contents of gari increased with increase in the level of melon flour addition.

Keywords: Cassava, gari, melon, mineral, proximate

INTRODUCTION

Cassava is the chief source of dietary food energy for the majority of the people living in the lowland tropics, and much of the sub-humid tropics of West and Central Africa (Echebiri and Edaba, 2008). The major constraint in the utilization of cassava is the perishability of the roots which results in post-harvest physiological deterioration (Isamah, 2004). According to Nwabueze and Odunsi (2007), cassava plays important role in alleviating African food crisis. Processing of cassava improved palatability, product quality, shelf life and reduce the hydro-cyanide contents of the products (Chijindu and Boateng, 2008). Cassava are processed into chips, pellets, flour, adhesives, alcohol, and starch, which are vital raw materials in the livestock feed, alcohol/ethanol, textile, confectionery, wood, food and soft drinks industries (Knipscheer *et al*., 2007).

Gari is a fermented dry product from cassava. It is a cheap and popular meal consumed by mixing with boiling water to form paste and eaten with soup in many rural areas of Nigeria especially among the low income earners (Makanjuola *et al*., 2012). Arisa *et al*. (2011) reported the use of gari as snack. It could be soaked with cold water and eaten with groundnut, fried fish and coconut with addition of sugar. Gari is a staple food and therefore consists of majorly carbohydrate. The protein content of cassava is low and of poor quality (Oluwamukomi and Jolayemi, 2012), due to this a lot of studies had been conducted to improve the nutritional value of gari using soybean, melon, groundnut and sesame seed flour (Osho, 2003; Oluwamukomi *et al*., 2005; Oluwamukomi and Jolayemi, 2012; Arisa *et al*. 2011; Oluwamukomi, 2015). Melon is a cucurbit crop that belongs to the Cucurbitaceae family with protein content ranging from 33.80-39.96% (Abiodun and Adeleke, 2010).

There is limited work on the enrichment of gari with melon seed flour despite its high protein content. However, Oluwamukomi and Jolayemi (2012) enriched gari with combination of soybean and melon seed flour and improvement in the protein contents were reported. Studying the effect of fermentation on gari enriched with melon seed flour could give an in-depth knowledge of possible reactions and contents of the product. Enrichment of gari with high proteineous crop such as melon could improve the nutritional contents of the product. Therefore, objective of this paper was to determine the chemical, anti-nutritional and sensory attributes of gari enriched with gari.

MATERIALS AND METHODS

Materials

Cassava was obtained in a farm at Ada, Osun State, Nigeria while the melon seeds were purchased at a market at Osogbo, Osun State.

Methods

Modified method of Oluwamukomi and Jolayemi (2012) was used for the gari production. The Cassava tubers were peeled manually with a sharp knife, washed and grated in a locally fabricated mechanical grater. The grated wet mash were then packed into sack and allowed to ferment for 1-5 days after which they were pressed and dewatered with a mechanical press. Melon seeds were sorted, cleaned, dried and milled into flour. The cassava and melon were mixed together in ratio 90:10 and 80:20 % respectively. The enriched cassava pulp was dewatered each day and toasted for a period of 5 days. The gari was processed according to the method in Fig. 1.

Analyses

Proximate, pH, mineral and anti-nutritional contents of the gari was determined using standard methods (AOAC, 1990). Temperature data of the experimental periods (17-21 November 2014) were obtained at Meteorological Agency in Osogbo, Osun State, Nigeria. *Eba*, a reconstituted paste was prepared by reconstituting it with hot water in ratios 1:2.2 (w/v) after which it was mixed thoroughly with spoon to form stiff dough (Oluwamukomi *et al*., 2005). The sensory evaluation was determined using untrained 20 panelists. The panelists were requested to examine the dough and score according to their degree of likeness using a 9-point Hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely) (Larmond, 1977). The parameters evaluated were the texture, aroma, appearance and overall acceptability.

Statistical analysis

The data were subjected to one way Analysis of Variance (ANOVA) and a difference was considered to be significant at $p \leq 0.05$. Means were separated using Tukey's tests through SPSS software (version16.0) (Abiodun and Akinoso, 2014).

RESULTS

The proximate composition of gari enriched with melon is shown in Table 1. Ash contents of gari ranged from 2.20 % in gari enriched 20% melon at day 5 to 2.99% in gari enriched 20% melon at day 3 while moisture contents ranged from 1.07% in day 4 control to 4.89% in day 1 control. Fat contents of gari with 20% melon at day 1 and 2 were not significantly different ($p>0.05$) from each other but significantly different ($p<0.05$) from the control and 10 % melon substitution. Crude fibre contents of 10 % (day 5) and 20 % (day 1 and 2) melon substituted gari were significantly different ($p<0.05$) from other gari samples. Protein contents ranged from 0.83-8.86 % with higher values in 20 % melon fortified gari. Gari with 20 % melon (day 1) was significantly different ($p<0.05$) from control and other samples.
Carbohydrate contents of the controls at day 3 (91.83 %) and day 4 (91.50 %) were significantly different ($p>0.05$) from the melon fortified gari. pH values ranged from 5.5 in control at day 5 to 6.6 in gari enriched with 20 % melon in day 1. pH value decreased slightly from day 1 to 5 in the control and gari enriched with melon. Table 3 showed the mineral composition of melon fortified gari. Highest sodium value (59.48 %) was in gari enriched with 20 % melon at day 2 while the least sodium content (20.20 mg/kg) was observed in day 5 of gari substituted with 20 % melon. Potassium contents of gari ranged from 30.00 to 175.00 mg/kg with highest value in control sample at day 2.

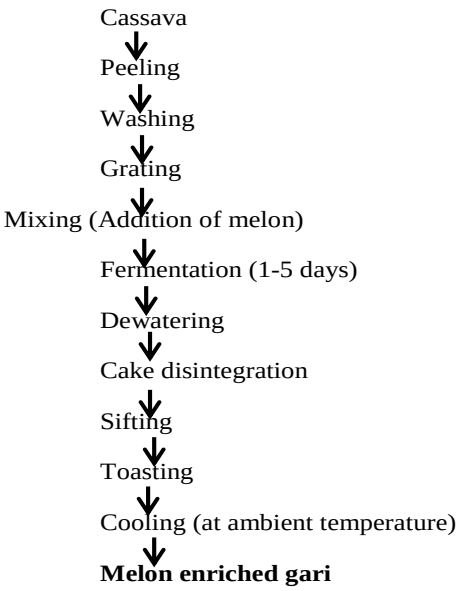

Figure 1: Production of gari enriched with melon flour

Table 1: Proximate composition (%) and pH of gari enriched with melon flour.

Sample	Day	Crude ash	Moisture	Fat	Crude fibre	Crude protein	Carbohydrate	pH
Control	1	2.65±0.03^{c}	4.89±0.07^{a}	0.92±0.04^{f}	2.21±0.02^{g}	0.83±0.02^{g}	88.50±013^{b}	5.9
	2	2.89±0.06^{b}	1.33±0.02^{h}	0.94±0.08^{f}	2.86±0.10^{d}	1.07±0.02^{g}	90.91±0.09^{b}	5.9
	3	2.34±0.12^{e}	1.10±0.06^{i}	0.89±0.02^{f}	2.80±0.10^{d}	1.04±0.04^{g}	91.83±0.23^{a}	5.8
	4	2.34±0.07^{e}	1.07±0.02^{i}	0.90±0.14^{f}	2.46±0.30^{f}	1.73±0.10^{f}	91.50±0.17^{a}	5.6
	5	2.60±0.01^{cd}	2.16±0.03^{f}	0.94±0.10^{f}	2.20±0.05^{g}	1.45±0.02^{f}	90.65±0.09^{b}	5.5
10 % melon	1	2.58±0.07^{d}	2.10±0.09^{f}	8.25±0.11^{e}	2.53±0.03^{e}	3.06±0.06^{e}	81.48±0.28^{c}	6.2
	2	2.50±0.09^{d}	2.30±0.10^{e}	8.93±0.05^{d}	2.67±0.06^{e}	3.51±0.20^{e}	80.09±0.06^{c}	6.0
	3	2.65±0.01^{c}	1.90±0.04^{g}	8.78±0.07^{d}	2.94±0.03^{c}	3.60±0.10^{de}	80.13±0.16^{c}	5.9
	4	2.99±0.05^{a}	2.66±0.07^{c}	8.10±0.16^{e}	2.55±0.12^{e}	4.32±0.07^{d}	79.38±0.08^{c}	5.9
	5	2.35±0.05^{e}	2.80±0.02^{b}	8.62±0.08^{d}	3.68±0.08^{a}	3.87±0.03^{d}	78.68±0.07^{c}	5.8
20 % melon	1	2.85±0.11^{b}	1.10±0.13^{i}	15.67±0.03^{a}	3.78±0.03^{a}	8.86±0.21^{a}	67.74±0.13^{d}	6.6
	2	2.70±0.09^{c}	2.20±0.09^{e}	15.43±0.04^{a}	3.76±0.01^{a}	8.00±0.05^{b}	67.91±0.18^{d}	6.5
	3	2.99±0.16^{a}	2.50±0.01^{d}	14.47±0.04^{b}	3.50±0.01^{b}	7.66±0.06^{c}	68.88±0.06^{d}	6.2
	4	2.85±0.01^{b}	2.23±0.03^{e}	14.54±0.02^{b}	3.60±0.08^{b}	7.82±0.04^{c}	68.96±0.15^{d}	6.0
	5	2.20±0.07^{f}	2.79±0.02^{b}	12.74±0.07^{c}	3.44±0.04^{b}	7.83±0.03^{c}	71.00±0.11^{d}	6.0

Value with the same letter down the column are not significantly ($p<0.05$) different.

Table 2: Temperature data for the experimental periods.

Day	Temperature (°C)	
	Maximum	Minimum
1	32.0	23.7
2	31.5	24.2
3	31.0	23.4
4	32.8	21.0
5	33.0	20.0

Source: Metereological agency, Osogbo, Osun State

Table 3: Mineral composition (mg/kg) of gari enriched with melon flour.

Sample	Day	Sodium	Potassium	Calcium	Magnesium	Phosphorous
Control	1	52.20±0.01^{b}	158.00±0.03^{b}	36.00±0.03^{d}	14.40±0.01^{de}	32.00±0.01^{c}
	2	52.40±0.02^{b}	175.00±0.03^{a}	20.00±0.03^{e}	13.20±0.02^{e}	30.00±0.03^{c}
	3	49.78±0.01^{c}	106.00±0.02^{c}	22.00±0.03^{e}	9.60±0.01^{ef}	24.00±0.02^{cd}
	4	50.08±0.03^{c}	102.00±0.01^{c}	28.00±0.05^{c}	11.60±0.02^{e}	16.00±0.10^{d}
	5	51.56±0.01^{b}	93.00±0.02^{c}	22.10±0.05^{e}	12.00±0.04^{e}	20.28±0.02^{d}
10% melon	1	40.89±0.02^{d}	76.20±0.01^{d}	48.02±0.04^{de}	16.00±0.01^{d}	21.60±0.04^{d}
	2	47.17±0.01^{cd}	75.90±0.01^{d}	42.17±0.05^{c}	18.00±0.02^{d}	24.15±0.05^{cd}
	3	50.40±0.01^{c}	64.80±0.02^{d}	66.00±0.03^{ab}	17.20±0.01^{d}	27.20±0.01^{c}
	4	47.95±0.02^{cd}	62.00±0.01^{d}	61.09±0.04^{b}	24.56±0.01^{c}	28.00±0.03^{c}
	5	49.48±0.01^{c}	51.00±0.04^{e}	54.00±0.02^{b}	25.20±0.02^{c}	22.40±0.03^{d}
20% melon	1	50.47±0.03^{c}	45.00±0.02^{e}	56.18±0.02^{b}	32.10±0.01^{a}	54.00±0.05^{a}
	2	59.48±0.02^{a}	38.96±0.01^{f}	70.10±0.04^{a}	36.00±0.02^{a}	40.10±0.02^{b}
	3	51.88±0.02^{b}	40.70±0.01^{ef}	60.00±0.03^{b}	27.60±0.01^{b}	44.40±0.02^{b}
	4	52.80±0.01^{b}	30.00±0.02^{f}	60.10±0.05^{b}	28.00±0.01^{b}	40.00±0.03^{b}
	5	20.20±0.01^{e}	30.78±0.02^{f}	68.00±0.03^{a}	28.80±0.03^{b}	32.00±0.01^{c}

Value with the same letter down the column are not significantly ($p<0.05$) different.

Anti-nutritional compositions of gari are shown in Table 4. The gari had low oxalate, tannin and hydrogen cyanide. Likewise, gari enriched with melon had higher phytic acid when compared to the control. The values ranged from 1.17 to 3.54 mg/g. Table 5 showed the sensory properties of melon fortified eba (gari dough).

DISCUSSION

There were significant differences ($p<0.05$) in the ash contents of the control and the melon fortified gari. Ash contents of gari fortified with 10% melon at day 4 and 20 % melon at day 3 were higher than other samples.

Table 4: Anti-nutritional composition (mg/g) gari enriched with melon flour.

Sample	Day	Oxalate	Tannin	HCN	Phytic acid
Control	1	0.45±0.10^{e}	0.33±0.14^{c}	0.18±0.13^{a}	1.42±0.16^{d}
	2	0.47±0.21^{e}	0.31±0.12^{c}	0.15±0.20^{b}	1.18±0.17^{d}
	3	0.33±0.13^{g}	0.24±0.10^{cd}	0.09±0.18^{c}	1.17±0.12^{d}
	4	0.54±0.11^{e}	0.29±0.11^{c}	0.08±0.15^{c}	1.99±0.17^{d}
	5	0.62±0.12^{d}	0.33±0.13^{c}	0.07±0.16^{cd}	1.76±0.12^{d}
10 %	1	0.63±0.20^{d}	0.43±0.14^{b}	0.08±0.10^{c}	3.14±0.10^{a}
melon	2	0.36±0.15^{g}	0.39±0.11^{b}	0.10±0.11^{c}	2.61±0.13$_{c}$
	3	0.35±0.21^{g}	0.44±0.10^{b}	0.08±0.10^{c}	2.01±0.17^{c}
	4	0.45±0.19^{f}	0.30±0.18^{c}	0.06±0.11^{d}	2.26±0.12^{c}
	5	0.35±0.15^{g}	0.43±0.19^{b}	0.05±0.16^{d}	2.71±0.17^{b}
20 %	1	1.35±0.11^{a}	0.63±0.20^{a}	0.08±0.12^{c}	3.54±0.12^{a}
melon	2	0.94±0.10^{b}	0.69±0.11^{a}	0.06±0.09^{d}	2.45±0.10^{c}
	3	0.72±0.09^{c}	0.41±0.12^{b}	0.06±0.23^{d}	2.28±0.22^{c}
	4	0.63±0.08^{d}	0.35±0.15^{c}	0.05±0.16^{d}	2.26±0.09^{c}
	5	0.73±0.09^{c}	0.45±0.16^{b}	0.05±0.12^{d}	2.21±0.19^{c}

Value with the same letter down the column are not significantly ($p<0.05$) different

Table 5: Sensory quality characteristics of eba from gari enriched with melon flour.

Sample	Day	Texture	Aroma	Appearance	Overall acceptability
Control	1	4.36^{d}	6.22^{b}	7.93^{a}	7.89^{b}
	2	4.82^{d}	6.94^{a}	7.86^{a}	7.85^{b}
	3	7.67^{a}	6.87^{a}	7.88^{a}	8.16^{a}
	4	7.65^{a}	6.95^{a}	7.73^{b}	8.14^{a}
	5	7.63^{a}	7.01^{a}	7.62^{b}	8.14^{a}
10 %	1	2.30^{f}	5.32^{c}	2.34^{f}	2.33^{f}
melon	2	2.55^{f}	5.12^{d}	3.21^{e}	3.46^{e}
	3	6.79^{b}	5.63^{c}	4.50^{d}	6.17^{c}
	4	6.86^{b}	5.77^{c}	5.17^{c}	6.26^{c}
	5	7.12^{b}	5.73^{c}	5.02^{c}	6.29^{c}
20 %	1	1.90^{i}	4.58^{e}	2.10^{f}	2.10^{f}
melon	2	1.95^{i}	4.34^{e}	2.00^{f}	2.18^{f}
	3	3.23^{e}	4.39^{e}	3.25^{e}	4.65^{d}
	4	5.77^{c}	4.11^{e}	3.67^{e}	5.16^{d}
	5	5.87^{c}	4.14^{e}	3.62^{e}	5.19^{d}

Value with the same letter down the column are not significantly ($p<0.05$) different

Control gari was significantly different ($p<0.05$) from other samples in moisture contents. Moisture contents of control gari and gari enriched with melon were low and within the Codex standard for gari (12 %) (Codex, 2013). Low moisture content is desirable in gari as this reduces the activity of microorganisms in the product. Therefore, low moisture contents of gari signified high stability of the products. Control samples had low fat contents than the melon substituted gari. Fat contents increased with increase in melon substitution. Increase in fat contents may reduce the shelf life of the gari due to its susceptibility to oxidative rancidity (Ihekoronye and Ngoddy, 1985). Addition of 20 % melon increased the crude fibre contents of the fortified gari. Crude fibre contents of gari substituted with 20 % melon flour were higher than the maximum level (3 %) recommended for gari (Ibe, 1981). Values obtained for ash, crude fibre and fat were higher than the values reported for gari by Makanjuola *et al*. (2012). Mokanjuola *et al*. (2012) recorded 0.69-0.78% for ash, 0.33-0.44% for fat and 0.48-0.66 % for crude fibre contents of gari. This may be due to the cassava cultivar and melon seed flour used.

Protein contents increased with melon substitution but these decreased with days of fermentation in 20 % melon substitution. Protein contents of gari enriched with 10 % melon increased from day 1 to day 4 and there was reduction in the protein value at the 5th day. In the control, the protein contents increased with fermentation days. Increase in protein contents in the control with duration of fermentation was in line with the study of Irtwange and Achimba (2009). Decrease in protein contents with fermentation periods in gari enriched with melon may be due to leaching of the nutrients especially the water soluble protein during dewatering process. Protein content is very important and is one of the reasons for enriching gari with melon so as to alleviate the problem of malnutrition. Carbohydrate contents decreased with increase in melon substitution. This may be due to increase in fat and protein contents of the melon

fortified gari. The pH of the gari was slightly decreased from day 1 to 5 in control and gari enriched with melon. The pH of gari enriched with melon was higher than the control samples. The control at day 5 had the lowest pH which indicates higher acidity in the control than the gari enriched with melon. The pH values observed in this study were higher than the values (4.3-4.5) reported for gari by Makanjuola *et al*. (2012). This might be as a result of low temperature as shown in Table 2. The fermentation temperature for gari reported by Ogueke *et al*. (2013) was 35-40 oC. However, the temperatures during the experimental periods were lower than these values. Lower temperature may hinder the activities of the fermentating microorganism. The experiment was carried out during harmattan period and invariably affected the rate of fermentation process as this resulted in higher pH values in the gari. This also led to reduced breakdown and utilization of the chemical components of the control and gari enriched with melon.

Gari with 20 % melon at day 2 was significantly different ($p<0.05$) from other samples in sodium content. There were slight increases in sodium contents of melon fortified gari. Potassium contents of the control samples were higher than melon fortified gari and substitution with melon reduced the potassium contents. This showed that the cassava tubers used for the gari product have high potassium contents. Magnesium, calcium and phosphorus contents were higher in melon fortified gari than the control samples. Mineral contents depend on the soil, location, species and cultural practices adopted during planting (Steven *et al*., 1985).

Oxalate and tannin contents of control and gari enriched with melon values decreased with melon substitution and days of fermentation. Hydrogen cyanide (HCN) contents in the control and melon fortified gari were low when compared to the report (4.31-4.77 mg/kg) of Ogueke *et al*. (2013) and maximum limit (10 mg/kg) recommended for gari (Codex, 2013). Low HCN may be as a result of the cultivar of cassava used for the experiment. Reduction in HCN might be due to the processing methods employed which include peeling, grating, fermenting, dewatering/pressing and toasting. Phytic acid values also decreased with fermentation periods. Slight increase in melon fortified gari samples may be as results of melon added to the grated cassava pulp. Reduction in anti-nutritional contents may be as a result of leaching of the anti-nutrients into the medium during fermentation and dewatering process.

As shown in Table 5, texture of the control was not acceptable to the panelists at day 1 to 2 of fermentation due to the high starch contents. But at day 3 to 5 of fermentation, the texture were acceptable with no significant difference ($p>0.05$) among the control samples. Fortified gari (10 and 20 %) were not acceptable at day 1 to 2 due to the texture of the eba but the textural qualities were improved from day 3 to 5. Aroma of eba from the control were acceptable than the fortified gari. Increase in melon substitution up to 20 % level imparted undesirable aroma on the eba. These may be due to high fat contents in the fortified gari. The appearances of the control eba were acceptable but the appearances became darker with increase in fermentation days. Among the fortified gari dough, appearances of eba from 10 % melon fortified gari at day 3 to 5 were acceptable and significantly different ($p<0.05$) from 20 % melon fortified gari. Overall acceptability revealed the control sample from day 3 to 5 as the most acceptable followed by enriched gari at day 3 to 5 at 10 % level.

CONCLUSION

The objective of this work was to improve the nutritional values of gari with melon flour. Addition of melon to gari increased the protein, fat and crude fibre contents of the gari at both 10 and 20 % levels. The pH of the enriched gari was higher than the control samples and fermentation rate was affected by low temperatures during this experimental periods. Lower anti-nutrients were observed in the control and fortified gari. The reductions in these anti-nutrients were observed with increase in number of days of fermentation. The dough made from gari with 10 % melon at day 3 to 5 were more acceptable to the panelist than the eba made from gari with 20 % melon in terms of texture, flavor and appearance.

REFERENCES

Abiodun, O.A. and Adeleke, R.O. (2010). Comparative studies on nutritional composition of four melon seeds varieties. *Pakistan Journal of Nutrition*, 9 (9): 905-908

Abiodun O.A and Akinoso, R. (2014). Effect of delayed harvesting and pre-treatment methods on the anti-nutritional contents of trifoliate yam flour. *Food Chemistry* 146: 515-520

AOAC (1990). Official Methods of Analysis. 15th edition. Association of Official Analytical Chemists, Washington DC.

Arisa, N.U., Omosaiye, O.B., Adenekan, A.O. and Alabi-MacFoy, A. (2011). Chemical and sensory qualities of gari fortified with groundnut flour. *African Journal of Food Science and Technology* 2(5): 116-119

Chijindu, E.N. and Boateng, B. A. (2008). Effect of nutritional content of processed cassava chips on development of Prostephanus truncatus (Horn). *World Journal of Agricultural Sciences*, 4 (3): 404-408

CODEX (2013). CODEX standard for gari. Codex Standard 151-1989

Echebiri, R. N and Edaba, M.E. I. (2008). Production and Utilization of Cassava in Nigeria: Prospects for Food Security and Infant Nutrition. *Production, Agriculture and Technology*, 4 (1): 38-52

Ibe, D.C. (1981). Semi Mechanized Gari Processing for Rural Communities in Nigeria. In: Terry, E.R., K.A. Oduro and E. Caveness, (Eds.), Tropical Root Crops: Research Strategies, for the 1980s. International Society for Tropical Root Crops. African Branch, Ibadan, pp: 159.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the tropics. Macmillan Publisher, London. 236-358.

Irtwange, S.V. and Achimba, O. (2009). Effect of the duration of fermentation on the quality of gari. *Current Research Journal of Biological Sciences* 1(3): 150-154

Isamah, G.K. (2004). ATPase, peroxidase and lipoxygenase activity during post-harvest deterioration of cassava (*Manihot esculenta* Crantz) root tubers. *International Biodeterioration and Biodegradation* 54: 319 – 323

Knipscheer, H., Ezedinma, C., Kormawa, P., Asumugha, G., Makinde, K., Okechukwu, R. and Dixon, A. (2007). Opportunities in the Industrial Cassava Market in Nigeria. International Institute of Tropical Agriculture, 1-47

Larmond, E. (1977). Methods of sensory testing. In : Laboratory methods for sensory evaluation of foods. Publication 1637. Ottawa, Canadian dept of Agric.

Makanjuola, O.M., Ogunmodede, A.S., Makanjuola, J.O. and Awonorin, S.A. (2012). Comparative study on quality attributes of gari obtained from some processing centres in South West, Nigeria. *Advance Journal of Food Science and Technology*, 4 (3): 135-140.

Nwabueze, T. U. and Odunsi, F. O. (2007). Optimization of process conditions for cassava (*Manihot esculenta*) lafun production. *African Journal of Biotechnology*, 6 (5): 603-611

Ogueke, C.C., Ehirim, C., Owuamanam, C.I., Ahaotu, I. and Olawuni, I.A. (2013). Quality characteristics and HCN in gari as affected by fermentation variables. *International Journal of Life Sciences* 2(1): 21-28

Oluwamukomi, M.O., Adeyemi, I.A. and Oluwalana, I.B. (2005). Effects of soybean supplementation on the physicochemical and sensory properties of gari. *Applied Tropical Agriculture*, 10: 44-49

Oluwamukomi M. O. and Jolayemi O.S. (2012). Physico-thermal and pasting properties of soy-melon-enriched "gari" semolina from cassava. Agric Eng Int: *CIGR Journal*, 14(3): 105－116.

Oluwamukomi M. O. (2015). Chemical and sensory properties of gari enriched with sesame seed flour (sesamum indicum l.). *FUTA Journal of Research in Sciences*, 1: 123-131

Osho, S.M. (2003). The processing and acceptability of a fortified cassava-based product (gari) with soybean. *Nutrition and Food Science*, 33 (6): 268 – 272

Steven, R.T., Vernon, R.Y. and Michael, C.A. (1985). Vitamins and Minerals. In: Fennema, O. (ed). Food Chemistry. (2nd ed), Marcel Dekker, New York. P 523

*****