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Effect of Fermentation Periods on the Physicochemical and Sensory Properties of Gari

[*1]Oluwafemi, Gbenga Isaac. And [2]Udeh, Charles Chiedu
[1]*Department of Food Technology, Federal Polytechnic, P. M. B. 5351, Ado Ekiti, Nigeria*
[2]*Department of Food Science and Technology, Delta State Polytechnic, P. M. B. 5 Ozoro, Delta, Nigeria*
Corresponding author's e mail: gbengaoluwafemi4u@gmail.com

Abstract: *Fresh cassava tubers of the bitter variety (Manihot esculenta) were processed into gari (fermented for five different periods).The proximate composition, chemical properties, cyanide content, functional and sensory properties were determined. The results showed that moisture content ranged between (7.45 -8.18%) in which the sample fermented for five days had the highest moisture content of 8.18% .The ash ranged between (1.74 - 2.19%), protein content ranged between (2.44-2.72%), crude fat ranged between (1.20-1.50%), crude fiber was between (2.60-3.20%) while carbohydrate content ranged between (83.09-83.94%) which were not significantly different from each other except the one fermented for four days which had the highest carbohydrate content of 83.94%. The cyanide content of all the samples ranged between 0.08 – 5.56 mg/kg, eighth day fermented sample had the least cyanide content. Water absorption capacity of all samples ranged between (10.50 - 11.75%) but was not significantly different from each other except the fourth day fermented sample which had the highest water absorption capacity of 11.75%. The pH of all the fermented samples ranged between (4.46-5.23) which was an indication that it decreases as the fermentation period increases while the total titratable acidity ranged between (0.03-0.06%) hence increases as fermentation period increases. Sample fermented for eight days (FG 8) was preferred most in term of taste and texture and colour and overall acceptability.*

Keywords: *Gari, proximate composition, functional, fermentation, cyanide, total titrable acidity*

I. Introduction

Cassava (*Manihot esculenta*) is a staple food for over 500 million people in the developing world. It belongs to the family Euphoerbiaceae. It is a perennial woody shrub producing enlarged tuberous roots. In Nigeria, cassava is one of the major staple foods that match the population growth. Cassava production in Nigeria is by far the largest in the world; a third more than production in Brazil and almost double the production of Indonesia and Thailand (FAO, 2006).

Cassava roots are highly perishable and cannot be kept in fresh condition for more than a few days after harvest without serious deterioration in quality. In the order to extend the shelf-life of the roots, cassava is processed into dried products in a variety of ways in different part of the world to meet the local needs, taste and for traditional use and storage (Akingbaka*et al*., 2005).

Cassava nutrition comes from the zinc, iron and magnesium, which help the blood, carry oxygen through the body with moderate level of potassium, meals prepared with cassava, actually help to regulate blood pressure and because cassava is gluten free, it can be used in special prepared foods. Cassava leaves are excellence source of vitamin K, which promotes call growth and bone mineralization (Buitrago, 1990). Fermentation is one method by which cyanogenic-glucosides in gari can be reduced. It also result in the production of volatile compounds that gives gari it unique flavor. Cassava is fermented to remove or reduce cyanide content. They should be fermented for at least three days. Cassava mash fermented for three days has the hydrogen cyanide reduced to a level tolerable for human consumption, there is an advantage of maximum swelling (gelatinization), in addition to desirable colour, aroma and texture, and it is then gari-fried to desirable colour, aroma and texture. It is also gari-fried to destroy enzymes and microorganisms and also dried off cyanide gas and to dry the product. Preservation is required by heating during garifrying. Low moisture content inhibits recontamination of bacteria. Packaging is especially in region of high humidity to retain low moisture content. (Westby and Choo, 1994).

Gari is rich in starch. It also has very high fibrous content, and contain some essential vitamins. The high fiber content makes it very filling and also makes this good in preventing or at least reduces likehood of constipation and bowel diseases. It is also low in saturated fat, cholesterol and sodium. It is also source of manganese and a very good source of vitamin C. Gari is a convenience food with a short preparation time. Its cheapness, ease of storage and preparation for consumption has combined to make it extremely popular among the urban dwellers in Nigeria and other West African Countries. It is far the most popular form in which cassava

is consumed in West Nigeria. It can also be relied upon as staple food to a large extent depends on how well it can be processed in hygienic forms (Borkarga, 1995).

Quality is the degree of excellence and acceptance. variation are observed in colour, fiber content, moisture content, particle sizes starch content and residual cyanide. These variations are caused by cassava variety age at the time of harvest, processing methods and equipment and duration of fermentation. The time allow for fermentation is critical, too short and detoxification product, too long and product will have a strong sour taste and the texture will be poor. The use of cassava as a food is limited by it perishability, low protein content and potential toxicity. (Azam-Ali *et al*., 2003)

The aim and objectives of the research work are; to produce gari from cassava being subjected to different fermentation period and to determine physiochemical and the sensory properties of the gari.

II. Materials and methods

Cassava roots were purchased from a local market in Ado ekiti, south western Nigeria, with acceptable appearance for consumption. The roots were manually cleaned to remove adhering soil and other extraneous materials before processing. It was immediately peeled, washed and allowed to drain, after which the roots were grated using locally manufactured grating machine. The mash were bagged in five different cloth sack and heavy stones placed on the sack for dewatering and fermented for a period of zero day, two days, four days, six days and eight days. For all the days that the fermentation lasted, a quantity from the mash was taken, sieved to remove the woody part of the cassava and toasted with moderate heat intensity while the samples obtained were analyzed for Proximate, Chemical, Functional and Sensory parameters. All reagents were analytically graded.

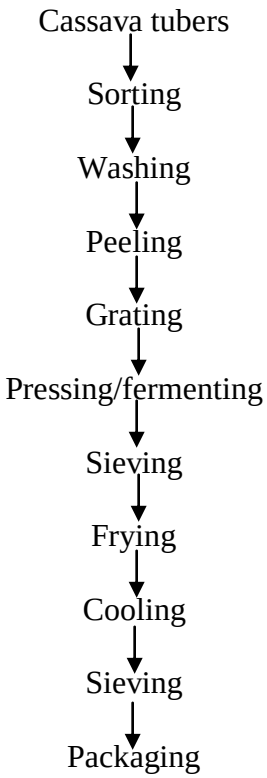

Figure 1: Flow Chart on the Processing of *Gari.*

Source: Ene (1992).

Reconstitution of gari

The overall ratio of gari to water used in "reconstituted gari" preparation was 1:2 (w/v). This was thoroughly stirred with a wooden spatula to produce thick dough called "eba" FG0= Zero day fermented gari, FG2=Second days fermented gari, FG4=Fourth days fermented gari, FG6=Sixth days fermentedgari, FG8=Eight days fermented gari.

III. Methods

The proximate analyses of the samples were carried out using the standard procedure of Association of Analytical chemist (AOAC, 2005).

Chemical Properties

Determination of Total cyanide content determined by a procedure of AOAC (1990), pH was measured with combo pH meter (Model HI 98129, Hanna Instrument, Italia) The percent titrable acidity was determined following the method of FAO (2005).

Functional Properties

Functional properties have been defined by Sathe*et al.* (1982) as those characteristics that govern the behaviour of nutrients in food during processing, storage and preparation as they affect food quality and acceptability. Some of the important functional properties that influence the utility of most starchy staples food such as gari include the drying characteristics, water absorption capacity, oil absorption capacity and bulk density which were determined by Sathe *et al.,* (1982)

Sensory Evaluation

A total of 10 – panelists were drawn from Federal Polytechnics Ado Ekiti, Food Technology Department assessed the sensory quality of the reconstituted gari "eba". The sensory quality of eba made from each of the sample was measured on a standard nine-point hedonic scale. The panelists rated the reconstituted gari samples for texture, taste colour and overall acceptability on a scale varying from 1 = dislike extremely to 9 = like extremely as described by Larmond, 1982.

Statistical analysis

Determinations were carried out in triplicates and the error reported as standard deviation from the mean of the three determinations.

IV. Results and discussion

Proximate composition: From the result of the proximate analysis of sample showing in table 1 It was observed that the moisture content of the samples range between 2.45% – 8.18%. However the moisture content increases as the fermentation period increases, the available moisture in the sample solely depends on the degree of dryness during garifrying, although values obtained were lower than the recommended 13% for Gari (FAO, 2006). The ash content ranged between 1.74% - 2.19%, this also increase as the fermentation period increases which is an indication of improvement in the mineral composition of the sample. The crude protein ranges between 2.44% - 2.70% which indicates that the protein content increases as the fermentation period increases, sample for zero day contain the least amount of protein (2.44%) while the eight days fermented sample had the highest protein content (2.70%). It could also be observed from the Table 1 that crude fat content reduces as the fermentation period increases with the range of 1.20%-1.50%, zero day fermented sample had the highest value (1.50%) while the eight days fermented sample had the least value (1.20%). The temperature is known to have an effect on the physical index of certain foods decreases, this temperature could probably be the reason for the rate of decrease of crude fat as reported by (collard and levi, 1959). The lower level of fat in the eight days fermented sample could give a higher probability of a longer shelf life in term of the onset of rancidity. Crude fibre content from the Table 1 above ranges between 2.60% - 3.20% which shows that the crude fibre content in the sample decreases as the fermentation duration increases. Carbohydrate was determined by different which ranges between 82.94% – 83.92% the sixth day fermented sample hadthe highest carbohydrate content (83.92%) while the fourth day had the least value (82.94%), which indicate that the carbohydrate content decreases as fermentation period increases.

Table 1: Proximate composition (%) of gari produced from different fermentation periods.

Component	FG0	FG2	FG4	FG6	FG8
Moisture (%)	7.91±0.00	7.45±0.01	7.97±0.02	8.10±0.00	8.18±0.00
Ash (%)	1.74±0.02	2.02±0.02	2.06±0.02	2.13±0.01	2.19±0.07
Crude protein (%)	2.44±0.00	2.49±0.03	2.62±0.03	2.52±0.02	2.72±0.00
Crude fat (%)	1.50±0.02	1.34±0.01	1.36±0.03	1.20±0.02	1.20±0.02
Crudefibre (%)	3.20±0.00	3.12±0.01	3.04±0.02	2.61±0.02	2.60±0.01
Carbohydrate (%)	83.20±0.00	83.56±0.01	82.94±0.03	83.92±0.49	83.09±0.04

Values in the table are mean ± standard deviation for three determinations.
FG0= Zero day fermented gari
FG2=Second days fermented gari
FG4=Fourth days fermented gari
FG6=Sixth days fermented gari
FG8=Eight days fermented gari

Chemical properties As shown in table 2, the Hydrocyanic content range between 0.80% - 0.56%, it was observed that hydrocyanic content decreased as the fermentation period increases. This result could be attributed to cassava processing which involve the grating of the peeled cassava roots to obtain the cassava mash rupture the structural integrity of plant cells, thus allowing the cyanogenicglucosides from storage of vacuoles to come in contact with the enzyme linamarase on the cell wall (Bokanga, 1995). Also, the reduction could be due to the volatilization of the hydrocyanic acid when toasting. This is in agreement with the observation of (Meuser and Smolnit, 1980) on the effect of heat in hydrocyanic acid content. It was also observed in the table that pH value ranged between 4.70% - 5.23%, this indicates that as the fermentation period increases the acidity reduces, the observed decrease in pH could be attributed to further activities of cassava microbes on the mash which brought about further acidification. Although the value obtained was still within the acceptable range as reported by Bainbridge *et al*., 1996. Also, from the above table the total titratable acidity of the sample ranges between 0.03% - 0.06%. Sample fermented for zero days had the least value (0.03%) while sample fermented for eight days had the highest value of (0.06%). The increase in total titratable acidity further suggests that organic acid were produced during fermentation of cassava mash and thus was probably due mainly to the increased activities of the fermenting microorganism native to fresh cassava and other organisms present at ambient temperature under which the fermentation was carried out. The value of total titratable acidity recorded in all the gari samples were in agreement with the Nigerian Industry Standard (NIS, 1998) recommendation of less than 1.00% total titratable acidity for gari sample.

Table 2: Chemical composition of gari produced with different fermentation periods.

Component	FG0	FG2	FG4	FG6	FG8
HCN (mg/kg)	5.56±0.16	2.33±0.03	2.19±0.17	1.18±0.17	0.80±0.20
Ph	5.23±0.06	4.70±0.00	4.90±0.00	4.46±0.06	4.73±0.05
TTA (%)	0.03±0.00	0.03±0.00	0.03±0.00	0.05±0.06	0.06±0.10

Values in the table are mean ± standard deviation for three determinations.
HCN % = Hydrogen cyanide percentage
TTA % = Total Titratable Acidity

Functional properties As shown in table 3 the bulk density of the samples range between 0.57 – 0.61g/ml. The bulk density increases as the fermentation period increases from day one to day two which later remain the same in day four and six but further increase in fermentation period lead to increase in the bulk density in sample eighth day fermented sample with the value of 0.61g/cm^3 The bulk density result in all the samples was desirable and fell within the acceptable range of 0.50g/cm^3 -0.91g/cm^3(Andidu, 2006). High bulk density implies reduction in volume and a larger quantity (weight) of gari can be packaged or transported per volume of space, this is one of the important reasons for the conversion of fresh cassava roots to gari.

In addition, as shown in the sametable, the water absorption capacity of the samples ranges between 10.05% - 11.75%, which indicates that the sample fermented on the fourth day had the highest water absorption capacity of 11.75%. Although, the level of heat intensity at which gari are toasted affect their rate of water intake and further influence rehydration during processing or reconstituting. The range of oil absorption capacity is between (13.2% -14.7%), sample fermented for zero day, two days and six days were not significantly different from each other, while the sample fermented for four days had the highest oil absorption capacity of 14.7%.

Table 3: Functional properties of gari produced from different fermentation periods.

Properties	FG0	FG2	FG4	FG6	FG8
Water Absorption Capacity (%)	11.00±0.00	11.00±0.00	11.75±0.00	11.00±0.25	10.50±0.50
Oil Absorption Capacity (%)	13.5±0.00	13.5±0.50	14.7±0.25	13.2±0.25	14.2±0.25
Bulk Density (g/cm^3)	0.59±0.03	0.63±0.01	0.57±0.00	0.59±0.04	0.61±0.03

Values in the table are mean ± standard deviation for three determinations.

Sensory properties of the reconstituted gari "eba"

Table 4 shows the sensory attributes of the reconstituted gari. The attributes rated by the panelist were taste, colour, texture and overall acceptability. Sample eighth day fermented sample was scored best for taste, colour, texture and overall acceptability, but the texture of second day fermented sample and fourth day fermented sample were not significantly different from each other, although, the zero day fermented sample rated better in term of colour. Reason for eighth day fermented sample being rated best in term colour could be due to slight non-enzymatic browning that took place during toasting of the gari, with moderate intensity of heat as reported by, Torte *et al.*, 2009.

Table 4: Sensory properties of the reconstituted gari "eba"

Sample	FG0	FG2	FG4	FG6	FG8
Texture	6.80	7.40	7.30	6.20	8.40
Taste	6.40	6.90	7.40	5.60	8.10
Colour	8.20	7.50	5.50	4.80	8.7
Overall acceptability	7.20	7.70	7.00	5.80	8.20

V. Conclusion

In this study, it could be concluded that the production of gari from different fermentation period has really helped us to know the nutritional distribution and chemical composition of gari produced from each of the fermentation period chosen.

As gari is generally known for its high carbohydrate content and low in protein content, from this study it was observed that the carbohydrate content decreases as the fermentation period increases whereas the protein content increases as the fermentation period increases, although still low compare to the Recommended Dietary Intake. Also, from the research work the moisture content obtained was still within standard storage requirement which is one of the factors that extends the shelf life of the sample.

The Bulk density of the samples increases as the fermentation period increases, the eight day fermented sample had the highest bulk density, high bulk density implies reduction in volume and larger quantity (weight) of gari which can be packaged or transportedper volume of space, which is one of the most important reason for the conversion of cassavas root to gari. Reduction in cyanide content with the extension of the fermentation periodwill stand as a great positive influence on the sampleeven during storage. Sample fermented for eight days was rated best in terms of texture, taste, colour and overall acceptability, while sample fermented for zero day was rated better for colour. Gari produce from different fermentation periods can be used in formulation of food product perhaps with soyabean flour etc; to evaluate their effectiveness and proficiency as food supplement / enrichment.

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