

Effect of Fermentation Time on the Physico –Chemical, Nutritional and Sensory Quality of Cassava Chips (Kpo-Kpo Garri) a Traditional Nigerian Food

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Abstract: Cassava chips (kpo-kpo garri) popularly consumed in the Niger-Delta Area of Nigeria was produced following fermentation of cassava mash for different time durations. The physico-chemical and nutritional quality of the chips was assessed using standard methods. Sensory quality was also assessed using a trained assessment panel. Results revealed a decrease in pH from 4.03 ± 0.00 at 0 hour fermentation time to 3.40 ± 0.01 after 24 hours fermentation and 3.00 ± 0.00 after 48 hours. Cyanogenic acid content also showed similar trend. Carbohydrate, fibre, ash, protein and moisture contents increased with increase in fermentation time. Carbohydrate content increased from $39.10 \pm 0.03\%$ after 0 hour fermentation to $42.50 \pm 0.05\%$ after 24 hours and $43.50 \pm 0.05\%$ after 48 hours fermentation. For fibre, ash, protein and moisture contents, the changes observed were 1.00 ± 0.02 to 1.08 ± 0.02 , 1.67 ± 0.02 to 1.80 ± 0.01 , 1.08 ± 0.10 to 3.03 ± 0.03 and 6.98 ± 0.10 to $9.10 \pm 0.00\%$ respectively from 0 hour to 24 hours fermentation time. Sensory quality assessment showed that the chips prepared from cassava mash fermented for 24 hours were more acceptable. All the quality changes were significantly different ($P < 0.05$) considering chips produced from mash of 0 hour and 24 hours fermentations. Allowing cassava mash fermentation for a period of 24 hours will therefore, yield cassava chips of better acceptable quality than when no fermentation is allowed to take place and an unnecessarily long period of 48 hours.

Keywords: Fermentation, Physico-Chemical, Nutritional, Cassava, Traditional, Product

1. Introduction

Cassava, (*Manihot esculenta-crantz*) is a root crop produced in the tropics. Starchy cassava roots are quantitatively the third most important food in the tropics after rice and corn, and are significant sources of calories for over 500 million people world-wide (FAO, 2000). Nigeria is reported to be the highest producer (about 34 million tons) of cassava in the world (FAO, 2006). Nutritionally, cassava contains 62% water, 35% carbohydrate, 1% protein, 0.3% fat and 1.0% minerals (Westby, 1991).

In Nigeria, as in most African countries, cassava roots are processed into different products as a means of preservation due to their perishability. These products vary depending on culture of the people they include garri, fufu (akpu), lafun, starch, flour, tapioca and cassava chips commonly called kpo-kpo garri. The processes involve fermentation at various stages of production. Fermentation is known to improve shelf

life, texture, taste, aroma, nutritional quality and digestibility. It also leads to lowering of anti-nutrient content of the products (Oyewole and Isah, 2012).

Cassava chips (kpo-kpo garri) are produced in Nigeria particularly in the Niger-Delta Area. It is prepared using a modified process of garri production (Adeyemi and Balogh, 1985) as is an emerging delicacy either eaten dry with edible worm, groundnut or dried fish, soaked in water with addition of sugar or salt and/or milk to taste.

Microorganisms known to be involved in cassava fermentation for cassava chips production are *Bacillus subtilis*, *Leuconostoc citrivorum*, *Streptococcus* sp, *Corynebacterium* sp, *Lactobacillus* sp. Others are fungi such as *Candida tropicalis*, and *Geotrichum candidum* (Oyewole and Odunfa, 1989; Oyewole and Isah, 2012).

Cassava contains two cyanogenic glycosides, linamarine

and lataustralin which on hydrolysis to hydrocyanic acid by the enzyme linamarase are hazardous when consumed at certain levels (Kobawila *et al*, 2005; Ernesto *et al*, 2000). Microorganisms are able to lower the cyanide content of cassava during fermentation due to their possession of linamarase activity.

Like many other local products, cassava chips are produced at home industry level using methods that vary as there is no standard processing technology particularly with respect to fermentation. This results in products with difference qualities. Marketability of such products therefore, depends on how much the quality of the processed product can be improved particularly with reference to the period of fermentation. Documented information exist on the improved methods for processing several cassava products for improved performance as in bikedi and ntoba in Congo (Kuboye, 1988; Kobiwala *et al*, 2005; Irtwange and Achumba, 2009). There is paucity of information on the methods for improving the quality of cassava chips as produced currently in Nigeria. This study was therefore carried out to assess how varying fermentation time during the production of cassava chips (kpo-kpo garri) can bring about improved quality as a way of increasing product marketability.

2. Materials and Methods

2.1. Processing of Cassava Chips (Kpo-Kpo Garri.)

The traditional method of garri preparation described by Adeyemi and Balogh (1985) was used with modifications. About 500kg of freshly harvested cassava tuber (roots) were peeled and washed with water to remove adhering soil particles. Thereafter, the tubers were milled (by grinding) using a milling machine (Simpay, China). The mash obtained was immediately divided into five portions of 10g each. To each portion was added 1litre of clean water, put a jute sack and pressed for dewatering. The jute sack allows for fast easy dripping of water. The content of the first sack was processed immediately after pressing to obtain cassava chips. The remaining four portions were processed after pressing and allowing them to stand at room temperature for 12, 24, 36 and 48 hours respectively for fermentation to take place.

Pressed cassava mash was processed into chips by frying (roasting) for between 10-15minutes in a shallow wide hot metal pan (pot) until consistently whitish chips (kpo-kpo garri) were obtained. The chips were removed from the pan using a large spoon with long handle allowed to cool to room temperature ($29\pm 2^{\circ}\text{C}$) before the physico-chemical, nutritional and sensory quality attributes were assessed for the various batches.

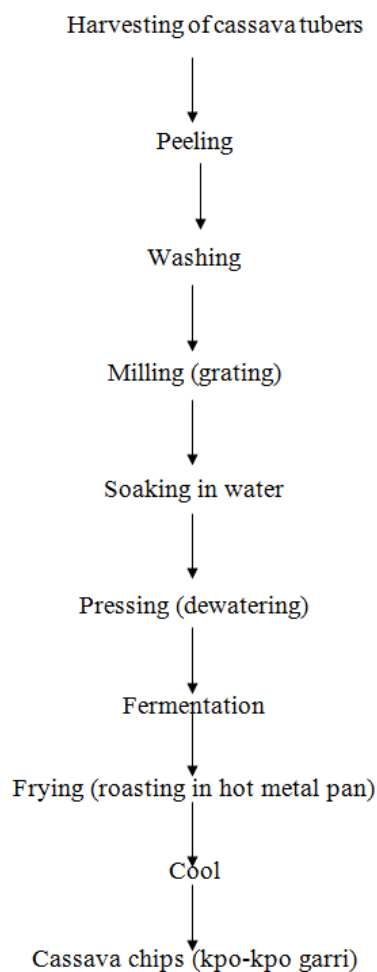


Fig. 1. Flow sheet for the production of cassava chips Adeyemi and Balogh, (1985).

2.2. Determination of Quality Attributes: All Experiments were Carried Out in Duplicates

2.2.1. Hydrogen Ion Concentration (pH)

The pH of each of the samples was determined with the aid of a pH meter (Jenway, model 302) after standardizing with buffer at pH 4. The sample in 10g quantity was soaked in 50ml distilled water in a 100ml beaker for 5 minutes with stirring. Thereafter, the pH meter electrode was dipped in and readings taken (AOAC, 1990).

2.2.2. Titratable Acidity (% Lactic Acid)

Titrateable acidity was determined by dissolving 10g of sample in a 100ml flask containing 50ml distilled water and stirring for 5 minutes. Sodium hydroxide (0.1N) was then titrated against 10ml of the sample decanted supernatant with phenolphthalein indicator. The result as expressed as percentage lactic acid calculated using the relationship below,

$$X = \frac{\text{strength of base} \times \text{volume of base} \times \text{acid factor}}{\text{Volume of sample}}$$

Strength of base = 0.10N

Volume of base = X

Acid factor =0.009008
Volume of sample = 10ml.

2.2.3. Moisture Content (%)

This was determined as a weight loss of water by 5g of sample in a weighed watch glass following drying in a vacuum oven (Elothrothermal, England) at 105°C to a constant weight. (AOAC 1990)

2.2.4. Protein Content (%)

The method of Lowry *et al* (1951) was employed. Optical densities (OD) read at 540nm differently for samples using SP30UV spectrophotometer were extrapolated from a

standard protein curve to obtain protein contents.

2.2.5. Ash Content (%)

Ash content was determined by the method of (AOAC, 1990). The samples were burned on a bursar burner and charred material was incinerated in an electronic muffle furnace (Model 0508-1, Technol and Technol, Texas, USA) equipped with pyrometer temperature indicator of 550°C to obtain a whitish grey ash. The ash so obtained was allowed to cool in a desiccator to room temperature (29±2°C), weighed and percentage ash content estimated from the relationship below

$$\% \text{ ash content} = \frac{\text{weight of dish + sample} - \text{weight of dish + ash}}{\text{weight of dish + sample}} \times \frac{100}{1}$$

2.2.6. Fat Content

Soxhlet method as described by Meloan and Pomeranz (1973) was employed. The extraction as carried out with petroleum ether (BDH, England) at a temperature range of 40 – 60oC for 5 minutes, followed by oven drying for 30 minutes at 100oC for the solvent to evaporate, allowed to cool and weighed..

2.2.7. Fibre Content (%)

To determine fibre content, the sample oven weight was estimated as well as the weight after ashing. Fibre content was calculated as the ratio the difference between the two values above to the sample weight (AOAC, 1990).

2.2.8. Hydrocyanic Acid (HCN) Content (mg/g)

Alkaline titration method was used to estimate the amount

of hydrocyanic acid in milligram per gram of sample (A0AC, 1990).

2.2.9. Sensory quality Assessment

This was carried out using the parameters of taste, colour (appearance) aroma (flavor), mouth feel and swelling index using a 9 – point hedonic scale (1 = 9, 9 = 1) as described by Larmond (1977). A ten (10) member panel made up of trained personnel was used to score the various parameters.

2.2.10. Statistical Analysis of Data

Data obtained were subjected to statistical analysis of mean, standard deviation and analysis of variance (ANOVA). The significant value was determined by t- distribution test using appropriate computer software.

Table 1. Effect of fermentation time on physico-chemical and nutritional quality of Cassava chips (kpo-kpo garri)

Parameters	Fermentation time (h)				
	0	12	24	36	48
pH	4.03±0.00	3.80±0.01	3.40±0.00	3.00±0.01	3.0±0.00
fibre Content (%)	1.00±0.02	1.06±0.02	1.08±0.02	1.20±0.03	1.30±0.02
TA (%)	0.01±0.00	0.04±0.00	0.04±0.00	0.06±0.01	0.06±0.01
Moisture Content (%)	6.98±0.10	8.90±0.04	9.10±0.00	8.60±0.01	9.50±0.02
Protein Content (%)	1.08±0.10	1.60±0.10	3.05±0.03	3.02± 0.02	2.60±0.02
Ash (%)	1.67±0.02	1.64±0.02	1.80±0.01	1.86±0.02	1.90±0.02
Fat (%)	2.10±0.02	2.90±0.10	3.10±0.02	2.20±0.01	2.00±0.03
CHO (%)	39.10±0.03	40.50±0.15	42.50±0.05	42.60±0.05	42.60±0.04
HCN (mg/g)	3.71±0.01	2.10±0.02	1.60±0.01	1.40±0.10	1.30±0.10

Note :Each value is the overall mean ± SD for duplicate determinations .TA=titratable acidity, CHO =carbohydrate, HCN =hydrogen cyanide

Table 2. Effect of fermentation time on sensory quality of Cassava chips (kpo-kpo garri).

Time (h)	Sensory quality attributes					
	Taste	Colour	Aroma	Swelling index	Mouth feel	Overall acceptability
0	3.20±0.60	5.40 ±0.74	4.80±0.70	5.40±0.80	6.60±0.60	6.40±0.66
12	5.90±0.64	6.00±0.71	5.40±0.70	6.00±0.80	6.80±0.69	6.90±0.60
24	7.60±0.80	7.60±0.71	7.40±0.80	7.60±0.76	7.30±0.65	7.65±0.70
36	7.00±0.84	7.20±0.72	7.20±0.72	7.30±0.70	7.00±0.60	7.10±0.06
48	6.90±0.74	6.80±0.72	6.80±0.68	7.00±0.68	7.00±0.50	6.80±0.70

Note: Each value is the overall mean ±SD for duplicate determinations.

3. Results

The results of the changes in physico-chemical and nutritional quality of cassava chips obtained following fermentation of cassava mash for 6,12,36, and 48 hours are presented in Table I.

There was a decrease in pH values from 4.03 ± 0.00 for product obtained from zero (0h) hour fermentation to 3.40 ± 0.00 and 3.00 ± 0.00 for product obtained after 24 hours and 48 hours respectively. Changes in fermentation time influenced the fibre content which showed an increase from zero hour (1.00 ± 0.02) up to 1.08 ± 0.02 after 24 hours and 1.30 ± 0.02 after 48 hour fermentation period. Other parameters such as titratable acidity, moisture, protein, ash and carbohydrate contents also increased with increase in fermentation time.

On the contrary, there was a decrease in the HCN with increasing fermentation period from 3.71 ± 0.01 mg/g at 0hour fermentation time to $2.10 \pm$ mg/mg after 24hours and 1.30 ± 0.10 mg/g after 48hours fermentation of cassava mash.. In all the cases, the changes as affected by fermentation time are significantly different ($P < 0.05$) when compared with the result at 0hour fermentation time.

The effect of duration of fermentation on sensory (organoleptic) quality of cassava chips is presented in Table 2. Considering the attribute of taste, there is a significant difference ($p < 0.05$) as seen in the scores which were lowest at 0hour when no fermentation was involved and higher after 24 hours fermentation. Further increase in fermentation time did not result in significant ($p < 0.05$) increase in scores recorded. The trends with other parameters are the same. Furthermore product obtained after fermentations of cassava mash for 24 hours showed more acceptability considering the taste, colour, flavour, swelling index and mouth feel. This was followed by chips from a longer fermentation time of 36hours.

4. Discussion

The changes in physico-chemical, nutritional and sensory quality of cassava chips (kpo-kpo garri) as a result of differences in fermentation times of the mash is an indication that fermentation plays a significant role in the product quality. This is in agreement with some earlier reports (Okafor, 1977; Onyekwere *et al*, 1983; Irtwange and Achumba, 2009).

There was a reduction in pH with time of fermentation (Table I). This suggests the production of organic acids during fermentation likely due to lactic acid bacteria which are known to be predominant during cassava mash fermentation. This assertion is in line with reports of Ogiehor, (2002) and Kobawila *et al.*, (2005). The pH reduction with concomitant increase in titratable acidity may equally be due to activities of microorganisms prompted by the prevailing temperature as has been earlier reported (Onwuaman *et al*, 2002; Chelule *et al*, 2010). Oshuntogun and Abaoba (2004)

opined that microorganisms release organic acids during fermentation leading to an increase TA and reduction in pH with time. There was an increase in each of protein, ash and carbohydrate contents with increase in fermentation. It is thought to be due to the action of fermenting microorganisms. This is in line with the reports of Eka, (1986); Tyleskar *et al.*, (1992). They had suggested that microbial fermentation is linked to break down of components of their substrates thereby releasing bound nutrients Similar result has also been reported (Nwafor and Ogiehor, 2004). The ability of microorganisms to synthesize amino acids may be the reason for the increase in protein content with increasing fermentation time. It corroborates the earlier report by Jokotagha and Amoo (2002). A reduction in fat content with fermentation time up till after 48 hours can be attributed to the influence of increasing temperature of fermentation. Temperature is known to affect the physical characteristics of fat foods (Irtwange and Achumba, 2009). It has been established that as temperature increases, the solid fat index of some foods decreases (Werss, 1983). Temperature may therefore be the reason for the rate of decrease in fat content of kpo-kpo garri recorded in this study.

The recorded decrease in HCN content may be due to various activities taking place during cassava mash fermentation. Fermentation is a detoxification process (Okafor, 1977, Okafor and Ejiofor, 1986, Agbor-Egbe and Mbome 2006). Most of the organisms involved in cassava mash fermentation are also known to possess linamarase activity, thereby ensuring elimination of cyanogenic glycosides as earlier reported by Bokanga (1995). The high temperature at which kpo-kpo garri is roasted also contributes to the reduction in HCN content. This agrees with the report of Menser and Smolnik (1980).

Acceptability scores show that cassava chips obtained following 24 hour fermentation was most acceptable. It has been reported that the taste effect of garri improves due to enhanced production and retention of desired organic acids and aroma (Onwuamanam *et al*, 2011). It is an indication that proper fermentation time of 24 hours may conserve and contribute to the properties responsible for enhanced sensory quality of kpo-kpo garri.

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