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Effect of Cassava Processing Equipment on Quality of *Gari* Produce in Selected Processing Site in Ghana

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***Abstract* – Cassava (*Manihot esculenta*, Crantz) is a food security crop and serves almost 250 million people in sub-Saharan Africa as global food security is in question today. *Gari* samples from nine different processing sites in the central region of Ghana were sampled and the effect processing equipment on the quality of *gari* produce at these processing sites was assessed. The samples were analysed for pH, TTA, starch, bulk density, moisture content, swelling capacity and ash content using A.O.A.C 2000 and other recommended protocols. Samples were found to have good pH level (3.745-4.685) with a low TTA (0.009-0.016). The samples had adequate moisture (4.469-7.763%), low level of ash (0.623-1.677%) with bulk density (0.588-0.666g^{cm-3}). The samples swell at a very good rate (3.175-3.750%) which is acceptable to most consumers. The starch content (46-56 g/100) was good with a little variation among the samples which may be attributed to processing style, variety and other traditional practices which varied slightly from one sites to the other. Processing equipment and traditional practices significantly ($p < 0.05$) affected almost all the physiochemical properties of *gari* samples. Notwithstanding, gari samples from all the processing sites met both Ghana Standard Authority and CODEX specification.**

***Keywords* – Cassava, Gari, Processing Equipment, Physiochemical Properties.**

I. Introduction

The global food security is in question today, with ever increasing food prices resulting from adverse climatic effects on agricultural production, rises in oil prices leading to increased running costs for farm tractors, increasing use of food items for other products and reduction of government spending on agriculture [1]. For these reasons and others, cassava (*Manihot esculenta*, Crantz) has become one of the most important food crops in the region to help solve some of these contingencies through processing.

It was estimated that Africa alone produces 121,469,000 tonnes of cassava, of the world estimate 242,069,000 tonnes [2]. In 2009, Ghana produced 12,231,000 tonnes of cassava which was cultivated over a land area of 889, 000 hectares [3].

It is estimated that 250 million people in sub-Saharan Africa derive half of their daily calories from cassava [4]. Cassava roots are very rich in starch, and contain significant amounts of calcium (50 mg/100g), phosphorus (40 mg/100g), and vitamin C (25 mg/100g) [1] and is .consumed in the form of local products such as “fufu” (pounded boiled cassava), “ampesi” (a traditional food for the people of Nzema) unpublished [5]. It root are also used for animal feed [6].

Gari (fried and fermented cassava flour) is the most popular cassava product consumed in West Africa and the most important food product in the diet of millions of Ghanaians and Nigerians [7] - [10]. Recently the *gari* processing industry in Ghana and the world at large is gaining an important recognition due to the crucial role it plays in maintaining world food security. In Ghana, most of the processors operate at cottage and small scale level which makes quality control very difficult. Studies were carried out to determine the effect of cassava processing equipment on quality of *gari* produced in some selected sites in Ghana.

II. Materials and Methods

A. Determination of pH

The pH was determined using [11] procedure. Ten grams each of the oven-dried fermented cassava mash was weighed in to a beaker and 100 ml of distilled water was added. The mixture was allowed to stand for 15 minutes, shaken at 5-minutes intervals and then filtered into a beaker, using Whatman No. 4 filter paper. The pH of the filtrate was then measured using a microprocessor pH meter (Hanna, Model 210)

B. Determination of Titrable Acidity (TTA)

The TTA was determined using [11] procedure. Ten grams each of the oven-dried fermented cassava flour were weighed into a clean beaker and mixed with 100 ml distilled water. The mixture was filtered using a Whatman No. 4 filter paper and ten millilitres of the filtrate was pipette into a 250 ml conical flask. Two drops of phenolphthalein was added. A standardized 0.1 M NAOH was titrated against the filtrate, with the conical flask being in constant swirling until a pink end-point was reached. The process was duplicated and the average titre value was taken.

C. Determination of Moisture content

The moisture content was determined using [11]. The metal dishes were cleaned, dried in oven and labeled for identification. The weight of empty dry metal dish was taken and recorded. Approximately 2 g of *gari* sample was weighed into each metal dish. The samples were dried at 105 °C overnight leaving the covering lid slightly ajar. The dish and the content were removed from the oven after first tapping covering lid and closing the dish. The dish were cooled in desiccator and weighed.

D. Determination of ash content

The ash content of the samples was determined using [11] procedure. Two grams each of *gari* sample was weighed (M1) into a crucible of known weight (M2)

(which has been pre heated in the furnace and cooled). The samples were then transferred into a furnace 40 (Gallenkamp Muffler furnace, size 3) at 550 °C – 600 °C overnight. The crucibles were then removed, cooled in a desiccator and weighed (M3). The process was repeated and ash was calculated on 100 g/sample basis

E. Determination of swelling capacity

The swelling capacity was determined based on the method of [12] modified by Natural Resource Institute [13] cited by [8] with a slight modification. A 100 ml measuring cylinder was filled with *gari* to the 20 ml mark (M1). Distilled water was added at room temperature (25±27°C) to give a total volume of 100 ml. The top of the cylinder was tightly covered and the contents mixed by inverting the cylinder. After 2 minutes the cylinder was inverted again and left to stand for 3 minutes (5 minutes total time) and the final volume occupied by the gari recorded (M2)

F. Determination of bulk density

The bulk density was determined using [14] method as cited by [15]. Ten grams of the gari were transferred into 50 ml measuring cylinder and the cylinder was tapped repeatedly for 5 minutes. The mean value was recorded from duplicate. The bulk density of *gari* was calculated as the mass of *gari* over the volume at the end of the tapping chosen.

G. Determination of starch

Starch was determined using Lintner's method as described in [16]. 5g of gari sample was dissolved with 20 ml of water and 40 ml hydrochloric acid. The mixture was washed into a 200 ml flask with hydrochloric acid (12% w/w HCL). 10 ml of 5% phosphotungstic acid was added to proteins and the volume was made up to 200 ml with 12% HCL. It was then shaken, filtered and the optical rotation was measured in a 200-mm tube.

III. Statistical Analysis

Data obtained was subjected to statistical analysis using Statistical Analysis System (SAS version 9.2). The statistical design used in studying the effect processing equipment and traditional practice on physiochemical properties was Completely Randomized Design (CRD) with duplicates. Samples from the processing sites where used as treatment. Comparisons between sample and quality indices were done using one-way analysis of variance design with no blocking (ANOVA). Least Significant Differences (LSD) at probability $P<0.05$ was used to separate the means.

IV. Results and Discussions

According to [13], the recommended pH range for acid fermented product should fall within 3.5-4.5. A good quality *gari* should have a slightly sour and sharp taste without any peculiar odours' [8]. pH values of samples recorded ranged from 3.745-4.685 (Table 1). These values though compared well with acid fermented product, some fall outside of the recommended range. The values also compared well with what [8] reported (3.58-4.47). Sample H from Mfafo/Obrakyere recorded the highest pH value (weak acidic) which research has attributed it to the duration of fermentation or the raw material. Reference [10] indicated in their work that during fermentation process, lactic acid bacteria hydrolyse carbohydrates in the cassava into sugar, alcohols and organic acids. The organic acids production, which increases with fermentation time, leads to an increase in acidity and result decrease in pH. Notwithstanding the statistical analysis showed that samples were significantly affected ($P<0.05$) by processing equipment and traditional practices among the processors. Reference [8] attributed such variation among *gari* samples to traditional practices such as differences in processing especially the duration of fermentation or the pressing time which may varies from a processing site to the other.

Table 1: Physiochemical properties of gari samples from different processing sites

Location	Sample code	pH	TTA (%)	MC (%)	ASH (%)
Bawjiase	A	3.960^{de}	0.009^{c}	4.469^{f}	1.229^{ab}
Ofadaa	B	3.985^{d}	0.012^{b}	6.273^{d}	1.117^{ab}
Ayensuako	C	3.745^{g}	0.016^{a}	6.909^{b}	1.344^{ab}
Awutu Breku	D	3.880^{fe}	0.005^{e}	7.763^{a}	1.529^{a}
Papase	E	4.205^{c}	0.006^{d}	6.679^{c}	1.677^{a}
Mankron	F	3.865^{f}	0.013^{b}	3.396^{g}	1.229^{ab}
Osaekrodua	G	4.355^{b}	0.013^{b}	6.337^{d}	1.252^{ab}
Mfafo/Obrakyere	H	4.685^{a}	0.009^{c}	6.034^{e}	0.623^{b}
Senya	I	4.025^{d}	0.010^{c}	6.595^{c}	1.322^{ab}

**Means with the same letter are not significantly different

The total titratable acidity shows percent lactic acid of samples and ranged between 0.009-0.016 percent (Table 1). Values recorded across the district were lower than what Codex has recommended thus 0.06-1.0% (Codex Alimentarius Commission, 1989). The values were also lower than what [8] reported in *gari* samples from the same region. They reported values ranging of 0.63-1.64%. They were higher than what [17] reported (0.002-0.004) when they stored cassava for different days and processed into *gari*. Notwithstanding the values obtained compared well with the values reported by [15] who wide variations in values may be a result of some traditional practices such

as duration of fermentation and extent of roasting can cause most of the lactic acid and other organic acids contributing to the TTA to evaporated [18]. Though sample recorded lower values, they were significantly affected (P<0.05) by processing equipment and traditional practices.

Traditional practices such as extent of pressing and roasting have an effect on moisture content of *gari*. Moisture content recorded during the study ranged from 4.469-7.763 percent (Table 1). The values recorded were below the standard specification set for *gari* by Ghana Standard Authority (8-10%) and Codex Alimentarius (12%). Reference [19] indicated that good quality gari should be dry. Moisture content of 9.54-11.57% was reported by [18] from study of on quality of gari from four elite cassava varieties in Ghana. The values also compared well with what [8] reported (4.30-7.44%) in their work within the same region. Samples from Mankron recorded the least moisture content within the district and may be attributed to some of their traditional practices and activities along the processing line. Adequate moisture will ensure absence of free moisture in *gari*, and this will discourage multiplication of micro-organism which will have an adverse effect on the quality of *gari*.

Ash content is a measure of mineral element content in plant, and is dependent on the mineral content of the soil [18] or the percentage of inorganic matter in a sample of some material. Ash content was significantly affected (P<0.05) by processing equipment and traditional practices. Values obtained ranges from 0.623-1.677% (Table 1) with samples from Mfafo/Obrakyere and Papase recording the lowest and highest values, respectively. All *gari* samples had ash lower than maximum recommended figure of 2.75% by Ghana and international specification for good quality (Ghana Standard Authority; Codex Alimentarius, 1989). The values obtained compared well with that Oduro *et al.,* (2000) quoted (0.72-1.96) in their work on quality of *gari* from selected processing zones in Ghana.

Bulk density of *gari* samples ranged between 0.588-0.666gcm^{-3} (Table 2). Only samples D and E compared well with the four varieties [18] worked on. These values were higher than those recorded by [20] for six different cassava cultivars whose bulk densities ranged between 0.15 and 0.30gcm^{-3}. The value were lower than those reported by [15] after treating gari samples with buffer strength whose bulk densities ranged between 0.999-1.687gcm^{-3}Ironically, bulk densities of the samples were influenced by grain size, which is affected by the agglomeration of partially gelatinized product during roasting stage [21]. Intermittent scrubbing between the walls of the roasting pan is needed to disintegrate the lumpy portions of the mash in order to control agglomeration [22].

Swelling capacity of samples ranged between 3.175-3.750 percent (Table 2) indicating all the *gari* samples had good swelling capacity. Reference [23] reported that, good quality gari should swell about three times its original volume when placed in water. The swelling ability indicates the degree of gelatinization and higher swelling capacity is very desirable for good quality gari [12], [24], [8]. Prolonged fermentation period (up to 3 days) for proper degradation of starch led to a higher swelling capacity of gari samples [25]. The data obtained compared well with what [8] reported (2.9-3.6) in their work within the same region where different gari sample were collected from various processing sites.

Table 2: Physiochemical properties of *gari* samples from different processing sites

Location	Sample code	Bulk density(gcm^{-3})	Swelling (%)	Starch (g/100)
Bawjiase	A	0.625^{b}	3.450^{cde}	52.0^{b}
Ofadaa	B	0.666^{a}	3.575^{abc}	52.0^{b}
Ayensuako	C	0.666^{a}	3.350^{def}	52.0^{b}
Awutu Breku	D	0.588^{c}	3.750^{a}	56.0^{a}
Papase	E	0.588^{c}	3.750^{bcd}	51.0^{c}
Mankron	F	0.666^{f}	3.675^{ab}	56.0^{a}
Osaekrodua	G	0.625^{b}	3.350^{ef}	50.0^{d}
Mfafo/Obrakyere	H	0.625^{b}	3.175^{def}	46.0^{f}
Senya	I	0.606^{bc}	3.175^{f}	47.0^{e}

**Means with the same letter are not significantly different

Starch content of *gari* samples varies from one processing centre to the other with sample H recording as low as 46g/100 of starch (Table 2). Samples were observed to decrease from 56-46 g/100; this might be as a result of difference in fermentation time from one centre to the other. Reference [10] reported that the decreases in starch content with increase in fermentation time are due to the breakdown of starch molecules into sugars by microorganisms during fermentation process. All the samples compared well with what [26] reported 54.6-78.0g/100, when he did quality evaluation of samples of *gari* from Ghana. But any variation might be due to the difference in fermentation process of the samples.

V. Conclusion

The study has shown that gari produced in these sites were of good quality and conform to both Ghana Standard Authority and CODEX specifications. It has also shown that processing equipment and traditional practices such as fermentatio

n can affect some physiochemical properties such as TTA, pH and swelling capacity. Notwithstanding, variation in quality parameters may be attributed to factors such as cassava variety, traditional practices at processing sites and duration of fermentation.

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