INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Appraisal of Technological Intervention in the Local Production of Gari in Selected Rural Areas of Lagos State, Nigeria

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Abstract:
The study appraises the intermediate technological intervention in the modified process line of the local and cottage gari processor, with a view to determine its effect on the quality of the gari produced at this level of production. The study was conducted in the rural Local Government Areas of Lagos state of Nigeria. Seventy-five (75%) of these rural Local Government Areas were systematically selected to have Epe, Ikorodu and Badagry Local Government Areas of the state.
Samples of gari collected from major traditional processing centers around the study area were compared in terms of physicochemical properties against the gari produced using this newly introduced technology. The study revealed that there is significance difference (at p<0.05) in terms of some of the properties of the two methods of production such as the ash content, pH, crude fiber and hydrocyanic acid content. However, the gari processed using modern method has a better quality in terms of moisture content, bulk density, particle size analysis, swelling index as well as the water absorption capacity. The study therefore concluded that the intermediate technology has the capacity to improve the quality of gari production at the small and cottage level of production and the improved process line when adopted and can produce a gari of international standards as stated in literatures.

Keywords: *Gelatinization temperature, Gari, Physicochemical properties, Intermediate technology, Fermentation*

1. Introduction

Gari is a gelatinized and dried starchy meal derived from cassava. It is often produced with a characteristic whitish or yellowish colour and in various particle sizes depending on local taste and demand. While some consumers prefer it sour, others do not (Robert, franklin, Bela, Bemjamin, Tessy, Olamide, Ugo, Abolore, Adebowale, Durodola, Noel, Njeufa, Chomdom, Forsythe, Dixon and Fliedel, 2020). The traditional method of producing gari involves peeling and washing of the harvested cassava tubers. This process removes over 80 – 85% of the poisonous cyanogenic compounds often contained in the tuber after harvest (Oyedele, Kilanko and Leramo, 2019). The washed tubers are then milled or grated into a wet mash containing about 60 – 70% moisture. The mash is collected in perforated polyethylene bags and pressed under some heavy load (a process known as dewatering) which reduces the moisture content to about 40 – 50% depending on the efficiency of the press used. Before pressing, the cassava mash is allowed to go through anaerobic fermentation for 1 – 3 days depending on local demand. The length of fermentation determines how sour the gari becomes. However, some local processors carry out fermentation and dewatering of the cassava mash simultaneously. After pressing the cassava mash is compressed into a heavy cake taking the size and shape of the bag in which it was dewatered. Before frying therefore, it is necessary to pulverize the pressed cakes and sift out the fiber content and unbroken cassava, which are not desired in the *gari.* Finally, the sifted meal is fried on hot metallic tray and stirred simultaneously, to achieve the gelatinized and dried meal (a process sometimes referred to as gasification). The yellow coloration is achieved by the addition of palm oil during grating, fermentation or frying (Bechoff, Chijioke, Westby and Tomlins, 2018).

With the introduction of intermediate technology in the gari production, the basic steps involved remains unchanged although machines have been employed to perform most of the unit operations, thereby minimizing human contact with the materials at every stage in the process line. Machines such as cassava peeler, washer, hydraulic press, pulverizer, fryer and sieve shaker are some of the recently introduced machine for the gari production. As presented in Table 1, gari production had presumably received a major boost with the introduction of these machines and establishment of a cassava processing plant in the teaching and research farm at the Michael Otedola College of Primary Education. However, there is no enough research index to justify this assertion.

This research work is embarked upon to investigate the effect of the intermediate technology in the process line of the local gari processors in the areas of comparative analysis of the quality of the product, consumer feedback and cost-effectiveness analysis of using the technology.

S/No	Unit Operations in Cassava Processing	Existing Method of Cassava Processing	Newly Developed Technology
1.	Peeling of cassava tubers	Manual peeling	Rotary drum peeling machine
2.	Washing of cassava tubers	Manual washing	Rotary drum washing machine
3.	Milling of peeled tubers	Grater -not durable -low throughput -contaminates gari -dangerous to operator	Hammer mill grater -durable -high throughput -made of stainless metal -no human contact
4.	Pressing of cassava mash	Manual screw press hydraulic assisted press – many disadvantages	Horizontal hydraulic/screw press – many advantages
5.	Pulverizing & sifting	Manual sieving with raffia sieve –time consuming	Rotary pulverizer/sifter many advantages
6.	Frying and drying	Manual frying in open frying pan –many disadvantages	Conductive rotary fryer/dryer –many advantages
7.	Cooling of *gari* before bagging	Open air cooling by spreading of *gari* on a mat on the ground	Cooling cyclone and reservoir for bagging
8.	Weighing and bagging	Small bowls (kongo) used to fill bags with *gari*	Bagging and sealing machine and weighing scale

Table 1: Technological Innovations for Complete Mechanization of Gari Production

2. Materials and Methods

2.1. Study Area

This research was conducted in the rural Local Government areas of Lagos State, Nigeria which include; Epe, Ibeju- Lekki, Ikorodu and Badagry Local Government Areas. Seventy-five (75%) of these rural Local Government Areas were systematically selected for the study. These are Epe, Ikorodu and Badagry Local Government Areas of Lagos State, Nigeria.

2.2. Sample Collection

Samples were collected in six different processing centers from each of the three selected rural Local Government Areas of Lagos State, Nigeria. The samples were collected in cellophane bags, neatly sealed to prevent insect or rodent infestation and absorption of moisture before analysis. The samples collected were analyzed in triplicate.

2.3. Gari Production Using the Intermediate Technology

The cassava processing plant established in the Michael Otedola College of Primary Education Teaching and Research Farm has been used as the alternative technology center for gari production. The processing techniques were different from the traditional gari production method currently practiced in most of the processing centers around the study area. Though the unit operations involved were practically the same, the main difference is the use of more efficient technologies. The system rather than being haphazardly as in the case of the cottage and small-scale processors, it is a continuous flow process line, with higher capacity and better quality of end product.

2.4. Determination of Chemical Properties of the Gari Samples

The chemical properties of the gari samples obtained from each of the processing centers were determined. Properties such as moisture content, ash content, crude fibre, pH and Hydrocyanic content were determined using standard methods. These were determined following the procedures described by Makanjuola, Akinwale, John and Samuel, (2012.). The moisture content was determined by drying about 5 g of the fuel sample in an oven at 105°C for about 1 hour 30 minutes. The dried sample was placed in a desiccator for 30 min to cool before weighing. The moisture content wet basis was calculated as given by the equation:

$$\frac{(W_i - W_f)X100\%}{Wi}$$

where:

W_i = initial weight of the material (before drying)
W_f = weight of the material after drying

The ash content was also determined by measuring 5 g of the sample into a crucible. The crucible was then placed in muffle furnace with the furnace maintained at 600 °C for 6 hours and allowed to cool down in a desiccator. The ash content was calculated using the equation below.

$$\% \text{ Ash content } = \left(\frac{\text{final weight} * 100}{\text{initial weight}} \right)$$

Crude fibre content of the gari sample from each processing centre was determined using method described by Pearson. The pH was determined on a 5g sample of gari dispersed into 50ml 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). Also, 5.0g of each gari sample was prepared into a paste and dissolved in 50mi distilled water in a corked conical flask. It was allowed to stay overnight. The solution was later transferred into a conical flask. About 4.0ml of alkaline picrate solution was then added and incubated in a water bath for 5 minutes

2.5. Determination of Physical Properties of the Gari Samples

Physical properties such as particle size analysis, swelling index, relative bulk density and water absorption capacity were determined following standard procedures. Following the methods used by Olaosebikan, Aregbesola and Sanni (2016), the particle size analysis was determined by putting 200g of the sample in a mechanical sieve shaker (endecotts test sieve shaker) with standard test sieves (mesh sizes of 2.36 mm, 1.70 mm, 1.00 mm, 0.50 mm, 0.25 mm, 0.15 mm, 0.075 mm, 0.053 mm and pan) and agitated for 15 minutes. The percentages of the sample retained on each of the sieves were recorded. The data obtained from the particle size distribution analysis were also used in determining the fineness modulus, uniformity index amongst other parameters. The average particle size (D) of each sample was calculated as a function of Fineness Modulus (FM) using equation 1 below:

$$D = 0.135 * 1.366^{FM} \quad 1$$

The cold-water swelling capacity was determined using Sanni, Ikuomola and Sanni. (2001) method. Fifty (50ml) measuring cylinder was filled with sample up to 10ml mark. Distilled water was added up to 50ml. The top of the cylinder was tightly covered and the content mixed by inverting the cylinder. After 2 minutes, the cylinder was inverted again. The cylinder was then left to stand for 3 minutes (5 minutes total) and final volume occupied was recorded. Swelling capacity was determined by finding the ratio of the volume of sample in water and initial volume of sample.

The relative bulk densities of the gari samples were determined by taking 5.0g of each sample and measuring equivalent weight of 5ml of water. Relative bulk densities were then calculated as mass of gari over the volume using a 5ml plastic container as described by Ukpabi and Ndimele (1990).

3. Result and Discussion

3.1. Chemical Properties of Gari Samples

As presented in Table 2, the chemical properties of the gari produced using the intermediate technology was compared with the gari around the study area using traditional processing techniques. The moisture content (wet basis) of the gari produced using the modern technology was found to be 9.79 % while the moisture content of the gari samples collected from other processing centers across the study area ranged between 10.11 to 11.69 %. These levels of moisture recorded are in line with the findings of Okolie, Brai and Atoyebio (2012) and Olaosebikan *at al.* (2016). The moisture content of all the gari samples is within acceptable level. The maximum allowable moisture content for gari as stipulated by gari Codex (1989) standards as well as gari regulations (1980) is 12% (wet basis) (Olagoke, Olawale and Mohammed 2014). The moisture content of the gari produced from the intermediate technology has a lower moisture content when compare to other samples from the traditional fryer. This indicates that the gari produced using the modern technology stand a better advantage in terms of storage potentials. Generally, all the gari samples with MC below 13% has a storage capacity of more than seven month according to the report presented by Sanni *et al.,* (2016).

The ash content of the gari produced using the modern technology was lower in ash content (0.77%) compared to the gari samples across the processing centers ranging between 0.97 to 1.11%. Gari regulations (1980) recommended 2.8% ash content while Codex, (1989), Okolie *et al.,* (2012) and Olaosebikan *et al.,* (2016) recommended 3% standard for gari ash content. The values obtained were much lower than the maximum benchmark which make the gari samples considered in this study acceptable in terms of ash content. The result obtained is corroborated by the findings of Makanjuola *et al.,* (2012).

The crude fiber content of all the gari samples varies slightly. The highest crude fiber content of 1.99 % was obtained at Eredo processing centre in Epe. gari sample while the lowest amount of crude fiber (1.25%) was obtained at

Ijede processing centre in Ikorodu gari sample. The fiber content of the modern gari was obtained to be 1.42%. These crude fiber contents are low for all the samples and are within the nutritional maximum level of 3% recommended by Codex (1981) and 2% crude fiber recommended by the Gari Regulations (1980).

The differences in pH values of the samples were also not significant. The highest average pH value (5.01%) was obtained from the Ibonwon processing centre in Epe while the pH value of the modern gari was obtained to be 4.49%. The pH value is a function of the fermentation period. In the case of the modern gari, the fermentation was carried out for 3days and which might also imply that other gari samples were also fermented for 3days which is evident in the similar results obtained for the pH values. The values obtained were close to values reported by Komolafe and Arawande, (2010), Makanjuola *et al.,* (2012).

The gari processed using the intermediate technology has the lowest hydrocyanic acid content. The HCN content of 0.008% was obtained which is slightly higher than the Ibonwon gari with a value of 0.006 and the highest HCN was obtained from the Eredo gari (0.015%). The values obtained for all the samples were generally low when compare to the 0.6% acceptable standard stipulated by the Gari Regulation (1980).

SAMPLE	Moisture Content (%)	Ash Content (%)	Crude Fiber (%)	pH	Hydrocyanic Content (%)
Intermediate technology	9.79	0.77	1.42	4.49	0.008
Noforija gari	11.35	1.02	1.59	4.11	0.009
Poka gari	11.69	1.11	1.74	4.87	0.011
Eredo gari	11.20	0.97	1.99	4.51	0.015
Igbooye gari	10.11	1.05	1.25	4.14	0.012
Ibonwon gari	11.02	1.01	1.81	5.01	0.006

Table 2: Chemical Properties of the Gari Samples in One of the Rural Local Government Areas
Values Were in Triplicates

3.2. Physical Properties of Gari Samples

The particle size distribution and other physical properties of the gari samples were presnted in Table 3. The fineness modulus of the gari sample produced using the inrtermediate technology (4.98) was higher than other samples collected from traditional processing centers with values ranging between 4.02 to 4.87. These values were corroborated by the findings of Burubai and Etekpe (2014). The avaerage particle size of the modern gari was obtained to be 0.64 mm while values of the average particle size of the gari from other centers were found to range between 0.47mm and 0.62mm. the particle sizes obtained for all the gari samples were in line with the findings of Agbetoye and Oyeleke, (2013). The uniformity index of the gari produced from the modern method was found to be 20:70:10 for coarse, medium and fine respectively. Sixty (60%) of five samples collected from traditional processors were found to be on the ratio 30:60:10 for coarse, medium and fine respectively. The uniformity index obtained for the intermediate technology processed gari is better than other traditional gari samples according to the standard stated by Burubai and Etekpe (2014), which stated that the acceptable uniformity index for premium quality garri should be 20 -30% coarse, 50 - 80% medium and 0 – 20% fine. The water absorption capacity of the modern gari was found to be higher than other samples. The average water absorption capacity of the modern gari was found to be above 73% while the highest and lowest value out of the other samples was found to be around 70.54% and 66.58% respectively. This indicated that all the gari samples considered in this study is well dried and will be able to absorb water adequately when soaked in water. There is no significant difference ($p<0.05$) in the relative bulk density obtained for all the traditional gari. However a higher value was obtained with the modern gari which indicated better quality gari. This is because gari sample with low bulk density will result to higher floatation and will not soak properly in water which maylead to rejection by the consumers. The relative bulk density varied between 0.79 to 0.81g/ml for all the traditional gari samples while the bulk density of the modern gari was observed to be higher at a value of 0.88g/mL. The swelling index of all the samples slightly varies from each other with values ranging between 2.98 to 3.24 , as stated by Makanjuola *et al.,* (2012). A good quality gari has been described as that which can swell to at least 3 times its original volume. This implies that almost all the gari samples satisfied this condition except the samples from Poka in Epe Local Government area and that of Topo in Badagry Local Government area samples with swelling index of 2.99 and 2.98 respectively.

Sample	Fineness Modulus	Average Particle Size (mm)	Uniformity Index (Coarse, Medium, Fine)	Water Absorption Capacity (%)	Relative Bulk Density (g/mL)	Swelling Index
Intermediate technology	4.98	0.64	2,7,1	73.15	0.88	3.24
Noforija gari	4.23	0.50	3,6,1	66.58	0.81	3.18
Poka gari	4.44	0.54	1,8,1	69.32	0.78	2.99
Eredo gari	4.02	0.47	1,9,0	68.17	0.79	3.04
Igbooye gari	4.87	0.62	3,6,1	70.14	0.79	2.98
Ibonwon gari	4.02	0.47	3,6,1	70.54	0.81	3.20

Table 3: Particle Size Distributionand Other Physical Properties of Gari Sample
Values Were in Triplicates

4. Conclusion

The study concludes that quality of the gari produced using the intermediate technology can be compared favorably in terms of standard agreed for gari in literatures. The gari produced through the intermediate technology process line has a higher capacity and better-quality end product than what is obtainable in local markets around the study area and can also compete favorably at regional and international markets. The modern gari sample has a better particle size distribution, water absorption capacity and swelling index when compared to locally processed gari. The technology when adopted has the capacity to improve the quality of the gari production by the cottage and local processor of gari which thereby bring about a better quality ofgari production and can make them compete favorably not only in local and regional markets, it can also open way for international patronage.

5. Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

6. Acknowledgements

The authors wish to thank the Tertiary Education Trust Fund (TetfFund) Nigera, for funding this work under the Institutional Based Research (IBR) scheme. The research team also which to acknowledge the effort of the management of Michael Otedola College of Primary Education (MOCPED) for providing the structure for the cassava processing factory where the equipment developed were installed for the local production of High-Quality Cassava

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