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Solid and Microbiological Quality Assesment of Gari within Ibadan Metropolis

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Authors' contributions

The work was carried out by the authors mentioned above. Author AODA carried out the experimental design and wrote the first draft of the manuscript. Author GGA performed the laboratory analysis and managed the experimental processes. Author CAK managed the literature searches and also served as corresponding author. However, all authors were involved in field work, also read and approved the final manuscript.

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ABSTRACT

The processing of cassava tuber to gari and its handling involve different stages. At each stage, there is a level of contamination by solid and microbial pathogen. The solid, micro elements and microbiological quality of gari obtained from three factories, markets and streets within Ibadan metropolis in Nigeria was investigated. Evaluation of solid particle level was carried out by sedimentation method, while micro element and microbial pathogen were determined by using appropriate media. A high level of solid (sand) was observed to range from 0.56 to 1.59%; while micro element such as cadmium 0.01 to 0.14mg/l, lead 0.04 to 0.25mg/l and chromium 0.04 to 0.35mg/l and pathogen like *Aspergillius*, *Fusarium*, *Staplylococcus* and *Basillus* were present in a range 0.00–26.9 cfu x 10^{-3}. These were found to be above WHO's guidelines for drinking-water quality (2006). Suggestions were offered for effective processing and handling of gari in the area.

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1. INTRODUCTION

Cassava (*Manihot esculenta crantz*) is an important food crop grown in tropical countries of the world for mostly its edible tuberous roots and in some places, its leaves. The world production in 2009 was about 242 million tones. Highest production in African, Asia and Latin America were 121, 83 and 36 million tons in respectively [1]. Nigeria being the highest producer in Africa with about 45 million tons [2]. Gari is a dehydrated coarse product obtained from peeled, grated, fermented and roasted cassava tuber. In Nigeria, annual production of cassava climbed to 52.4 million tonnes in 2011 [3].

The quality of the product depends on the management of each stage of processing and handling. The processing of cassava into gari usually takes three to five days both at household and factory levels and its average moisture content is about 8-14 percent. Whichever method is adopted, the most important thing is to maintain stringent hygienic measures especially between the period of finishing and consumption of food [4]. Traditionally, the processing of gari is performed manual by women and children, which is laborious and time consuming. The improved method is expensive due to high cost of machines for an individual small scale processing or for the emergence of cassava processing centres.

The practices associated with the production, processing and handling such as drying on the floor, mat, rock, road side etc after frying and display in the open bowls, bags and mat at point of sale increases solid and microbial contamination [5]. [6] studied the microbiological quality of gari obtain from open markets and traditional processing industry in Benin city and obtained a total heterotropic bacterial count of the open market samples as $7.75 \pm 2.87 \times 10^3$cfu/g with correspond staphilococal count of $1.85 \pm 0.82 \times 10^3$ and fungal propagate count of $2.50 \pm 1.14 \times 10^2$ cfu/g.

Gari is taken in various forms in Nigeria, which include viscous paste (eba), soaking in cold water, mixed with other food like beans, moin-moin, etc. Gari itself may not constitute health hazard, since it has been estimated that various operation involved during processing usually resulted in reduction in total cyanide content. The unhygienic handling and poor sanitary measures that are very obvious as being observed between the last stage of production and the time its being displayed in the markets where the main patronage of many consumers could constitute serious health implications as many chances have been given to contamination by organisms of epidemiological importance [4].

The dust being raised by the breeze, storm, passing-by vehicle and every other form of air movement brings solid particles and heavy metals into gari. Other source of contaminants are from the processing machines. The effects of contaminants could be accumulation of the particles in the stomach, which can cause cancer and appendicitis. Heavy metal content in food has a strict limit. If these limits are exceeded, it could cause harm to the human body. Health based guideline by [7] reported safe level of Lead at 0.01mg/l, Cadmium at 0.003mg/l, Chromium at 0.05mg/l and solid particles at 0.015% [8].Save levels of microbial are E-coliial at +20, streptococcus at 5×10^3, absent of *Aspergillius*, *Fusarium*, pseudomonas and *Basillus*. Pathogens causing diseases like typhoid were some time contacted through the exposure of food to different contaminants in the environment. It is generally observed that some diseases could be contacted through the consumption of food such as gari. This happens due to the way the food is been handled from processing to consumption stage. Therefore, the need to study the levels of solid particles, micro elements and pathogens in gari at processing, marketing and consumption areas and make necessary suggestions for proper handling is inevitable.

2. MATERIALS AND METHODS

2.1 Materials

Gari samples were collected from three different areas i.e gari processing centre/factory, market and community (street vendor). Each area has four locations. The markets and communities were selected based on their closeness to the processing centres/factory on the assumption that most gari produced from each factory are sold in nearest market and consumed in market neighborhood. The located factories are Bakatari, Federal College of Agriculture, Akinyemi and Old-Ife road, the market are Omi, Apata, Oke-Ado and Gbagi while the communities are Amuludun, Adefashe, Bere and Alakia.

2.2 Methods

A complete randomize block design of 4x3x3 replicated 3 times was used for the experiment with a total samples of 108. The samples were weighed by an electric weighing balance as 1gm for heavy metal and bacteria determination respectively. The digest of the ash of each sample was washed into 100ml volumetric flask with deionized or distilled water and made-up to mark. The diluents was aspirated into the bulk 211 Atomic Absorption spectrophotometer (AAS) through the suction tube. Each of the trace mineral elements read at their respective wavelengths with their respective hollow cathode lamps using appropriate fuel and oxidant combination. Likewise for microbiological contaminants, 1gm fried cassava flour (Gari) portion of a water sample was added to a test tube containing 99ml of sterile waters and then subculture into nutrient agar, blood agar and Mac Conkey agar for isolation and differentiations. Further subculture was made for individual colony present. Then, relevant characteristics tests were carried out on each Colony for isolates. For the solid particles, 1gm of each gari sample in a beaker was taken. Enough distilled water 10ml was added and stirred to allow the solid particle settled at the bottom. The particles were then separated by sedimentation/floatation method. The solid particle was allowed to dry and the weighed. The percentage was calculated.

3. RESULTS AND DISCUSSION

3.1 Results

Heavy metals such as lead (Pb), cadmium (cd) and chromium (Cr), microbiological contaminants, bacteria and fungi species such as: Bacillus cereus, streptococcus, Escherichia coli, *Aspergillus* fumigants and fusarium were identified as associated with gari through out production area, marketing and streets in Ibadan metropolis. The average bacterial loads and heavy metals that were obtained in all location were higher than the maximum allowable concentration for human consumption. Also solid contaminants were found to be high in all locations and centres. The results obtained were as presented in Tables 1 and 2.

3.2 Discussion

Heavy metal means any chemical element that has a relatively high density and is toxic or poisonous at high concentration if consumed. Those identified from the study carried out were cadmium (cd), lead (Pb) and chromium (cr). Cadmium derives its toxicological properties from its chemical similarity to zinc and essential micronutrient for plants, animals and human. Cadmium is biopersistant, and once absorbed by any organism above the tolerance level (2-4µg) can cause bone defect (Ostomalacia osteoporosis) in human and animals and it can also cause high blood pressure. The main symptoms are nausea, vomiting, diarrhea and abdominal pain.

Lead is one of the most dangerous heavy metals in the body. Constant exposure or consumption of contaminated food can result in toxic biochemical effects in human which in turn cause problem in the synthesis of hemoglobin, can affect kidney, gastro intestinal track, joints and reproduction system and acute or chronic damage to the nervous system. Lead can also cause renal dysfunction and affect Children's mental development. The tolerance level of lead is about 46-49.6µg. chromium is used in metal alloys and pigments for paints, cements paper, rubber and other materials. Low-level exposure can irritate the skin and cause ulceration. Long-term exposure can cause damage to kidney, liver, circulatory system and Nervi tissues. Chronic arsenic poisoning is manifested as fatigue, weakness, palpitation, convulsion, skin damage, hair loss, pigment deposition and cancer.

It is observed that these heavy metals presence at the processing centres (factory) were the highest, followed by markets and least in the consumption areas (streets); though lead are not significantly different from each other. This might be due to the metallic composition and unhygienic handling of the machines used for grating, sieving, frying and handling. Due to prolong handling of the gari from processing to the consumption area, some of the heavy metals might be lost. Some may settle at the base of containers which are usually discarded due to presences of much solid particles.

Pathogen associated with disease and food poisoning syndrome were identified and isolated in this research work. Those identified E. coli, staphylococcus, bacilli, pseudomonas and fungi.

Table 1. Effect of location on mean value of solid and microbial of garri samples

Area	Location	Metal mg/l			Microbial CFU x 10^{-3}						Solid %
					E. coli	*Staphylococcus*	*Bacilli Sp*	*Pseudomonas sp*	Fungi		
		Lead	Cadimium	Chromium					*Aspergilus sp*	*Fusarium sp*	
Factory	Bakatari	0.15BC	0.11A	0.25C	3.17ED	0.4F	2.17I	2.0E	0.00C	0.003B	0.61CD
	FCA	0.11E	0.08B	0.35A	4.02D	1.23D	1.0J	11.22BC	0.01C	0.003B	0.59D
	Akinyemi	0.25A	0.13A	0.32B	11.3C	0.3F	3.3F	9.5CD	0.06C	0.003B	0.92ABC
	Old-ife	0.04G	0.03C	0.11G	1.53EF	1.2D	2.43H	12.83BC	0.06C	0.02B	0.60CD
Market	Omi	0.12E	0.08B	0.14F	2.23DEF	2.5A	2.53H	2.83DE	0.20C	1.27B	0.62CD
	Apata	0.08F	0.06BC	0.18E	0.57F	1.6C	2.57H	15.16ABC	0.34BC	0.06B	0.68BCD
	Oke-ado	0.16B	0.11A	0.24D	13.47B	0.57E	4.27C	22.33A	0.7AB	0.003B	0.92ABC
	Gbagi	0.05G	0.04C	0.06I	2.53DE	1.6C	4.07D	16.9ABC	0.00C	0.10B	0.84BCD
Street	Amuludun	0.14CD	0.04C	0.07H	0.53F	0.4F	3.53E	2.87DE	1.06A	0.01B	1.22A
	Adefashe	0.14D	0.08B	0.11G	0.57F	2.4A	3.13G	16.33ABC	0.04C	0.03B	0.98AB
	Bere	0.12E	0.08B	0.07H	15.16A	1.33D	5.3B	18.66AB	0.00C	0.007B	0.99AB
	Alakia	0.09F	0.04C	0.05I	2.60DE	1.77B	6.67A	17.5AB	0.07C	1.08A	0.92ABC
SD		0.05	0.03	0.10	5.21	0.73	1.47	7.39	0.38	1.10	0.24
Average		0.12	0.07	0.16	4.81	1.28	3.41	12.34	0.21	0.2	0.83
Minimum		0.04	0.01	0.04	0.07	0.3	1.00	2	0	0.00	0.56
Maximum		0.25	0.14	0.35	15.30	2.6	6.8	26.9	1.10	1.3	1.59

Key FCA - Federal College of Agriculture, Ibadan
- - Absent

Table 2. Effect of area on mean values of solid and microbial of garri samples

Area	Metal mg/l			Microbial CFU x 10^{-3}						Solid %
				E. coli	*Staphylococcus*	*Bacilli sp*	*Pseudomonas sp*	Fungi		
	Lead	Cadimium	Chromium					*Aspergilus sp*	*Fusarium sp*	
Factory	0.14A	0.09A	0.26A	5.01A	0.78B	2.23C	8.88A	0.03A	0.01A	0.68B
Market	0.11A	0.07AB	0.15B	4.7A	1.57A	3.35B	14.31A	0.31A	0.33A	0.77B
Street	0.12A	0.06B	0.08C	4.72A	1.48A	4.66A	13.24A	0.29A	0.28A	1.03A

These pathogens were observed in all area with least concentration in the processing areas (factories). Both bacteria and fungi contamination were detected at different concentrations at almost all locations. It is observed that microbial counts increased generally from processing areas (factories) to consumption areas (streets). However, there are no significant differences between the means of *E. coli*, pseudomonas and fungi. From FAO/WHO expert consultation on microbiological specifications for foods, maximum allowable numbers of bacteria unit yielding unsatisfactory test for coliform unit above or equal to two is unfit for human consumption [9]. Similarly, *Aspergillus sp* of fungi are main source of aflatoxin which is very risky to human health even at low level of 10ppb [10]. The consumption of these organisms may results to serious problem as food-borne bacteria manifest their pathogenicity either by multiplication in the intestine or through vomiting. Bacillus cereus causes gastroenteritis, *E. coli* causes blood diarrhea in human, fungi are known to be associated with many human and animal diseases of the lungs, liver and other intestinal organs [4]. However for the study area, the product is fairly safe for consumption. It is advisable that before direct consumption as snack, gari should be diluted twice and decant to reduce the microbial load to a very low level which is considered safe for consumption.

The presence and level of microbial load suggests the unhygienic handling of gari in the metropolis. However, the values were found to be less than those observed for open markets and traditional processing industry in Benin City [6]. The microbial contamination was likely from containers, bags, measuring and transport device used, quality of water for washing the peeled tubers, sneezing, talking, coughing, dust raised by passer-by and vehicle, dirty environment and other unhygienic habits of the chains of handlers in accordance with [5,6,4].

Solid particles includes sand and iron fillings get into gari through processing ie grating, sieving, frying and also in the course of handling the product at all levels. High consumption rate of solid particle could cause appendicitis, ulcer and tooth decay. It is observed from the study that, solid particle contamination increased from factory to the community (food vendor). This is due to poor handling, such as dropping of gari bags directly on the ground and the quality of handling materials used which also affects the shelf stability of gari [11].

4. CONCLUSION

From the study carried out, the following conclusions were drawn:

(i) There is presence of pathogen (E. coli, staphylococcus, bacilli, pseudomonas and fungi) in the gari sample in the area of study. Also present are heavy metals (lead, cadmium and chromium), which were found to be above the recommended human body tolerance. Solid particle level was found to be 0.56–1.59% which is well above the recommended level.
(ii) Microbial Pathogen, heavy metal and solid particle were found to be present right from processing (factories), markets to consumption areas (streets) in the metropolis.
(iii) The presence of heavy metals, microbial pathogens and solid particle suggests poor level of processed product and handling in the country. If urgent measure is not taken to create awareness about the slow poison food products, it could play a major role in epidemic outbreak in various communities.

5. RECOMMENDATIONS

(i) Effort should be made by authority concerned to encourage machine fabricators and importers for quality machine parts so as to avert wears and contamination of gari during processing.
(ii) Quality water should be insisted upon for washing of tubers rather than stream water as most gari processing pools are located near stream for this purpose irrespective of the danger.
(iii) The habit of drying half fried gari on concretes, rocks, mat etc should be disallowed to reduce the level of solid particle and microbial contamination.
(iv) The sanitary conditions of our factories, markets and communities should be improved. Gari displayed for sale should be well covered and unhygienic habits in public places should be discouraged.
(v) Properly fried gari would not only reduce the moisture content to safe storage level but also inhibit microbial growth.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. APCTN, Action plan for a cassava transformation in Nigeria. Accessed 11th February, 2013. Available: http://:www.unaab.edu.ng. 2013;508–511.
2. FAO, Food Outlook, Global Market Analysis; 2009. Accessed on 1st feb, 2013. Available: http://:www.fao.org/docrep.
3. Osagie C. IITA moves to position as major source of animal feed; 2013. Accessed 4th Nov; 2013. Available: http://:www.thisday.com/articles/iita.
4. Arasi MA, Adebayo GG. Survey of microbial pathogen in Gari Displayed in open markets within Ibadan Metropilis. Proceedings of the 18th Annual Conference of the Nigerian Institute of Science and Technology. 2000;83–93.
5. Ogiehor IS, Ikenehomeh MJ. Extension of shelf life of garri by hygienic handling and sodium benzoate treatment. Africa Journal of Biotechnology. 2005;4(7):744–748.
6. Omonigho SE, Ikenebomeh MS. Microbiological quality assessment of gari with reference to thermo release.
7. WHO Guideline for drinking water quality. Firt addendum to third edition. 2006;I. ISBN 924154696.
8. Adetayo AO. Impact of waste dump and industrial effluents on groundwater quality at Oluyole industrial estate, Beere and Bodija estate aaaarea of Ibadan metropolis. Lautech journal of engineering and technology. 2007;4(2):13-18.
9. William CF, NS, Dennis CW. "Food Microbiology," Tala McGraw-Hill Publishing Company Limited New Delhi; 1998.
10. Van W. Guidelines FAO/WHO/UNICEF) Protein Advisory Board; 1973.
11. Ogiehor IS, Ikenebomah MJ. The effect of different packing materials on the shelf stability of gari. African Journal of Biotechniology. 2006;5(23):2412–2416.

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