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THE MICROBIAL QUALITY OF GARRI SOLD IN SWALI MARKET IN BAYELSA STATE NIGERIA AND ITS PUBLIC HEALTH IMPLICATIONS

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ABSTRACT
The microbial quality of garri sold in Swali market in Bayelsa State, Nigeria was studied. A total of eight (8) samples (4 white and 4 yellow) were purchased from different spots in and around the market. The samples were analyzed for total aerobic plate count and total coliform count on nutrient and MacConkey agar respectively using spread plate method. The moisture content was also analyzed. The moisture content ranged from 10.09% to 15.4% for yellow garri while white garri had a moisture range of 10.45% to 14.95%. The total aerobic plate count for the yellow garri was between 1.5×10^4 and 2.8×10^4, total coliform count ranged from 5.2×10^3 to 1.14×10^4, while the white garri had a range of between 3.6×10^3 and 1.2×10^4, for total aerobic plate count, and from no growth (NG), to 9.5×10^3 for total coliform count. From the result of the study, the moisture content of some of the samples exceeded the safety limits; total aerobic plate count was within the tolerable range, while the presence of coliform calls for concern. Proper handling, packaging and storage under hygienic conditions are recommended. Also proper drying of garri to lower its moisture content should be encouraged.

KEYWORDS: Total aerobic plate count, total coliform count, moisture content.

INTRODUCTION
The diet of many African people especially the Nigeria people are supplemented with cassava products preserved by special method such as garri, fufu etc. It may be partially or completely backed or precooked ready for eating and serving. During preparation, food may be contaminated with microorganisms. Unless the growth and metabolism of this microorganism are controlled, they are capable of altering the condition of food resulting in food spoilage.

In garri preparation the cassava is pealed, washed, grated then follow by dehydration under pressure, finally frying, packaging and storage. These processes if not handled under hygienic conditions could lead to contamination by micro-organisms which could result to disease and even death thus reduce the working force and leading to increased poverty rate due to heavy hospital bills. Several studies have been carried out on the microbial quality of garri sold in markets in Nigeria. Oranusi *et al* (2014) carried out a research on the microbiological quality of fermented cassava (garri) at Ota, Ogun State of Nigeria. Their study reported bacteria isolates from the various samples which included *Bacillus spp Enterobacter spp*, *Pseudomonas*, *Staphylococcus* and Klebsiella spp. Fungi isolated included *Aspergillus niger*, *Aspergillus fumigatus*, *Fusarium*, *Rhizopus* and *Penicillium* spp. Orji *et al* (2016) determined the bacteriological quality of fermented cassava (garri) sold in Okwor and Nkalagu markets in Ebonyi State, Nigeria. Their results revealed a high microbial burden in the garri samples examined ranging from 6.6×10^6 to 1.07×10^7. The study reveals unacceptable bioload in garri. The microbiological quality of garri obtained from open markets and traditional processing industry in Benin City with reference to staphylococcal contamination was investigated by Ominigho and Ikenebomeh (2002). From the study, it was found that there was contamination and growth of *Staphylococcus aureus* and possibly the presence of staphylococcal enterotoxin in the product. Johnson *et al*, (2016), studied the bacteriological assessment of cassava products in three different main markets, modern, Wadata and Wurukum markets all in Makurdi Benue State to determine bacterial contamination. Five major bacteria isolated were *Escherichia coli. Aerobacter aerogenes Salmonella species*, *Streptococcus faecalis* and *Staphylococcus aureus.*

MATERIALS AND METHODS

Collection of samples

The study was carried out between September and October, 2017. A total of eight (8) samples of which four (4) were yellow garri and the other four (4) white garri were purchased from different areas at the Swali market. The samples were labeled appropriately to indicate the name of the market, garri type (yellow or white), sample number, date and time of collection. Samples were transported in sterile containers to the laboratory for analysis within 24 hours of collection.

Sterilization

Glassware's were washed with detergent and rinsed several times with distill water. After rinsing, glassware's were put in an autoclave for 15 minutes at 121^{o}c.

Determination of moisture content

The moisture content of each sample was determined by the modification of methods described by AOAC (Association of Analytical Chemist). Ten grams of each sample was weighed and dried in an oven at 100ºC for 1 hour after which, they were placed in desiccators to cool and then reweighed. This was repeatedly done until a constant weight was obtained. The moisture content was then determined by finding the difference in weight.

Percentage (%) Moisture Content= W2-W3
W1= Weight of empty petri dish
W2= Weight of petri dish + Sample before
W3= Weight of empty petri dish + Sample after

Preparation of Culture Media

Nutrient Agar (Na)

5.6g of nutrient agar was dissolved in 200ml of distilled water mix in a conical flask plugged with cotton wool and covered with aluminum foils paper. The nutrient agar in the conical flask was sterilized by autoclaving at 121^{0}c for 20 minutes.

Microbiological analysis

Ten gram (10g) of samples of garri were homogenized in 90 ml sterile distilled water (10-1 dilution), tenfold serial dilution was prepared by transferring 1ml of aliquot into 9ml of sterile peptone water. The further serial dilution of sample homogenate to 10-4 was carried out also in sterile distilled water.

1ml of appropriate dilution was aseptically plated using spread plate method for total aerobic plate count on nutrient agar and total coliforms on McConkey agar. All plates were incubated at 30^{o}c for 24hours. At the end of the incubation period, discrete colonies were enumerated and expressed as log of colony. Colony forming units per gram (CFU/g) of sample

RESULTS

The result of the analysis of the garri samples were as follows:

The total aerobic plate count for the yellow garri recorded was highest in point C which recorded 2.8×10^4, with a total coliform count of 1.14×10^4 and moisture content of 15.0% and, followed by point B with 2.1×10^4, 9.6×10^4 and 15.4% for total aerobic plate count, total coliform count and moisture respectively. Point D had 1.6×10^4, 6.8×10^3 and 14.5% for TAPC, TCC and moisture respectively, while the least TAPC was recorded at point A, with 1.5×10^3, TCC 5.2×10^3 and moisture 10.9% for

The result for white garri is as follows;
The total aerobic plate count for the white garri recorded was highest in point B which recorded 1.2×10^4, TCC 9.5×10^3 with moisture content of 14.06%, followed by point A with 1.1×10^4, 7.9×10^3 and 14.95% for total aerobic plate count, total coliform count and moisture respectively. Point D had 4.9×10^3, NG and 12.00 for TAPC, TCC and moisture respectively, while the least TAPC was recorded at point C, with 3.6×10^3, NG (no growth) for TCC and moisture 10.45%.

Table 1: Total Aerobic Plate Count of bacteria.

Yellow garri	White garri
1.5×10^3	1.1×10^4
2.1×10^4	1.2×10^4
2.8×10^4	4.9×10^3
1.6×10^4	3.6×10^3

Acceptable plate counts for ready to eat food
$\leq10^3$ - acceptable
$10^4 - 10^5$- tolerable
$\geq10^6$ - unacceptable
(source: International Commission On Microbiological Specifications For Food ICFSF 1999).

Table 2: Total Coliform count.

Yellow garri	White garri
5.2×10^3	7.9×10^3
9.6×10^4	9.5×10^3
1.14×10^4	NG
6.8×10^3	NG

The African Organization of Standardization recommends the absence of coliform in ready to eat food.

Table 3: Moisture content.

Yellow garri	White garri
10.09	14.95
15.4	14.06
15.0	10.45
14.5	12.0

Safety levels for moisture content: Yellow garri- 13.60%
White garri- 12.70%

DISCUSSION

The garri samples contain total aerobic plate counts within the acceptable and tolerable limit. Ready to eat foods with plate counts of 10^3 are acceptable, counts of

10^4 to 10^5 are tolerable while counts 10^6 are unacceptable (ICMSF, 1996).

Coliform was detected in most of the garri samples at high counts 10^3, although no fecal coliform was detected, the presence of coliforms generally signifies poor sanitary condition in the production of garri. Garri after frying (heat treatment) is often spread in the open to cool and air dry and it is there after sieved. Products are often displayed in open basins/bowls for sales in the market place. The presence of coliform could therefore be from post process contamination via food handlers and the environment. The ICMSF (1996) and the African Organization for Standardization, recommends the absence of coliform in ready to eat foods. The presence of coliform in most of the garri samples therefore makes it of poor quality for human consumption.

Although the total aerobic counts with the exception of coliform counts are within acceptable and tolerable standard limits (ICMSF, 1996), further analysis could have revealed the presence of pathogenic bacteria that have been implicated in food borne intoxication (Mensah et al., 1999; Oranusi et al., 2007).

A lot of studies carried out outline various microorganisms found in garri. Such studies include; Oranusi et al, 2014, which reported organisms such as *Bacillus spp Enterobacter spp, Pseudomonas, Staphylococcus and Klebsiella spp*. And Fungi isolated which included *Aspergillus niger, Aspergillus fumigatus, Fusarium, Rhizopus and Penicillium spp.* This present work also conforms to that of Adeniran and Ajifolokun (2015) who reported the following *Corynebacterium manihot, Lactobacillus plantarum, Bacillus subtilis, Bacillus coagulans, Bacillus species and Corynebacterium species.* Also isolated were *Saccharomyces cerevisae, Saccharomyces fragilis, Saccharomyces rouxii and Geotricum candidum.* Two moulds, *Aspergillus niger* and *Rhizopus stolonifer,* were found associated with co-fermented meals of cassava and breadfruit.

There is however a difference when compared to that of Isichei-Ukah and Imiere (2017) who studied the microbial quality of processed garri with the aim of assessing the impact of the processing environment on the microbial quality of the garri. The various stages were also found to harbor microorganisms such as *Staphylococcus* sp., *Salmonella* sp., *Escherichia coli*, *Lactobacillus* sp., *Pseudomonas* sp., *Aspergillus niger*, yeast cells, *Penicillium chrysogenum* and *Penicillium notatum* which directly or indirectly found its way to the processed garri. Microorganisms isolated from the different garri samples showed that microorganisms isolated from the identified sources of contamination apart from *Mucor* sp., *Aspergillus fumigatus* and *Aspergillus tamari* were all present in the garri.

The microbial content of food and food products depicts interplay between pH and moisture contents.

The results of this present study showed that the moisture content of the garri samples studied was higher than the safety levels of 12.70% (for white garri) and 13.60% (for yellow garri). The higher the moisture content of the garri sample the higher the total bacterial count for both white and yellow garri samples studied. This study corroborates the work of Ogiehor *et al.* [2007] that high pH and moisture content supports the growth of microorganisms in the garri samples.

CONCLUSION

From our study we found out that the total aerobic plate count was within the acceptable and tolerable level as recommended by the International Commission on Microbiological Specification for Food, while total coliform was recorded although the African Organization on Standardization recommend the absence of coliform in ready to eat food. The moisture level of the garri was higher than the safety levels of both white and yellow garri. Also the moisture content of the garri is also a predisposing factor to the bacterial contamination. Storage area is also another predisposing factor as well as the manner in which both the buyers and sellers handle the garri.

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