MICROBIAL QUALITY OF GARRI SOLD IN ILARO TOWN

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ABSTRACT

Garri is a staple food made from cassava tuber that is consumed in many homes across Nigeria and other West Africa countries. Microbial quality of yellow and white garri sold in Ilaro town was investigated in this study. Twenty garri samples were obtained from various marketing sites in the town. The microbial load of the samples was determined using pour plate technique and the isolates were identified using conventional method. The total aerobic plate count of the white garri ranged from 1.0 x 10^5 to 4.0 x 10^7cfu/g and *Staphylococcus aureus* count ranged from 7.0 x 10^2 to 1.5 x 10^3 cfu/g, while coliform count and fungal count ranged from 1.1 x 10^2 to 1.5 x10^2 cfu/g and 6.0 x 10^2 to 3.5 x 10^3 cfu/g respectively. The microbial load of the yellow garri ranged from 6.1 x 10^5 to 7.3 x 10^7cfu/g for total aerobic plate count while the *Staphylococcus aureus* count ranged from 3.0 x 10^2 to 6.0 x 10^3cfu/g. More so the coliform count ranged from 1.0 x 10^2 to 2.0 x 10^2cfu/g and the fungal count was from 4.0 x 10^2 to 3.0 x 10^3cfu/g. The bacteria isolated from the samples include *Bacillus cereus*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli*, although presence of *Pseudomonas aeruginosa* was not recorded in white garri. Fungi isolated from the garri include *Aspergillus niger*, *Aspergillus flavus*, *Mucor* sp., *Rhizopus* sp. and *Penicillium* sp. High microbial load and array of microorganisms associated with garri sold in Ilaro are of great concern.

Keywords: Garri, microbial load, bacteria, fungi, great concern

Introduction

Garri is one of the fermented products derived from cassava (*Mannihot esculenta*) tuber mash. It is consumed in many homes across Nigeria and other West African countries, and form significant part of their diet (Ogbugbue *et al.*, 2011). It is a ready-to-eat food that is consumed across the various age groups, gender, regions and tribes. It is a starch food that supplies required energy to the consumers. Garri is also consumed irrespective of the financial status and education (Ajayi *et al*., 2017) Garri is dehydrated product obtained from peeled, grated, fermented, and roasted cassava tuber. It is a granular flour product that is usually creamy white or yellow in colour. The yellow type is usually fortified with palm-oil, although, there is new breed of cassava tuber that is yellowish in colour. It is commonly consumed by soaking in cold

water with sugar, coconut, roasted peanut or boiled cowpea as compliments. More so, it is also consumed as a stiff past, known as "Eba" in Western Nigeria; made with hot water and eaten with soup or stew (Awoyale *et al*., 2017). The choice of consumers varies; usually the acceptability of the product depends on its sourness, particle size and colour.

Despite the acceptability of garri across West African countries, it is mostly produced as cottage product, and the method of production in most places remains the traditional type that affects products quality constituency. The quality of the garri is also affected by storage and handling methods. Fermentation duration also determines the sourness of the product and degree of dryness determines its shelf-life. According to Arasi and Adebayo (2011) the average moisture content of garri is usually about 8 – 14 %. The safety of this product is usually compromised at the marketing sites. It is most times displayed openly in bowls order to call the attention of buyers or consumers. It is usually tasted at the marketing sites with unhygienic bear hands. The product is usually contaminated with dust and other improper handling methods. At times the product is dried under the sun along the roadsides; this drying method exposes the product to different contaminants (Ogbugbue *et al.*, 2011). Post-processing issue is always associated with garri sold in most markets across the Nigeria. Poor handling and storage techniques expose garri to microbial contamination. The study aimed at determining the microbial quality of white and yellow garri sold in selected marketing sites in Ilaro town.

Material and Methods

Area of the Study and Sample collection

The study was carried out in Ilaro, located in Yewa- South Local Government area of Ogun State, Nigeria. Twenty (20) garri samples were obtained from four (4) marketing sites in the town; O and Sample collection rita, Igboro, Gbodidi and Sabo. The samples were collected in sterile polyethylene bags. They were analysed within 24 hours of collection.

Analysis of Microbial Contamination

The total viable count of the garri samples was determined using pour plate method as describe by Ajayi *et al.* (2017). A ten-fold serial dilution was carried out. The appropriate dilution factors were plated Nutrient agar, MacConkey agar, Baird Parker agar and Salmonella/Shigella agar for bacterial count. Potato dextrose agar (PDA) supplemented with streptomycin was used for mould isolation. The bacterial plates were incubated at 35^{o}C for 24 h while the mould plates were incubated at 27±2^{o}C for 72 h. The samples were inoculated under aseptic condition. The isolates enumerated and sub-cultured in order to get pure cultures. The organisms were preserved on agar slant and kept at the refrigerated temperature (4^{o}C) until further analysis.

Identification of Bacterial Isolates

The pure isolates were identified based on their colonial/cultural characteristic, cellular characteristic (shape, and Grams staining) and biochemical test were carried out as described by Cheesbrough (2006) and Holt *et al*. (1994) Bergey's Manual Determinative Bacteriology were used as guides.

Identification of Fungal Isolates

The fungal isolates were identified based on morphological characteristics. Slides of the fungal were prepared using cotton blue lactophenol. The slides were observed under microscope using x10 and x40 objectives. The isolates were be tentatively identified by using Fungi atlas (John and Mishra, 2017).

Results

The microbial load of the garri samples from the four marketing sites is shown in table 1. The total aerobic plate count (TAPC) ranged from 4.0 x 10^7 to 7.3 x 10^7 cfu/g. The least and highest TAPC were recorded in Gbogidi samples. Only five samples showed presence of coliform, and the least coliform count (1.0 x 10^2 cfu/g) was recorded in sample $YGSY_1$ while sample $YBSY_1$ had the highest coliform count (2.0 x 10^2 cfu/g). There was no presence of coliform in Gbogidi samples. All the samples recorded high *Staphylococcus aureus* count and mould count.

The presence of *Pseudomonas* species, *Pseudomonas aeruginosa*, *Klebsiella* sp., *Escherichia coli*, *Bacillus cereus*, *Bacillus* sp., *Mucor* sp., *Aspergillus niger*, *Aspergillus flavus*, *Penicillium* sp., and *Rhizopus* sp in varying degrees in all the samples.

Table 6 shows the frequency and percentage of occurrence of isolates present in all samples. It shows the percentage of occurrence isolates. The table shows that *Aspergillus niger* has the highest frequency of occurrence while *Penicillium* sp *and Rhizopus* sp have the lowest

TABLE 1: Microbial Load of Garri Samples

Sample Source	Sample code	Microbial Load (cfu/g)			
		TAPC	**Coliform count**	***Staphylococcus aureus* count**	**Total mould count**
Orita	WGO_1	1.3×10^5	1.5×10^2	7.0×10^2	6.0×10^2
	WGO_2	1.4×10^5	Nil	1.4×10^3	7.0×10^2
	WGO_3	2.1×10^5	Nil	1.5×10^3	2.5×10^2
	YGO_1	6.1×10^5	Nil	3.0×10^2	4.0×10^2
	YGO_2	6.3×10^5	Nil	4.0×10^2	3.0×10^3
Igboro	WGI_1	1.1×10^6	Nil	7.4×10^2	6.0×10^2
	WGI_2	7.5×10^6	Nil	8.0×10^2	7.0×10^2
	WGI_3	1.5×10^7	1.1×10^2	1.5×10^3	3.0×10^3
	YGI_1	6.2×10^7	Nil	5.0×10^2	4.0×10^2
	YGI_2	7.0×10^6	Nil	6.0×10^3	4.0×10^2
Gbogidi	$WGSY_1$	4.0×10^7	Nil	8.0×10^2	1.4×10^3
	$WGSY_2$	1.6×10^7	Nil	7.0×10^2	6.0×10^2
	$WGSY_3$	1.2×10^6	1.5×10^2	$1.3. \times 10^3$	6.0×10^2
	$YGSY_1$	7.3×10^7	2.0×10^2	5.0×10^2	3.0×10^3
	$YGSY_2$	6.0×10^6	1.2×10^2	6.0×10^3	4.0×10^2
Sabo	GSB_1	1.6×10^5	Nil	7.5×10^2	6.0×10^2
	GSB_2	1.0×10^5	Nil	7.0×10^2	3.5×10^3
	GSB_3	1.2×10^6	Nil	1.3×10^3	6.0×10^2
	GSB_1	6.1×10^6	Nil	3.0×10^2	3.5×10^2
	GSB_2	6.2×10^6	Nil	4.0×10^2	3.0×10^3

Key: Garri Orita (GO), Garri Igboro (GI), Garri Sayedero (GSY), Garri Sabo (GSB), TAPC (Total aerobic plate count), White (W), Yellow (Y)

TABLE 2: Identification of Bacteria Isolate

Sample Code	Colonial Morphology	Cellular Characteristic			Biochemical Test						Probable Organism
		Gram reaction	Shape	Arrangement	Catalase test	Coagulase test	Lactose	Sucrose	Glucose	Oxidase test	
GO_1B	Circular, creamy, opaque, undulate and dry	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.
GO_1ST	Circular, golden yellow opaque, entire, and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
GO_2ST	Circular, golden yellow, opaque, entire and butryous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
GO_2B	Circular, creamy, opaque, undulate and dry	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.
GO_2K	Irregular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
GO_3B	Irregular, creamy, opaque, undulate and dry	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.
GO_3ST	Circular, golden yellow, opaque, entire and butryous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
GO_3K	Circular, creamy, opaque, entire, and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
GI_1ST	Circular, golden yellow, opaque, entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
GI_1P	Irregular, greenish, opaque, entire and butryous	-	Rod	Cluster	+	-	-	-	+	+	*Pseudomonas* sp.
GI_1K	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
GI_1B	Circular, creamy, opaque, undulate and dry	+	Rod	Pair	+	-	+	+	+	ND	*Bacillus* sp.
GI_2B	Circular, creamy, opaque, undulate and dry	+	Rod	Pair	+	-	+	+	+	ND	*Bacillus* sp.
GI_2K	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
GI_3K	Circular, creamy, opaque entire, and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
GI_3ST	Circular, golden yellow, opaque entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
GI_3B	Circular, creamy, opaque undulate and dry	+	Rod	Pair	+	-	+	+	+	ND	*Bacillus* sp.
$GSAY_1K$	Circular, creamy, opaque entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
$GSAY_1ST$	Circular, golden yellow, opaque, entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAY_1B$	Circular, creamy, opaque, undulatery	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.
$GSAY_2ST$	Circular, golden yellow, opaque, entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAY_2B$	Circular, creamy, opaque, undulate and dry	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.

$GSAY_2P$	Irregular, greenish, opaque, entire and butyrous	-	Rod	Cluster	+	+	-	-	+	-	*Pseudomonas* sp.
$GSAY_2K$	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
$GSAY_3B$	Circular, creamy, opaque, undulate and dry	+	Rod	Cluster	+	-	+	+	+	ND	*Bacillus* sp.
$GSAY_3ST$	Circular, golden yellow, opaque, entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAY_3K$	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
$GSAB_1ST$	Circular, golden yellow, opaque, and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAB_1B$	Circular, creamy, opaque, undulate and dry	+	Rod	Chain	+	-	+	+	+	ND	*Bacillus* sp.
$GSAB_2K$	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
$GSAB_2ST$	Circular, golden yellow, opaque, entire and butryous	+	Cocci	Clustered	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAB_3ST$	Circular, golden yellow, opaque, entire and butyrous	+	Cocci	Cluster	+	+	+	+	+	ND	*Staphylococcus aureus*
$GSAB_3K$	Circular, creamy, opaque, entire and mucoid	-	Rod	Scattered	+	-	+	+	+	-	*Klebsiella* sp.
$GSAB_3B$	Circular, creamy, opaque, undulate and dry	+	Rod	Pair	+	-	+	+	+	ND	*Bacillus sp.*

Key: + = Positive, - = Negative, ND = Not Done

Table 3: Identification of fungal isolates

Colonial Character	Microscopic Character	Probable Isolates
Fast growing, white to grey brown, loose mass of cotton brown lover whole plate.	Sporangia supported by columella, lack of rhizoids, sporangioshore arising from any part	*Mucor* species
Densely packed black conidia, florescent yellow reverse side.	Yellowish-brown smooth conidosphore, rough globose conidiospores, biseriate phiallides	*Aspergillus niger*
Fast growing cotton like texture, white yellowish	Presence of sporangia, sporangiospores, rhizoids and group of sporangiophore arising from nodes	*Rhizopus* species
Light grey-green to pale, blue green, fluffy mycelium cream white to dull white, reverse of the plates yellow orange and wrinkled	Pale brown conidiosphore, globose, smooth and rough conidiospores, biseriate and uniseriate	*Aspergillus flavus*
Pale, bluish green to dark green	Spherical, smooth green conidia with branched hyphea and medulla	*Penicillum* species

TABLE 4: Organisms associated with the Garri Samples

Sample Code	Isolate
WGO_1	*Bacillus cereus., Staphylococcus aureus, Mucor* sp., *Aspergillus niger*
WGO_2	*Staphylococcus aureus, Bacillus cereus, Klebsiella* sp., *Mucor* sp., *Penicillium* sp.
WGO_3	*Staphylococcus aureus, Bacillus cereus., Klebsiella* sp., *Rhizopus* sp., *Aspergillus niger*
YGO_1	*Bacillus sp., Staphylococcus aureus, Aspergillus niger, Rhizopus* sp.
YGO_2	*Bacillus sp., Staphylococcus aureus, Penicillium* sp., *Aspergillus niger*
WGI_1	*Staphylococcus aureus, Bacillus* sp., *Klebsiella* sp., *Rhizopus* sp. *Bacillus sp., Staphylococcus aureus Staphylococcus aureus, Mucor* sp., *Penicillium* sp.
WGI_2	*Klebsiella* sp., *Bacillus cereus, Aspergillus niger, Rhizopus*
WGI_3	*Staphylococcus aureus, Bacillus* sp., *Klebsiella* sp., *Aspergillus niger, Rhizopus* sp.
YGI_1)	*Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus cereus, Aspergillus niger, Rhizopus* sp.
YGI_2	*Staphylococcus aureus, Bacillus cereus, Aspergillus niger, Penicillium* sp.
$WGSD_1$	*Staphylococcus aureus, Klebsiella* sp., *Bacillus cereus, Aspergillus niger, Mucor* sp.
$WGSD_2$	*Staphylococcus aureus, Bacillus cereus., Klebsiella* sp., *Aspergillus niger, Penicilluum, Mucor* sp.
$WGSD_3$	*Staphylococcus aureus, Klebsiella* sp., *Bacillus cereus, Aspergillus niger, Mucor* sp.
$YGSD_1$	*Staphylococcus aureus, Klebsiella sp., Bacillus cereus,, Aspergillus niger, Penicillium* sp.
$YGSD_2$	*Pseudomonas aeruginosa. Klebsiella* sp., *Aspergillus niger, Rhizopus* sp.
$WGSB_1$	*Staphylococcus aureus, Bacillus cereus. Aspergillus niger, Rhizopus* sp.
$WGSB_2$	*Staphylococcus aureus, Klebsiella* sp., *Penicilluum, Mucor* sp.
$WGSB_3$	*Bacillus cereus., Staphylococcus aureus, Klebsiella* sp., *Rhizopus, Aspergillus niger*
$YGSB_1$	*Staphylococcus aureus, Bacillus cereus, Penicilluum, Mucor* sp.
$YGSB_2$	*Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus cereus, Bacillus cereus,, Aspergillus niger, Penicillium* sp.

Discussion

All samples collected from Four (4) market sites showed high total aerobic plate count and mould count. The high bacterial and fungal count is due to post-production contamination. Microbial contamination could be due to non-covering of the garri and improper handling. Both the white garri and the fortified garri (yellow) showed high level of microbial loads. The finding agrees with similar work reported by Awoyale *et al* (2017), this might be due to similar handling and storage technique by the produces and marketer. The results of this study corroborate the finding of Akoma *et al*. (2019). The isolation of diverse microbial species from the garri samples corroborate the findings of Ogbugbue *et al*. (2011), Adejumo *et al*. (2015), and Oranusi *et al*. (2012). The presence of coliforms could therefore be from-post processed contamination via food handlers and the environment. Coliforms are known as indicators of faecal contamination. The presence of coliform could be due poor hygiene of the producers and handlers. The out of this finding also agrees with similar studies carried out by Akoma *et al*. (2019), Ajayi *et al*. (2017) and Orji *et al*. (2016) but at variance with finding of Ogiehor and Ikenebomeh (2005) The presence of *Staphylococcus cereus* observed in the study agrees with the reports of Ogiehor *et al*. (2006). Presence of *Staphylococcus aureus* could be from the handler, since the organism is a normal flora of the body. They might have found their way into the garri through carriers, since the organisms could have been found around the nose, throats, hands and clothing of the carrier. *Staphylococcus aureus* is known its enterotoxigenic ability and is the causative agent of staphylococcal food poisoning.

The isolation of diverse microbial species from the garri samples corroborates the findings of Ogbugbue *et al*. (2011), and Adejumo *et al*. (2015) that worked on similar ready-to-eat foods. Presence of various bacteria like *Bacillus* sp., *Escherichia coli, Klebsiella* sp., *Pseudomonas* sp., and *Staphylococcus* spp. in this finding agrees with the studies of Orji *et a*l. (2016), Ajayi *et al*. (2017) Okafor *et al.* (2018), and Akoma *et al*. (2019). This could be due to relative lack of personal hygiene among the sellers of garri, and exposure of the garri at the marketing sites to dust. This is due to poor handling, such as dropping of garri bags directly on the ground and the quality of handling material used which also affects the shelf-life of garri (Ogiehbor *et al*., 2006). The moulds that are associated with the samples are common environmental contamination due to their ability to produce spores. *Aspergillus* sp., *Penicillium* sp. are known to produce

deleterious mycotoxins under unfavourable condtion. Fungi are known to be associated with many human and animal diseases of the lungs, liver, and other intestinal organs in agreement with (Arasi *et al*., 2000). The study observed various combination of fungi growth which could be as a result of the presence of microflora that is associated with fungal growth of other moulds in stored products (Kabak *et al*., 2006). The distribution of these fungi probably results from the ubiquitous nature of fungi and production of numerous airborne conidia which are easily dispersed by air and possibly, insects too.

Conclusion

The arrays bacteria and moulds associated with the garri sample could post a great threat to the health of the consumers since it's a read-to-eat food. Some of the moulds isolated from the garri samples are known to be toxigenic. Proper handling and packaging method should be encouraged to guide against post processing contamination, so as to protect the health of the consumers.

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