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Research Article

Isolation, Identification of Bacteria and Fungi and FTIR and Proximate Analysis of Cassava Flakes (Garri) in Dutsin-Ma Markets

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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. This study isolated, identified bacteria and fungi and Furrier Transformed Infrared Spectrometer (FTIR) and proximate analysis of garri in Dutsin-Ma markets. Nine garri samples (smooth white garri, yellow graveled garri and yellow garri) were obtained from various marketing sites in Dutsin-Ma Town, from three different markets: Wednesday, Abuja Road and Tsamiya markets respectively. The microbial load of the samples was determined using pour plate technique and the isolates were identified using conventional method. The bacteria colony count was done and the bacteria were identified using gram staining and biochemical test. Three bacteria species were isolated; *Klebsiella pneumonia* (44.4%), *Staphylococcus aureus* (88.9%) and *Bacillus* spp (11.1%) and Twelve Fungi: *Aspergillus* spp (33.3%), *Colletotrichum coccoides* (11.1%), *Histoplasma capsulatum* (11.1%), *Trichophyton schenlenii* (11.1%) *Trichomonas equinum* (11.1%), *Trichophyton equinum* (11.1%), *Balassezia baillon* (11.1%), *Coniochaeta haffmannii* (11.1%), *Cryptococcus* spp (11.1%), *Microsporidium* (11.1%) and *Rhizopus* spp (11.1%) in all the samples. The FTIR of Smooth white garri (Sample A) shows five (5) peaks, Yellow gravel (Sample B) show five (5) peaks and the yellow garri (Sample C) show eight (8) peaks indicate indicating different wave number, intensity and compound The proximate analysis result shows the compositions for garri. The Moisture content recorded showed higher content in yellow garri (7.31%) while white garri is (5.98%). The presence of these bacteria and fungi in all the garri samples indicate a serious threat to the health of consumers.

Keywords: White Garri; Bacteria; Fungi; Proximate Analysis; Moisture Content

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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 Dutsin-Ma Market of Katsina State.

MATERIALS AND METHOD

Study Area

The Study was carried out around Dutsin-Ma Market of Dutsin-Ma Local Government Area of Katsina State, Nigeria. The various markets included: Wednesday Market, Abuja Road Market and Tsamiya Market

Sample Collection

Three varieties of cassava flakes were collected which include: white smooth garri, white graveled garri and yellow garri. These nine (9) Samples were collected from different locations and from different garri sellers.

Sample Analysis

Microbial analysis was carried on the sample which was weighed and crushed to powder with sterile mortar and pestle. One (1) g was then placed in a sterile test tube and homogenized with 10 ml of sterile distilled water to make the stock. Homogenate was serially diluted with sterile distilled water. About 0.1ml aliquot of appropriate dilutions were inoculated into Nutrient agar, Mac Conkey agar and Potato Dextrose agar plates, for total aerobic plate count, coliform count and fungal counts respectively. Plates, using the pour plate method. The plates were allowed to set and subsequently incubated at 37^{o}C for 48h.Potato Dextrose agar (PDA) plates were however incubated at 37^{o}C for 5 - 7 days. At the end of each incubation period, the culture plates were examined for enumeration and identification of colonies counted (Ravimannan *et al.,* 2016)

Enumeration and Identification of Bacteria and Fungi Isolates

Colony count at the end of each incubation period was done with digital colony counter, total microbial load was expressed as colony forming units per gram of sample. Pure cultures of isolates obtained by repeated sub culturing were stored on slants at 4^{o}C until characterized. Bacterial isolates were characterized on the basis of their Gram-stain reaction and biochemical test and the identification was according to Bergey's Manual of Determinative Bacteriology. Fungal isolates were identified based on colonies morphology and microscopy (Cheesebrough 2009; Olanrewajy *et al.,* 2017; Oyeyinka *et al.,* 2019).

Determination of pH Content of Sampled Garri

The pH of the samples was determined respectively. One grams of each sample were homogenized in 10ml of distilled water and the pH of the suspension determined using the glass electrode pH meter (Uchechukwu. *et al.,* 2015).

Biochemical Test

Biochemical test was carried out to Identify Bacteria. (Cheesebrough, 2009; Olanrewajy *et al.,* 2017).

Catalase test

Most aerobic and facultative anaerobic bacteria produce the Catalase enzyme and its function is to detoxify hydro peroxide (H_2O_2) which is toxic to cells.

Procedure:

Take a microscopic slide and using a wooden stick or sterile glass rod take one portion of pure bacterial culture. Apply the bacterial colony in a slide and add a drop of 3% H_2O_2.

Observe for the effervescence of gas formation that shows the organism has a Catalase enzyme.

Catalase producing organisms are: *Staphylococcus aureus, Escherichia coli, Mycobacterium tuberculosis, and Legionella pneumophila.*

Oxidase Test

Oxidase test detects the bacteria that produce cytochrome C oxidase or cytochrome a3 when it undergoes an electron transport chain.

Procedure of Oxidase Test

A piece of filter paper soaked with 1% tetramethyl-p-phenylenediamine dihydrochloride gotten, the organism was rubbed on the paper with a sterile glass rod and was observe for dark blue purple colour formation within 30 second. Positive organisms are: Pseudomonas spp, *Aeromonas*spp, *Vibrio spp,* and *Neisseria gonorrhoeae.*

Oxidative/Fermentative Test

Oxidative/fermentative test was used to determine whether organisms utilize the substrate either in aerobic or anaerobic conditions. Two tubes are used in this method where one tube is open to the air and another is sealed with paraffin oil on the top. When an organism utilizes the substrate, it changes colour due to the acid production that reacts with the pH indicator Bromothymol blue.

Procedure of Oxidative/Fermentative test

Take two tubes of O/F medium and label the organism. Stab the organism with a sterile inoculating wire. Put 1ml of paraffin oil in one tube only and incubate both tubes. Observe for the development of colour from green to yellow which indicated the fermentation of substrate.

Fermentative organisms: *E. coli, S. cerevisiae. Oxidative organisms: P. aeruginosa.*

Indole Test

Indole test is done whether an organism produces the tryptophanase enzyme or not. If yes, then it hydrolyzes the tryptophan into indole. If the test organism gives a positive indole test, then it forms a cherry red colour layer.

Procedure of Indole Test

Take the SIM media and inoculate the bacterial culture. After incubation, add 4-8 drops of Kovac's reagent and mix the tube. Observe for the development of cherry red colour, black precipitation for H2S production, and bacterial spread for motility. Indole positive organism is *E. coli.*

Methyl Red

This test is done to detect organisms' ability to maintain stable acid or not as some organism undergoes mixed acid fermentation. Methyl red is added as a pH indicator to test the amount of acid which turns red at low pH which is a positive result and yellow at high pH as a negative result.

Procedure of MRVP Test

Take two tubes with MR-VP medium and inoculate with organism and incubate. Add 5-6 drops of MR reagent in one tube and Barrit's reagent A and B in another and again incubate for few minutes. Observe for the red colour formation. *E coli* is a positive organism for MR whereas Enterobacter cloacae for VP.

Citrate Test

Some organism use citrate as a sole source of carbon for metabolism, those organisms can be detected by citrate test.

Procedure of Citrate Test

A slant of Simon's citrate agar was taken and organism inoculated in a zigzag manner on a flat surface. It was incubated and observed for colour change which forms Prussian blue indicates positive result.

Positive organism: *Klebsiella pneumonia*

Urease Test

This test detects the organism that produces urease enzyme and converts urea to ammonia and CO_2 in the presence of water. Phenol red is used as pH indicator which gives orange to deep pink colour.

Procedure of Urease Test

Take a tube of urea agar and streak the organism in the slant. Incubate and observe for colour change. Positive organism: *Proteus vulgaris*

Nitrate Reduction Test

This test detects the organism that produces nitrate reductase enzyme which reduces nitrate to nitrite. Nitrate reagent A and nitrate reagent B are used which develops red precipitation at the end of the test.

Procedure of Nitrate Reduction Test

Take a nitrate broth and inoculate loopful of organism and incubate. Add 5 drops of nitrate reagent A and then 5 drops of B nitrate reagent and

observe for development of red colour. Nitrate reducing organisms: *Neisseria mucosa, E. coli.*

Serial Dilution

Serial dilution is the stepwise dilution of a substance in solution. Usually the dilution Process involves, inserting 9ml of distilled water into 6 test tubes. Then the stock solution is prepared by measuring 1g of the Sample and combining it with 9ml of distilled water. Then 1ml of the Stock solution is inserted into the next dilution series and the process is done continually serially until the last which is discarded.

Preparation of Media

The media was weighed, measured and prepared according to the manufacturer's instructions. The glass wares used for this study were properly sterilized in a hot air oven at 160°C for an hour. Other materials (Petri dishes, conical flask, and tubes etc.) were sterilized by autoclaving at 120°C for 15minutes.

Physical Forms of Microbiological Media

Media can be prepared as a broth (liquid), a slant (agar in a test tube that has been slanted when cooling to create a larger agar surface area), a deep (agar in a test tube typically inoculated using an inoculation needle by stabbing into the agar), and a petri plate (a larger surface area for growing microbes on the surface).

Gram Staining

Make a smear of inoculum and air dry then heat fix, cover the fixed smear with crystal violet stain for 30-60 second; wash the stain with clean water. Tip off all the water and cover the smear with lugols iodine for 30-60 seconds. Wash off iodine with clean water. Decolourize rapidly (few seconds) with acetone-alcohol. Wash immediately with clean water, cover the smear with neutral red stain (safranin) for 60-80 seconds and wash off the stain with clean water. Wipe the back of the slide clean and place it in a draining rack for smear to air dry and examine the smear microscopically using oil immersion and the 100× objective lens to report the bacteria cells. (Cheesebrough 2006*)*

RESULTS

Results obtained from the evaluation of the microbial quality of white and yellow garri sold in selected markets in Dutsin-Ma markets of Katsina State revealed the presence of various microbes. Antibiotic susceptibility and resistance pattern of the gram positive (S*taphylococcus aureus)* and gram negative (*Klebsiella pneumoniae*) bacteria isolated from the garri samples are presented in Table 1. The isolate *S. aureus* was resistant to Pefloxacin 5(55.56%), Gentamicin 9(99.9%), and Ampiclox 1(11.11%), Zinnacep 0(100%), Amoxicillin 2(22.22%), Roceptrin 3(33.33%), Ciprofloxacin 8(88.89%), Streptomycin 7(77.78%), Septrin 2(22.22%) and Erythromycin 3(33.33%). *Klebshiella pneumoniae* was resistant to the following antibiotics at 100 percentages: Septrin (2), Ciprofloxacin (2) and Amoxicillin (2), while resistant to Chloramphenicol 1(50%), Augmentin (1), Gentamicin (1), Pefloxacin (1) and Streptomycin 1, at 50% each.

Staphylococcus aureus was susceptible to Pefloxacin 4(44.45%), Gentamicin 0(100%), Ampiclox 8(88.89%), Zinnacep 9(99.99%), Amoxicillin 7(77.78%), Roceptrin 6(66.67%), Ciprofloxacin 1(11.11%), Streptomycin 2(22.22%), Septrin 7(77.78%) and Erythromycin 6(66.67%). Antibiotics sensitive against *Klebshiella pneumoniae* included Chloramphenicol 1(50%), Augmentin 1(50%), Gentamicin 1(50%) and Streptomycin 1(50%).

Morphological and cultural characteristics of Fungi Isolates from the garri Samples (Smooth white garri, Graveled yellow garri and Yellow garri) are presented in Table 2. The macroscopically examination involved the use of the microscope using lens 10/40 magnification while the macroscopic examination involves the plate observation and fungi atlas is been used to identify and name the fungi isolated which includes *Aspergillus lentulus, Aspergillus nidulans, Colletotrichum coccoides, Histoplasma capsulatum,T richophytonschenlenii, Trichomonas equinum, Asper gillussp, Trichophyton equinum, Balassezia baillon, C oniochaetahaffmannii, Cryptococcus, Microsporidium, Rhizopus* spp.

The fungi isolated are presented in Table 3, which included *Trichomonas equinum* 1(11.1%)*, Colletotrichum coccoides* 1(11.1%)*, Histoplasma capsulatum* 1(11.1%)*, Aspergillus lentulus* 1(11.1%) and *Aspergillus nidulans* 1(11.1%) in Smooth white garri sample while in Graveled yellow garri *Cryptococcus sp* 1(11.1%)*, Trichomonas equinum* 1(11.1%)*, Balassezia baillon* 1(11.1%)*, Coniochaetahaffmannii* 1(11.1%) *and Microsporidium* 2(22.2%) are isolated. Also in yellow garri *Rhizopus sp* 2(22.2%)*, Cryptococcus sp* 1(11.1%)*, Aspergillus sp* 1(11.1%)*, Trichomonas equinum* 1(11.1%)*, Histoplasma capsulatum* 1(11.1%) and *Microsporidium* were isolated.

Bacteria isolated from the three garri samples are *Staphylococcus aureus* 6 (66.7%), *Klebsiella Pneumoniae* 2(22.2%) and *Bacillus spp* 1(11.1%) from the Smooth white garri; and also in the graveled yellow garri sample *Staphylococcus aureus* 6 (66.7%), *Klebsiella Pneumoniae* 2(22.2%) and *Bacillus spp* 1(11.1%) were isolated while in Yellow garri *Staphylococcus aureus* was the only single organism that was isolated 9(100%) (Table 4).

Table 5 Proximate Analysis on Cassava Flakes (Garri) samples. Among the three samples. Sample B has the highest carbohydrates content with (65.67) followed by sample C with (63.92) and then sample A having (60.67) carbohydrates content. Sample A contains the highest protein with 13.04% while sample C has 12.51% and sample B (10.93%) respectfully. Sample A contained the highest fibre of 3.48%, followed by sample B with 2.95% and then sample C (2.73%). Sample B has the fat content of 8.39%, while sample A has 7.24% and then sample C (3.47%). The highest sample with ash content is sample C (10.06%) followed by sample A with 9.61% and then sample B (7.83%). Sample C contains the highest moisture content (7.31%), followed by sample A (5.98%) and then sample B (4.23%).

The Table 6, 7 and 8 shows Fourier transform infrared spectrometer (FTIR) analysis which was carried out on all the three Garri samples. The FTIR analysis of Smooth white garri (Sample A) shows five (5) peaks) peaks indicate indicating different wave number, intensity and compounds. Yellow gravel (Sample B) show five (5) peaks indicate indicating different wave number, intensity and compounds. The yellow garri (Sample C) show eight (8) peaks indicate indicating different wave number, intensity and compound. And the yellow garri (Sample C) show eight (8) peaks indicate indicating different wave number, intensity and compounds. Fig. 1shows proximate analysis of the three (3) garri samples.

Table 1. Sensitivity and Resistance test for *Staphylococcus aureus* and *Klebsiella pneumonia*

Antibiotics	**R. SA (%)**	**R. KP (%)**	**S.KP (%)**	**S.SA (%)**
Septrin	2 (22.22)	2 (100)	0 (0)	7 (77.78)
Chloramphenicol	-	1 (50)	1 (50)	-
Ciprofloxacin	8 (88.89)	2 (100)	0 (0)	1 (11.11)
Amoxicillin	2 (22.22)	2 (100)	0 (0)	7 (77.78)
Augmentin	-	1 (50)	1 (50)	-
Gentamicin	9 (99.9)	1 (50)	1 (50)	0 (100)
Pefloxacin	5 (55.56)	1 (50)	1 (50)	4 (44.45)
Streptomycin	7 (77.78)	1 (50)	1 (50)	2 (22.22)
Ampiclox	1 (11.11)	-	-	8 (88.89)
Zinnacep	0 (100)	-	-	9 (99.99)
Roceptrin	3 (33.33)	-	-	6 (66.67)
Erythromycin	3 933.33)	-	-	6 (66.67)

KEYS: R. SA = Resistance for *Staphylococcus aureus* , **S. SA** = Sensitivity for *Staphylococcus aureus*. **R. KP** = Resistance for *Klebsiella pneumoniae* **S. KP** = Sensitivity for *Klebsiella pneumoniae*

Table 2. Morphological and cultural characterization of fungi isolated from the Garri Samples

Fungal Species	Macroscopic identification	Microscopic identification
Aspergillus lentulus	Colonies are suede-like to fluccose while with intersperse grey green coloration	Conidia globose broadly Ellipsoidal (2--3.2um in diameter) Smooth to Finely roughed
Aspergillus nidulans	Colonies are typically plain green in color with dark red brown cleistothecia developing within and upon the candidate layer	Candida heads are short, brownish and smooth-walled candida are globosal (3-3.5um in diameter and rough walled)
Colletotrichum coccoides	Colonies usually darkly pigmented with white aerial mycelium	Appressoria are common clavately brown, 11-16.5 * 6-9.5um variable in shape
Histoplasma capsulatum	Slow Growing white or bulf-brown suede-like colony with a pale brown-brown reverse	Shows a characteristics large-rounded, single celled, 8-14um in diameter
Trichophytonschenlenii	Colonies are slow-growing, waxy or suede-like with a deeply folded honeycomb by thallus.	Nail head, hyphae also known as fallic chandeliers
Trichomonas equinum	Colonies are usually flat but some may develop gentle folds or radial groves, white or puff in colour	Nodular organs are present and contains a micro conidia
Aspergillus sp	Colonies appear light blue to green with moderate growth rate	Nodular organs are present. Septed are present with conidia
Trichophyton equinum	Colonies are usually flat but some may develop gentle folds or radial groves, white or puff in colour	Nodular organs are present and contains a micro conidia
Balassezia baillon	Colonies are creamy to yellowish, smooth or lightly wrinkled	Conidia are about 10um in diameter
Coniochaetahaffmannii	Colonies are flat, smooth, moist, pink to orange with regular and sharp margin	Conidia are hyaline,smooth and thin walled broadly ellipsoidal to cylindrical or a allontoid 3.0-3.5*1.5-2.5um
Cryptococcus	Colonies are muccoid or slimy in Appearance	Glubose to Ovoid budding yeast like cells 3.0, 7.0*3.3-7.9cm
Microsporidium	Colonies are slow growing, forming a waxy convoluted thallus	Irregular branching hyphae with Prominent cross walls.
Rhizopus spp	Fast growing colonies that rapidly filled the petri dish with loose, light grey mycelium	Nodular organs are present. They have Sporangia Septed are absent

Table 3. Frequency Occurrences of Isolated Fungi from Garri Samples

Fungil Isolate	Smooth White Garri	Greved Yellowgarri	Yellow Garri
Rhizopus sp	-	-	2(22.2%)
Cryptococcus sp	-	1(11.1%)	1(11.1%)
Aspergillus sp	-	-	1(11.1%)
Trichomonas equinum	1(11.1%)	2(22.2%)	1(11.1%)
Balassezia baillon	-	1(11.1%)	-
Coniochaetahaffmannii	-	1(11.1%)	
Colletotrichum coccoides	1(11.1%)	-	-
Histoplasma capsulatum	1(11.1%)	-	1(11.1%)
Microsporidium	-	1(11.1%)	1(11.1%)
Aspergillus lentulus	1(11.1%)	-	-
Aspergillus nidulans	1(11.1%)	-	-

Table 4. Frequencies of Occurrences of Isolated Bacterial in the Garri Samples

Bacterial Isolate	Smooth White Garri	Greved Yellowgarri	Yellow Garri
Staphylococcus aureus	6 (66.7%)	6(66.7%)	9(100%)
Klebsiella Pneumoniae	2(22.2%)	2(22.2%)	-
Bacillus spp	1(11.1%)	1(11.1%)	-

Table 5. Proximate Analysis White Smooth Garri, White Graveled Garri and Yellow Garri Samples

S/N	SI	%M.C	%A.C	%C.FAT	%C.F	%C.P	%CHO
01	A	5.98	9.61	7.24	3.48	13.04	60.65
02	B	4.23	7.83	8.39	2.95	10.93	65.67
03	C	7.31	10.06	3.47	2.73	12.51	63.92

KEY: M.C = MOISTURE CONTENT, A.C = ASH CONTENT, C. FAT = CONTENT FAT, C.F = CONTENT OF FIBRE, C.P = CONTENT OF PROTEIN, CHO, CARBOHYDRATES, SI = SAMPLE IDENTITY A WHITE SMOOTH GARI, B = YELLOW GRAVELED GARI and C = YELLOW GARI

Table 6. Furier Transform Infrared Spectrometer (FTIR) Analysis of Sample A (Smooth White Garri)

Sample ID:SAMPIE A UMYU CENTRAL LAB KTN
Method Name:C:\Users\Public\Documents\Agilent\MicroLab\Methods\Default.a2m
Sample Scans:64
User:Admin
Background Scans:64
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Range:4000 - 650
System Status:Good
Apodization:Happ-Genzel
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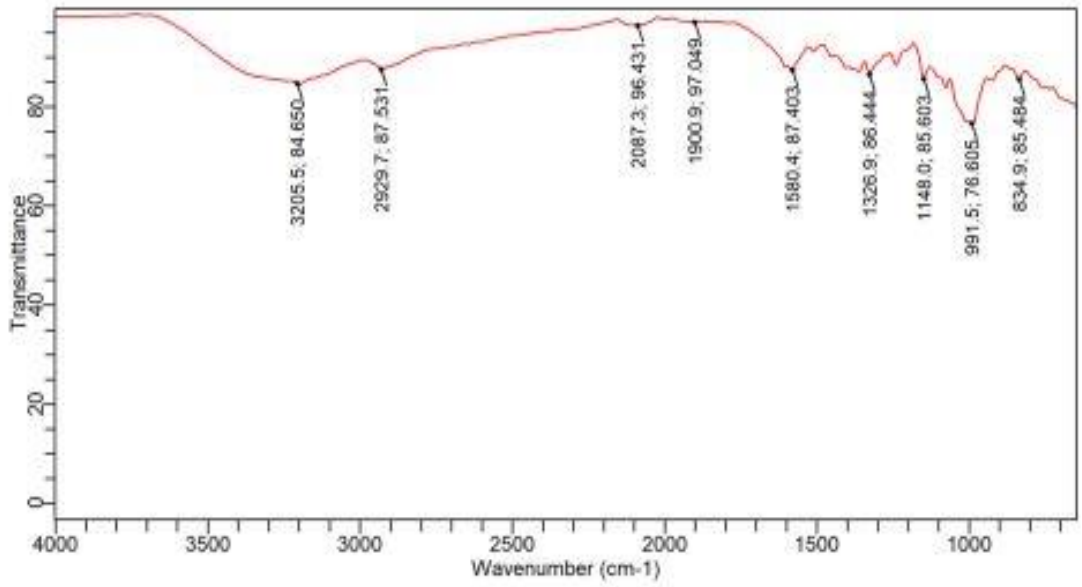

Peak Number	Wavenumber (cm^{-1})	Intensity
1	834.92368	85.48421
2	991.47186	76.60540
3	1148.02005	85.60309
4	1326.93227	86.44394
5	1580.39124	87.40296

Table 7 Furier Transform Infrared Spectrometer (FTIR) Analysis of Sample B (Yellow Gravel Garri)

Sample ID:SAMPIE B UMYU CENTRAL LAB KTN
Method Name:C:\Users\Public\Documents\Agilent\MicroLab\Methods\Default.a2m
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User:Admin
Background Scans:64
Date/Time:09/20/2023 3:03:44 pm
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System Status:Good
Apodization:Happ-Genzel
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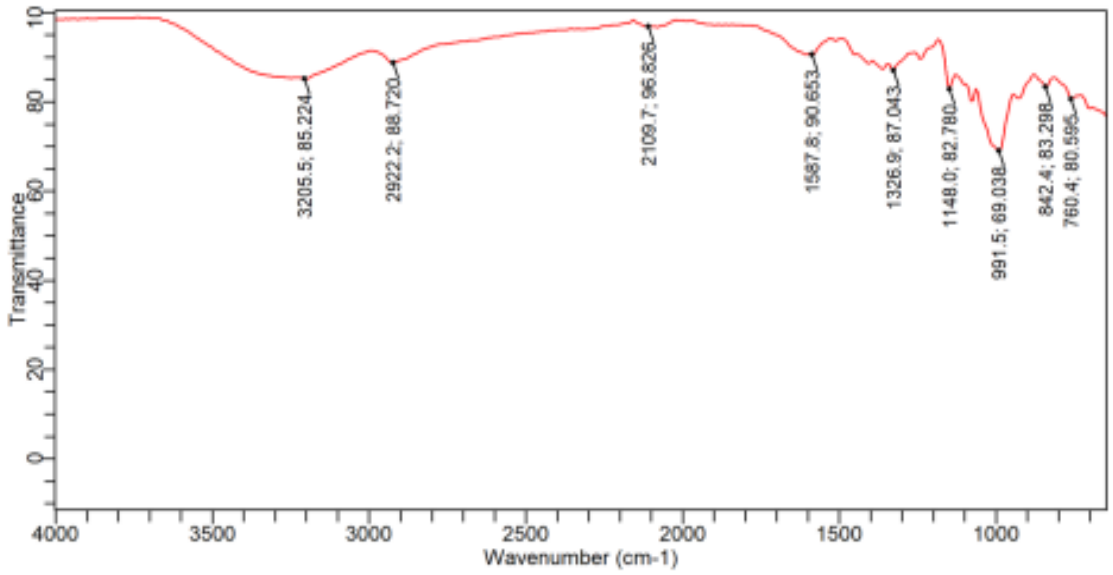

Peak Number	Wavenumber (cm^{-1})	Intensity
1	760.37692	80.59493
2	842.37835	83.29769
3	991.47186	69.03844
4	1148.02005	82.78023
5	1326.93227	87.04251

Table 8. Furier Transform Infrared Spectrometer (FTIR) Analysis of Sample C (Yellow Garri)

Sample ID:SAMPIE C UMYU CENTRAL LAB KTN
Method Name:C:\Users\Public\Documents\Agilent\MicroLab\Methods\Default.a2m
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Background Scans:64
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System Status:Good
Apodization:Happ-Genzel
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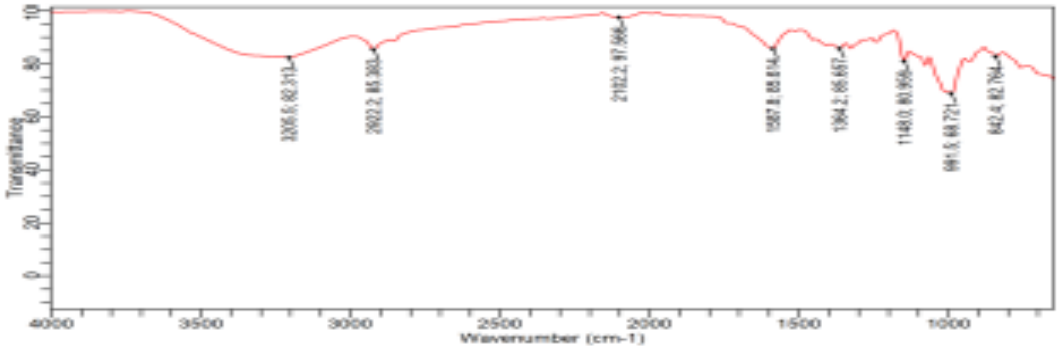

Peak Number	Wavenumber (cm $^{-1}$)	Intensity
1	842.37835	82.76372
2	991.47186	68.72095
3	1148.02005	80.95890
4	1364.20565	85.65688
5	1587.84592	85.61390

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6	2102.21854	97.56645
7	2922.23286	85.38250
8	3205.51054	82.31329

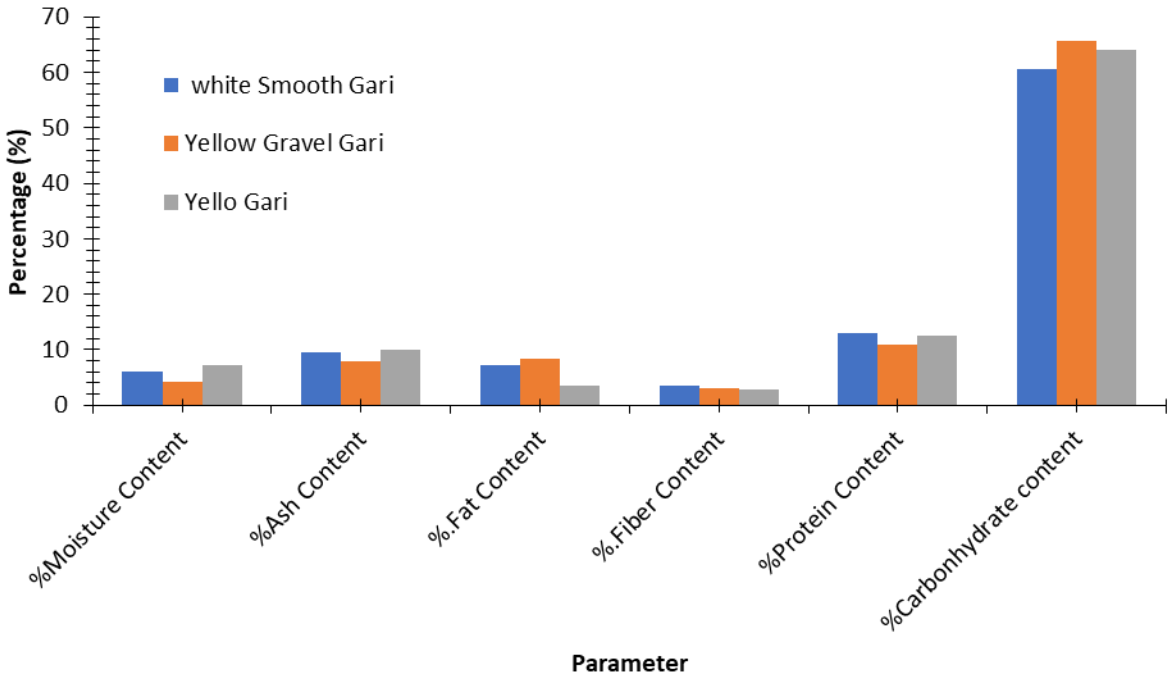

Fig. 1. Proximate analysis of the three (3) garri samples

DISCUSSION

In this study, The Susceptible pattern to *S. aureus* are Pefloxacin (44.45%), Ciprofloxacin (11.11%), Septrin (77.78%) and Erythromycin (66.67%). This result is in disagreement the finding reported by Nwankwo and Nasiru (2011) who recorded high sensitivity of Ciprofloxacin (78.9%) and strongly agrees with Nwankwo and Nasiru (2011) who recorded high sensitivity of the isolates to Erythromycin (52.4%). This result also disagreed with the research work carried out by Kumurya (2015) who recorded high sensitivity of Ciprofloxacin (96.7%).

The high fungi count recorded may be associated with inadequate post processing handling practices such as spreading on the floor, mat and sometimes on high density polyethene spread on the floor after frying to allow it to cool before sieving into finer grains; and the open display in bowls and basins in the market, measurement with the aids of bare hands, coughing and sneezing while selling and the use of non-microbiologically determined hessian bags for packaging and haulage. These may also be responsible for the vast array of microorganisms detected and isolated. These finding corroborate some other reports (Agbonlahor *et al.,* 1997) and (Ogiehor, 2002)

The Fungi that are associated with the samples are common environmental contamination due to their ability to produce spores e.g. *Aspergillus sp., Histoplasma capsulatum, Candida,* e.t.c. are known to produce deleterious mycotoxins under unfavorable condition and 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 as also reported by Kabak *et al*. (2006).

The high fungal contamination which may be as a result of Post-production Contamination as reported by Ogugbue *et al.* (2011). The Microbial Contamination could be as a result of Uncovering of the garri and improper handling. Both the White and Yellow garri showed a high level of Microbial load. This Finding agrees with Ayodele *et al.* (2017) which may be as a result of similar handling and Storage techniques. This work also corroborate with Akoma *et al.* (2019). This research Correspond with the research of Ogbugbe *et al.* (2011), Adejumo *et al.* (2015) and Oranusi *et al.* (2012).

The isolation of diverse bacteria species from the garri samples in Dutsinma market corresponds to 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., Klebsiella sp.,* and *Staphylococcus spp* in this finding agrees with the studies of Orji *et al*., (2016), Ajayi *et al*., (2017) Okafor *et al*., (2018), and Akoma *et al*.,(2019). There presences 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 and also 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 as reported by (Ogiehbor *et al*., 2006). The presence of *Staphylococcus aureus* observed in the study agrees with the reports of Ogiehor *et al*., (2006). Presence of *Staphylococcus aureus* could be handling or Manufacturing Processes since the organism is a normal body Flora of Man. The sites for this organism include the nose, Throats, hands and Clothing of Carriers.

In the Proximate Analysis of Garri samples. The highest moisture content of (7.31%) was observed in Yellow gari and that of Smooth white gari was (5.98%) of Moisture content (Table 5).The finding in the research is similar and strongly agreed with the findings of the moisture content reported by Aguoru *et al.,* 2014 who reported higher values of 11.7% and 12.5% for white and yellow garri respectively and (Ogugbue *et al.,* 2011) who also reported higher moisture content in the garri.

The Table 6, 7 and 8 shows Fourier transform infrared spectrometer (FTIR) analysis which was carried out on all the three Garri samples. The FTIR analysis of Smooth white garri (Sample A) shows five (5) peaks, Yellow gravel (Sample B) show five (5) peaks, the yellow garri (Sample C) show eight (8) peaks indicate indicating different wave number, intensity and compounds.

CONCLUSION

In conclusion, the presence of these bacteria and fungi in all the garri samples indicate a serious treating to the health of consumers which include student and low income inners, therefore proper measures should be taking in a way to curtail appearance of these microorganisms. Since this study is the isolation and Identification of Bacterial and Fungal species in garri. The Current results reveals that during storage period, handling and Manufacturing period among others, fungi and Bacteria Species are been introduced in garri.

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