PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 26 (6) 1007-1013 June 2022

# Microbial Analysis and Sensory Attributes of Garri Produced and Marketed in Bida Niger State, Nigeria

**[1,2*]OBI, PU; [2]MOHAMMED, YM; [1]OKEKE, KS; [1]IBRAHIM, NJ; [1]AJAYI, MA; [1]BENEDICT, AU; [3]UMAR, M**

*[*1]Department of Biological Sciences, Federal Polytechnic Bida, Niger State, Nigeria.*
*[2]Department of Biological Sciences, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria*
*[3]Department of Biochemistry, Federal University of Technology Minna, Niger State, Nigeria*

**Corresponding Author Email: obiuche4@gmail.com; Tel: +2347067270190*

*Other Authors Email: yakubmohammedmanbe@yahoo.com; sussanokeke@gmail.com; juliibrahim2014@gmail.com; opeyemiadeola58@gmail.com; benedict2012@gmail.com; umarmuazu1321@gmail.com*

**ABSTRACT:** Garri is one of the most preferred cassava products due to its less expensive nature, less bulky, easy to cook and not readily perishable. This study was carried out to ascertain the microbial analysis and sensory attributes of garri produced and marketed in Bida Niger state, Nigeria. The collected samples were analyzed using standard methods and procedures. The results show moisture content of the garri sample ranged from 7.0 to 11.0%. The swelling index ranged from 2.0 to 4.0%. The mean bacteria count ranged from 4.04±3.98 to 4.11±3.98 Cfu/g and the mean fungal count ranged from 3.57±3.50 to 3.62±3.50 Cfu/g. There was no significant difference ($p>0.05$) in the mean bacterial and fungal count observed among the samples from the studied garri production area. The bacterial isolates encountered were *Micrococcus* sp., *Streptococcus* sp., *Bacillus* sp., *Staphylococcus aureus* and *Shigella* sp. While the fungal isolates were *Aspergillus flavus, Aspergillus niger, Cladosporium sp., Rhizopus* sp., *Penicillium* sp. and *Fusarium* sp. Most of the isolates are of public health importance and there is need to maintain a clean, safe personal and environmental hygiene in garri producing areas of Bida Niger state to avoid microbial contamination.

**DOI**: https://dx.doi.org/10.4314/jasem.v26i6.3



**Impact factor**: http://sjifactor.com/passport.php?id=21082

**Google Analytics:** https://www.ajol.info/stats/bdf07303d34706088ffffbc8a92c9c1491b12470



**Dates**: Received: 25 March 2022; Revised: 13 April 2022; Accepted: 11 May 2022

**Keywords.** Garri, Bacteria, Fungi, Microbial contamination, Bida

In tropical Africa, Nigeria inclusive grows cassava and it is among the most important staple food crops grown in the region (Chinwe *et al.,* 2016). Globally Nigeria is among the current leading cassava producing countries and Cassava plays a major role in efforts to alleviate the African food crisis because of its efficient production of food energy, year-round availability, tolerance to extreme stress conditions, and suitability to present farming and food systems in Africa (Chinwe *et al.,* 2016). This crop is vital for both food security and income generation (FAO, 2004). Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to local customs and preferences. One of the processed products of Cassava is Garri. It is widely eaten in the West and Central Africa and forms a staple food for majority of the people in the southern part of Nigeria. An estimate of about ten million tones is produced in Nigeria alone per annum (Okafor *et al*., 2018). Garri is a well-known processed product of cassava (*Manihot esculenta Crantz*) tubers. It is one of the commonly consumed cassava products in Nigeria and other West African countries (Awoyale *et al*., 2021). *Garri* is one of the most preferred cassava product due to its less expensive nature, less bulky, easy to cook and not readily perishable (FAO, 2010; Oluwafemi and Udeh, 2016). Most of the cassava harvested from farms in Nigeria are being processed into Garri (Adebayo *et al*., 2012; Okolo and Makanjuola, 2021) and to obtain garri is done in different ways depending on the locality and usage but the general process for commercial production of garri

involves harvesting the matured cassava roots, peeling the roots, washing the peeled roots, grinding the washed roots, de-watering the mash, fermenting the mash, wet sieving the fermented mash, dry-frying/roasting, open air-cooling on floor or mat and packaging for sale (Okafor *et al.,* 2018; Okolo and Makanjuola, 2021). Consumption of Garri varies with localities and transverses the low, middle and high class both in urban and rural areas (Tamang *et al*., 2016). They are generally consumed soaked in water along with other food supplement such as sugar, dried fish, groundnut, coconut or bean cake and they are also soaked in hot water to make 'eba' and taken with soup (Okolo and Makanjuola, 2021). Microbial contamination of garri could arise due to processing conditions and storage containers, which could serve as means of potential growth enhancer for microorganisms such as bacteria and fungi (Akindele and Abimbola, 2018). Microorganisms such as bacteria and fungi are of public health importance (Okolo and Makanjuola, 2021). Microorganisms such as *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* sp., *Shigella* sp., *Aspergillus* sp., *Cladosporium* sp. and *Fusarium* sp. have been isolated from stored, retailed and ready-to-eat garri from some communities in Nigeria (Ogbonna *et al.,* 2017; Okafor *et al*., 2017). To date garri is still being consumed largely in most households and various communities without any pre-treatment form which may expose some consumers to some microbial associated health risks and their toxins (Okafor *et al*., 2018). Thus, there is need to ascertain and evaluate the microbiological quality of garri produced and sold within Bida community to ascertain their safety. This study was aimed at determining the microbial quality of Garri produced and sold within Bida community in Niger state, Nigeria.

## MATERIALS AND METHODS

*Sample source and collection:* The study area lies between the latitudes 9°05" North and longitudes 6°01" East. A total of four (4) garri samples were bought from four different production sites including Zamfara Area (Sample A), Banwuya area (Sample B), Masaga area (Sample C) and Esso Area (Sample D) in Bida town and the samples collected were packaged respectively in polythene. The garri samples were randomly collected thrice in each production site and were taken to the laboratory of Biological Science Department, The Federal Polytechnic Bida for microbial analysis.

*Determination of Moisture content, Swelling index and other organoleptic properties of the samples:* The moisture content of the garri was determined by using the standard methods as described by (AOAC, 2005). The crucibles were washed and dried in oven at 50°C for 30minutes. The dried crucibles were weighed and marked as W1. 5g of each garri sample were put into each labelled crucible and weighed separately and marked as W2. The crucibles were heated in an oven under the temperature of 100°C for a period of 2 hours, allowed to cool and weighed again (W3). The moisture content of the samples were determined as the average weight difference using the following formula;

$$\text{Moisture content} = \frac{W2-W3}{W2-W1} \times 100$$

The Swelling capacity of the samples were determined using the method described by Sanni *et al*., (2001). Five (5) grams of garri samples were added to a clean measuring cylinder and 25mls. of distilled water was added to the sample. The mouth of the measuring cylinder was sealed tightly and the content was mixed thoroughly by inverting the cylinder for 2 minutes. It was re-inverted and allowed to stand for 3 minutes after which the final reading of the volume occupied by the distilled water was taken. The percentage swelling capacity was estimated using the following formula.

$$\text{Swelling capacity (\%)} = \frac{\text{Volume of the gari in water}}{\text{Initial volume of gari}} \times 100$$

The organoleptic properties such as the color, texture, dryness was carried out using sensory evaluation method. The sensory form was administered and the data gotten were presented.

*Media Preparation and Inoculation of Samples:* Twenty eight (28) grams of Nutrient agar (NA) was dissolved in 1000mls of distilled water and 10g of potato dextrose agar (NA) was dissolved in 250mls of distilled water, the dissolved media both Nutrient agar and Potato dextrose agar were thoroughly mixed using a sterilized glass rod, the media were autoclaved at 121°C for 15minutes. 1g of each garri sample was suspended in 9mls of distilled water in a test tube, the samples were homogenized and a ten (10) fold serial dilution technique was employed by dispensing 1ml of the suspension into another 9mls of distilled water up to the $10^{th}$ test tube. 1ml of the diluents were taken and placed on the already prepared Nutrient Agar and Potato Dextrose Agar solidified in a petri dish.

For bacterial examination, the petri dishes containing nutrient agar were incubated at 35°C for 24hours, the growth was observed by colony appearance on the incubated nutrient agar and the bacteria colony were counted and the samples were subcultured to obtain pure isolates. Each bacteria colonies that appeared on the culture plates were counted with the aid of a colony

counter and recorded as colony-forming unit (cfu/g). All isolates were sub-cultured and transferred to a slant media to obtain a pure culture where a gram-staining and other biochemical test such as catalase test, coagulase test, methyl red test, indole test, citrate utilization and Sugar fermentation test were conducted to identify the isolates based on the method described by Cheesbrough (2006).

In fungal examination, the petri dishes containing potato dextrose agar were incubated at 25°C for 5days using the outer chamber. Fungal Identification was based on both macroscopic and microscopic characteristics of the isolates. The microscopic characteristics includes, the morphology of the fungal isolates as observed under the microscope at ×10 and x40 objectives and macroscopic colonial morphology of fungi observed on the plates such as colony texture, size, pigmentation, color on the reverse side of the plates and colony margins (Samson and Reenen-Hoekstra, 1988; Watanabe, 2010).

*Data analysis:* The data obtained from this study was analyzed with the help of Microsoft Excel Windows 7 using descriptive statistical tools. Differences in the mean values were compared using ANOVA at $p<0.05$ level of significance.

## RESULTS AND DISCUSSION

The moisture content of the garri samples obtained from the four garri processing areas in Bida town were shown in figure 1. The moisture content of the garri samples ranged from 7.0 to 11.0%; sample from Zamfara had the highest moisture content of 11.0%, while Masaga sample recorded the lowest moisture content. The swelling index of garri samples varied from 2.0 to 4.0%. From table 1, the mean bacteria count ranged from 4.04±3.98 in sample D to 4.11±3.98 in sample A, the mean bacteria count shows no significant difference ($p>0.05$) between the various garri samples from various production areas in Bida Niger state. The mean fungal count ranged from 3.57±3.50 in sample A and B to 3.62±3.50 in sample C. There was no significant difference ($p>0.05$) in the mean fungal count observed among the samples from the studied garri production areas.

Table 2 shows the sensory characteristics of some sampled garri from different production areas in Bida Niger state. The sensory characteristics were estimated using the Hedonic score. In terms of texture, garri sample from Zamfara recorded 3.60±0.26, Banwuya 3.62±0.24, Masaga 3.60±0.16 and Esso area recorded 3.91±0.22. The collected garri samples showed no significant difference ($p>0.05$) in texture as they recorded similar scores in texture throughout the study period by the respondent.

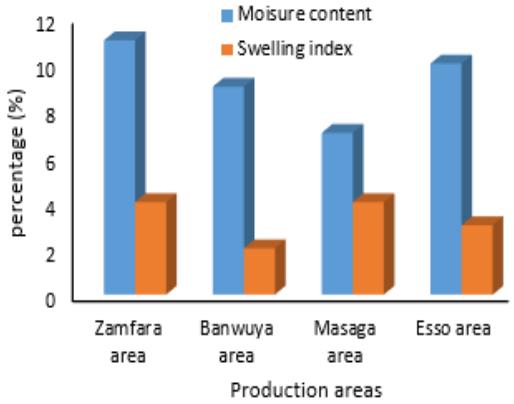


**Fig 1.** Percentage moisture content and swelling index of garri sampled from different production areas in Bida Niger state

The color of the garri ranged in score from 2.89±0.31 in Zamfara area to 3.34±0.21 in Esso area. The observed garri color score shows no significant difference ($p>0.05$) among the different production areas studied. The odor characteristics of the garri ranged from 2.60±0.28 in Banwuya area to 3.11±0.19 in Masaga area. Using the hedonic scores from the respondent, the odor characteristics showed significant difference ($p<0.005$) among the production areas as Masaga and Esso scored high mean odor characteristics as compared to other production areas. In terms of dryness characteristics, Banwuya area recorded lowest 2.62±0.16, followed by Zamfara area 2.94±0.6, Masaga area 2. 97±0.22 and the highest dryness score was observed in Esso area. The dryness score characteristics showed significant difference ($p<0.05$) among the different garri production areas observed in this study. The overall quality of the garri produced from various production areas in Bida Niger state, revealed a mean score of 2.83±0.19, 2.86±0.24± and 3.14±0.19 from Zamfara area. Banwuya area and Esso area respectively while Masaga area recorded highest score of 3.17±0.15. The overall quality attributes differ significantly ($p<0.05$) among the garri samples obtained from different production areas in Bida Niger state. A total of five (5) bacterial species comprising of four gram positive bacteria and one gram negative bacteria were isolated from garri samples used in this study. The gram positive bacteria isolated from the garri samples are *Micrococcus specie*, *Streptococcus specie*, *Bacillus specie* and *Staphylococcus aureus* while *Shigella specie* is the only gram negative specie isolated in this study (Table 3). In terms of bacteria species assemblage, garri sample produced from Zamfara area recorded highest with the presence of all the species of bacteria. Banwuya area recorded the presence of four species of bacteria which are *Bacillus sp.*, *Staphylococcus aureus*, *Shigella sp.* and *Micrococcus sp*.

**Table 1:** Mean Microbial Count **(**log10cfu/g**)** of Garri Sampled obtained from different production area in Bida Niger state.

| Sampled area | Bacteria load (log10cfu/g) | Fungi load (log10cfu/g) |
|---|---|---|
| Zamfara area (Sample A) | 4.11±3.98[a] | 3.57±3.50[a] |
| Banwuya area (Sample B) | 4.06±4.50[a] | 3.57±3.50[a] |
| Masaga area (Sample C) | 4.05±3.98[a] | 3.62±3.50[a] |
| Esso area (Sample D) | 4.04±3.98[a] | 3.61±3.50[a] |

*Note: Mean in same column with same superscript are not significantly different (p>0.05)*

**Table 2:** Mean sensory characteristics of Garri Sampled obtained from different production areas in Bida Niger state

| Sampled area | Texture | Color | Odor | Dryness | OA |
|---|---|---|---|---|---|
| Zamfara area (Sample A) | 3.60±0.26[a] | 2.89±0.31[a] | 2.80±0.24[a] | 2.94±0.16[a] | 2.83±0.19[a] |
| Banwuya area (Sample B) | 3.62±0.24[a] | 3.23±0.13[b] | 2.60±0.28[a] | 2.62±0.16[a] | 2.86±0.24[a] |
| Masaga area (Sample C) | 3.60±0.16[a] | 3.31±0.30[b] | 3.11±0.19[b] | 2.97±0.22[a] | 3.17±0.15[b] |
| Esso area (Sample D) | 3.91±0.22[a] | 3.34±0.21[b] | 3.02±0.24[b] | 3.08±0.25[b] | 3.14±0.19[b] |

*Note: Mean in same column with different superscript differs significantly (p<0.05)*

Similarly, the garri produced from Masaga area also had the presence of four bacteria species *Staphylococcus aureus, Shigella sp., Micrococcus sp.* and *Streptococcus specie*. Garri sample produced in Esso area had the lowest number of bacteria isolates with three species of bacteria only. The bacteria isolates present in garri produced from Esso area are *Staphylococcus aureus, Shigella sp*. and *Micrococcus sp*.Table 4 shows the Morphological and Microscopic characteristics of fungi isolated from garri sample obtained in different production area in Bida Niger state. A total of six (6) fungi species were isolated from the garri samples obtained from different production areas in Bida Niger state during the study period. The fungi species isolated were *Aspergillus flavus, Aspergillus niger, Cladosporium species, Rhizopus species, Penicillium species* and *Fusarium species.* In terms of occurrence of fungi isolates, garri produced from Zamfara area and Esso area had the highest, all the fungi species were present in the garri samples from these areas while Banwuya and Masaga areas recorded the absence of one species of fungi which is the *Aspergillus niger* as shown in table 5.

**Table 3:** Biochemical characteristics of bacteria isolated from garri samples obtained in different production areas in Bida Niger state.

| Sample area | Shape | Gram test | Coagulase | Catalase | Methyl red | Indole | Glucose | Lactose | Sucrose | Maltose | Suspected organisms |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Zamfara area | Cocci | + | + | + | - | - | - | - | - | + | *Micrococcus* sp |
| | Cocci | + | + | + | - | - | - | - | + | + | *Streptococcus sp* |
| | Rod | + | - | + | + | - | + | + | + | - | *Bacillus* sp |
| | Rod | - | | + | + | + | + | - | - | - | *Shigella sp* |
| | Cocci | + | + | + | + | - | + | + | + | + | *Staphylococcus aureus.* |
| | Cocci | + | + | + | - | - | - | - | - | + | *Micrococcus* sp |
| Banwuya area | Rod | + | - | + | + | - | + | + | + | - | *Bacillus* sp |
| | Cocci | + | + | + | + | - | + | + | + | + | *Staphylococcus aureus.* |
| | Rod | - | | + | + | + | + | - | - | - | *Shigella sp* |
| | Cocci | + | + | + | - | - | - | - | - | + | *Micrococcus* sp |
| Masaga area | Cocci | + | + | + | + | - | + | + | + | + | *Staphylococcus aureus.* |
| | Cocci | + | + | + | - | - | - | - | - | + | *Micrococcus* sp |
| | Rod | - | | + | + | + | + | - | - | - | *Shigella sp* |
| | Cocci | + | + | + | - | - | - | - | + | + | *Streptococcus sp* |
| Esso area | Cocci | + | + | + | + | - | + | + | + | + | *Staphylococcus aureus.* |
| | Cocci | + | + | + | - | - | - | - | - | + | *Micrococcus* sp |
| | Rod | - | | + | + | + | + | - | - | - | *Shigella sp* |

*Note: -=Negative +=positive*

Garri is a basic staple food in Nigeria and some African countries, it accounts for 70% of the entire cassava production in Nigeria (Olopade *et al.*, 2014). Since garri is widely consumed by many households in Nigeria and the entire west African region, there is need to maintain proper sanitary conditions so as to avoid its contamination with microorganisms which could give rise to health risks. The moisture content of garri samples is low and within standard specification, this could have accounted for keeping the microbial load of the garri low (Olopade *et al.*, 2014). The sensory attributes such as texture, color, odor, dryness and overall quality of garri produced in Bida showed that garri produced in Bida was in good condition in terms of overall quality (Chinwe *et al.*, 2016). The results of this study in terms of microbial loads showed that *Micrococcus* sp., *Streptococcus* sp., *Bacillus* sp., *Staphylococcus aureus*, *Shigella* sp., *Aspergillus*

*flavus, Aspergillus niger, Cladosporium* sp., *Rhizopus* sp., *Penicillium* sp. and *Fusarium* sp., were the groups of microorganisms isolated and identified from garri produced in different areas in Bida Niger state. This groups of microorganisms have also been isolated from garri in other parts of Nigeria (Ogiehor *et al.*, 2007; Olopade *et al.*, 2014; Okolo and Makanjuola, 2021).

**Table 4**: Morphological and Microscopic characteristics of fungi isolated from garri samples obtained in different production areas in Bida Niger state.

| Samples | Cultural characteristics | Microscopic characteristics | Probable organism |
|---|---|---|---|
| 1 | Light yellow to greenish colony | Radial conidial head | *Aspergillus flavus* |
| 2 | Surface colonies like yellow to white hyphae edges | Hyphae are septate, hyaline and conidiophores are long and globase at the tip. | *Aspergillus niger* |
| 3 | Has a light green-grayish surface, its reverse side were grey-black. | Long septate, upright conidiophore with branched cluster | *Cladosporium* sp. |
| 4 | Dark gray smooth surface | Spore enclosed in sporangium with root like rhizoid | *Rhizopus* sp. |
| 5 | Grayish-green to dark green colonies, while reverse was creamy-yellow. | It has subglobose conidia shape that is smooth finely roughed. Septate hyphae. | *Penicillium* sp. |
| 6 | The colony was pink with white patch on surface. Round shaped colony. | Slender conidiophore with short irregular branches and macro conidia | *Fusarium* sp. |

**Table 5:** Occurrence of fungi isolates from garri samples obtained in different production areas in Bida Niger state

| Fungi species | Zamfara area | Banwuya area | Masaga area | Esso area |
|---|---|---|---|---|
| *Aspergillus flavus* | + | + | + | + |
| *Aspergillus niger* | + | - | - | + |
| *Cladosporium* sp. | + | + | + | + |
| *Rhizopus* sp. | + | + | + | + |
| *Penicillium* sp. | + | + | + | + |
| Fusarium sp. | + | + | + | + |

*Note + = present - = absent*

This study shows general poor sanitary state of the production and handling of garri in the studied areas which gives way for the contamination and infestation of garri by the microorganisms. Some bacteria isolated in this study are of medical importance because they have been associated with different human ailments (Prescott *et al*., 2002). *Staphylococcus aureus* is a well-known commensal of human microbiota and are regarded as normal flora of the human (Prescott *et al*., 2002; Mohammed *et al.*, 2019) and can contaminate food during processing and handling with bare hands, as such their presence in the garri samples suggests possible contamination from direct contact or aerial-droplet mechanisms such as coughing or sneezing by the producers (Okolo and Makanjuola, 2021). The presence of *Shigella* sp., *Streptococcus* sp. and *Bacillus* sp. have been implicated in food infections and intoxication leading to different forms of diarrheal diseases among other complications especially in young children, the elderly and the immune compromised (Prescott *et al*., 2002; Olopade *et al.*, 2014; Okolo and Makanjuola, 2021). The processing of garri for consumption often involve mild or no heat treatment, and toxins produced from *Bacillus* sp.and *Staphylococcus aureus* if ingested or when they found their ways into food are heat stable, the consumption of contaminated garri could therefore portend a potential risk to consumers (Ogiehor *et al.*, 2007).

Fungi are common environmental contaminants due to their capability to produce spores; and this could explain their presence in garri. Different species of fungi have been implicated in ready to eat foods and in unregulated / mixed fermentation (Ogiehor *et al.*, 2007). Species of *Aspergillus, Penicillium* and *Fusarium* are known to produce deleterious mycotoxins under favorable conditions (Oranusi *et al.*, 2013; Olopade *et al.*, 2014)), their presence in garri must therefore be treated with caution. Similarly these groups of fungi have been associated with the production of several types of aflatoxins under different conditions (Ogiehor *et al.*, 2007) and human exposures to aflatoxins through ingestion of contaminated foods and inhalation of toxins have been linked to acute and chronic toxicity in the body system with effects such as acute liver damage, liver cirrhosis, induction of tumors and teratogenic and other genetic effects in animals and humans (Lund *et al.*, 2000; Ogiehor *et al.*, 2007). Furthermore, since produced garri require little or no further treatment prior to consumption, there is always the possibility of ingesting large dosage of microbial loads over a period

of time with possible health hazards. Hence the need to develop adequate processing and handling techniques for this relish food item.

*Conclusion:* The present work revealed high microbial load and different species of bacteria and fungi in garri produced and marketed in Bida, Niger state. The presence and abundance of these group of microbes are quite alarming and life threatening. There presence might arise due to the processing conditions, handling techniques and handlers technical known how, hygiene practices and safety of finished products. It is therefore recommended that garri should be sold in well packaged bags and not exposed to air in basin or bowls as displayed in various production areas and markets. In addition, strict application and implementations of quality control, quality assurance, good manufacturing practices and hazard analysis critical control point principles will help to ensure the safety of garri produced and consumed by several people in Bida Niger state, Nigeria.

## REFERENCES


Adebayo, BA; Nanam, TD; Bamidele, EA; Braima, DJ (2012). Quality management manual for the production of garri. International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. Pp. 1-41.

Akindele, ST; Abimbola, WA (2018). Microbial evaluation of garri sold in Ijebu community. *IOSR J. Env. Sci. Tox. Food Technol. (IOSR-JESTFT).* 12(7): 35-38.

Association of Official Analytical Chemists (AOAC) (2005). Official methods of analysis of the Association of Analytical Chemists International. 18th ed. AOAC, Gaithersburg, MD.

Awoyale, W; Oyedele, H; Adenitan, AA; Alamu, EO; Maziya-Dixon, B (2021) Comparing the functional and pasting properties of garri and the sensory attributes of the Eba produced using back slopped and spontaneous fermentation methods. *Cogent Food & Agriculture.* 7(1): 188-197.

Cheesbrough, M (2004). District Laboratory Practice in Tropical Countries. Part 2. Cambridge University Press, Great Britain. pp. 62-70.

Chinwe, OU; Ozumba, IC; Adejumo, OA; Ayuba OL; Nwosu, C; Bosa, SO; Idowu, O (2016). Sensory and Comparative Analysis of Ordinary Garri and Cocos garri (Nutritionally enriched). *Int. J. Res. Studies Agric. Sci. (IJRSAS).* 2 (8), 27-32.

Food and Agriculture Organization (FAO) (2010). Agriculture Statistics for Food and Agriculture Organization. News Bulletin.

Food and Agriculture Organization of the United Nations, (2004). The global cassava development strategy and implementation plan. Proceedings of the validation forum on theglobalcassavadevelopmentstrategy,1.RetrievedMarch14,2005,fromhttp://www.fao.org/documents/show_cdr.asp?url_file= / docrep/006/y0169e/y0169e00.htm

Lund, BM; Parker, TC; Gould, GW (2000). The microbiological, and safety and quality of food. "Toxigenic fungi and mycotoxin" Aspen Inc. Publishers 2000; Pp 1490-1517.

Mohammed, YM; Adamu, KM (2019). Bacteria Associated with Some Freshwater Fishes in Dangana Lake Lapai, Nigeria. *Jewel. J. Sci. Res.* 4(1&2): 83–90.

Ogbonna, IO; Agbowu, BI; Agbo, F (2017). Proximate composition, microbiological safety and heavy metal contaminations of garri sold in Benue, North-Central Nigeria. *African J. Biotech.*16 (18): 1085-1091,

Ogiehor, IS; Ikenebomeh, MJ; Ekundayo, AO (2007). The bioload and aflatoxin content of market garri from some selected states in southern Nigeria: public health significance. *Afr. Health Sci.* 7 (4): 223-227

Okafor, AC; Aquaowo, UA; Ojiagu, KD; Agu, KC (2018). Preliminary studies on processed *gari*as a source of bacterial hazards to students. *Imm. Infectious Dis*. 5(3): 25-29.

Okolo, E; Makanjuola, AT (2021). Microbial Evaluation of Garri Sold Within Ahmadu Bello University Main Campus, Samaru, Zaria, Kaduna State. *Science World Journal*, 16(3): 259-265.

Olopade, BK; Oranusi, S; Ajala, R; Olorunsola, SJ (2014). Microbiological quality of fermented Cassava (Garri) sold in Ota Ogun State Nigeria. *Int. J. Curr. Microbiol. App. Sci*, 3(3): 888-895

Oluwafemi, GI; Udeh, CC (2016). Effect of fermentation periods on the physicochemical and sensory properties of garri. *IOSR J. Env. Sci. Tox. Food Technol. (IOSR-JESTFT).* 10 (1): 37- 42.

Oranusi, S; Wesley, B; Oguoma, OI (2013). Antifungal properties of lactic acid bacteria LAB

isolated from *Ricinus communis*, *Pentaclethra macrophylla* and Yoghurts. *Global Adv. Res. J. Food Sci. Tech.* 21: 01- 06.

Prescott, LM; Harley, JP; Klein, DA (2002). Food and Industrial Microbiology. In: Microbiology 5th Edition. The WCB McGraw-Hill companies, Boston, USA.

Samson, RA; Reenen-Hoekstra, ES (1988). Introduction to foodborne fungi, 2ndEdn. Central Bureau VoorSchimmel Culture, Baarn. The Netherlands, pp540

Sanni, LO; Ikuomola, DP; Sanni, SA; (2001). Effect of length of fermentation and varieties on the qualities of sweet potato gari. Proc. 8th Triennial Symposium of the International Society for Tropical Root Crops Africa Branch (ISTRC-AB), Ed. M. O. Akoroda, IITA, Ibadan, Nigeria , Pp. 208-211.

Tamang, JP; Shin, DH; Jung, SJ; Chae, SW; (2016). Functional properties of microorganisms in fermented foods. *Frontiers in Microbiol.* 7: 578.

Watanabe, T (2010). Pictorial Atlas of Soil and Seed Fungi: morphologies of cultured fungi and key to species. Boca Raton: CRC Press.

World Health Organization and Food and Agriculture Organization of the United Nations Guidelines on food fortification with micronutrients. (2006). Micronutrient Fortification of Food: Technology and Quality Control.