FEDERAL UNIVERSITY WUKARI INTERNATIONAL JOURNAL OF BIOSCIENCES (FUWIJOB)
pISSN: 3121-9799, eISSN: 3121-973x; Volume 2, No. 2, June, 2026
https://fuwijob.com.ng

Microbiological Quality Assessment of Fermented Cassava Products from Garri and Lafun Sold in Wukari Markets Taraba State, Nigeria.

[1]Obasi, B. C.*, [1]Friday, J. A. & [2]Mani, V. N.

[1]Department of Microbiology, Federal University Wukari, PMB 1020, Taraba State, Nigeria.

[2]Department of Food Science and Technology, Federal University Wukari, PMB 1020, Taraba State, Nigeria.

***Corresponding author**:obasibc@fuwukari.edu.ng

ABSTRACT
Fermented food products such as garri and lafun are widely consumed staple foods in Nigeria and other parts of sub-Saharan Africa due to their affordability and ease of preparation. However, their traditional methods of processing, handling, and storage exposes them to microbial contamination, posing potential public health risks. This study aimed at assessing the microbiological quality of fermented food products; garri and lafun sold in wukari markets Taraba State. A descriptive cross-sectional study design was employed, and a total of six samples comprising white garri, yellow garri, and lafun were collected. Standard microbiological methods, including physiological and biochemical tests, were used to isolate, enumerate, and identify microorganisms present in the samples. The results revealed that total aerobic plate counts ranged from 6.6×10^4 to 2.1×10^5 CFU/g, with lafun samples showing higher microbial loads compared to garri. Coliforms were absent in yellow garri but present in white garri and lafun, indicating possible contamination due to poor hygiene. The result from various antimicrobial susceptibility profiles of bacterial isolates recovered from samples analysed exhibited complete resistance to all the antibiotics tested, indicating a multidrug-resistant (MDR) profile. *Enterococcus faecalis*, *Staphylococcus aureus*, *Aspergillus flavus*, and *Saccharomyces cerevisiae*, were identified. The study revealed the need for improved hygienic practices and proper storage conditions during processing and handling. Although the microbial loads were within the acceptable limit, the presence of pathogenic bacteria indicates potential health risks, emphasizing the importance of routine bacteriological monitoring to ensure food safety and protection of consumers of these products.

Keywords: Antimicrobial susceptibility, microbiological quality, Fermented food products, multidrug-resistant (MDR), public health risks.

INTRODUCTION
Fermented food products play a vital role in the dietary pattern of many populations in sub-Saharan Africa, particularly in Nigeria, where cassava (*Manihot esculenta*) serves as a major staple crop. Cassava is processed into several traditional foods to improve its palatability, shelf life, and safety. Among these products, garri and lafun are widely consumed due to their affordability, ease of preparation, and high carbohydrate content (Adebayo and Adebola, 2022).

Garri is a fermented, granular cassava product obtained through peeling, grating, fermentation, pressing, sieving, and roasting, while lafun is a fermented cassava flour produced by soaking cassava roots in water, followed by drying and milling. These products are often processed using traditional methods that rely on natural fermentation and manual handling. Although fermentation contributes to flavor development and partial microbial reduction, it does not completely eliminate bacterial contamination, especially when hygienic practices are inadequate (Oluwafemi *et al.,* 2021).

Garri and lafun are among the most commonly consumed cassava-based starchy food products in Nigeria and are relied upon daily by a large proportion of the population. Despite their importance as staple foods, their production, handling, storage, and marketing are largely carried out using traditional methods that often lack adequate hygienic control. These practices increase the likelihood of bacterial contamination, thereby posing potential public health risks to consumers (Adebayo *and* Adebola, 2022).

In many local settings, garri and lafun are processed using untreated water, rudimentary equipment, and open-air drying methods, which expose the products to contamination from soil, dust, insects, and human handlers. In addition, post-processing handling during packaging, transportation, and market display further contributes to microbial contamination. Studies have reported the presence of pathogenic and indicator bacteria in fermented cassava products, suggesting lapses in sanitation and food safety practices (Adekanmi *et al.,* 2023).

During processing, storage, and marketing, garri and lafun are exposed to various sources of microbial contamination, including water, soil, processing equipment, air, and food handlers. Several studies have reported the presence of bacteria of public health importance in cassava-based foods, such as *Escherichia coli*, *Staphylococcus aureus*, *Bacillus* species, *Salmonella* species, and *Pseudomonas* species. The presence of these organisms is often associated with poor sanitation, improper handling, and post-processing contamination (Adekanmi *et al.,* 2023).

Consumption of contaminated starchy foods may pose serious health risks, particularly to vulnerable populations such as children, the elderly, and immunocompromised individuals. Foodborne infections linked to contaminated fermented foods products such as garri and lafun remains a public health concern in developing countries where routine monitoring and enforcement of food safety regulations are limited (FAO and WHO, 2022). Thus, this study was designed to assess the microbiological quality of garri and lafun in order to determine the types of microorganisms present and evaluate their potential public health implications thereby ensuring consumers protection and safety.

MATERIALS AND METHODS

Sample collection

Six hundred grams (600g) of samples were collected, comprising of 200grams each of white, yellow garri and lafun samples . The samples were purchased from markets in Wukari metropolis. All samples were collected in sterile containers, properly labelled and transported to the Microbiology Laboratory, Federal University Wukari for analyses. The collected samples were analysed within 2-4 hours of collection to

prevent changes in microbial load that could compromise the accuracy of the bacteriological assessment.

Research Design
The study employed a descriptive cross-sectional research design to assess the microbial quality of microorganisms associated with fermented food products (garri and lafun) in Wukari, Taraba State, Nigeria. This design was selected because it allows for the systematic collection and analyses of data at a single point in time to determine the prevalence and diversity of microbial contaminants present in these foods, which are commonly consumed by the local population (Fawole and Oso, 2021).

Media Preparation
Culture media were prepared in accordance with the manufacturer's instructions. The culture media used were Nutrient Agar 2.8g, MacConkey Agar 5.5g, 1.5g of Peptone water, Potato Dextrose Agar 3.9g and de Man Rogosa Agar 3.3g was weighed and dissolved in 100ml each of peptone water and sterilized by autoclaving at 121°C for 15minutes Pounds per Square Inch (PSI). After sterilization, the media were allowed to cool to approximately 45–50°C before being aseptically poured into sterile Petri dishes prior to inoculation of the samples.

Isolation and Enumeration.
Ten grams (10 g) of each garri and lafun samples were aseptically weighed and transferred into 90 ml of sterile peptone water to obtain stock solution. The mixture was thoroughly homogenized by shaking to ensure even distribution of microorganisms present in the sample. Tenfold serial dilution were carried out (1:10,1:100,1:1000...10,000). 1.0 ml of appropriate dilution (10^2 and 10^4) was plated on various Agar plates using pour plate method and incubated at 37^0 C for 18- 24 hours for total bacteria, coliform and lactobacillus. Fungi was incubated at room temperature (28 ± 2 °C) for 72hours. The actual number of bacterial and fungi count was calculated as colony-forming unit (CFU/g)

Purification and Maintenance of Isolate
Microbial isolates obtained from the samples of garri and lafun were purified to obtain pure cultures for accurate identification and further analyses. Purification was carried out using the streak plate method on appropriate media. Nutrient agar was used for bacterial isolates, MacConkey agar was used for the isolation of coliform bacteria and Potato Dextrose Agar (PDA) was used for yeast and mold isolates. Individual colonies exhibiting distinct morphological characteristics were carefully selected and re-streaked onto fresh agar plates. The purified cultures were store on slants for further analyses.

Identification and Characterization of Microbial Isolates
The Identification and characterization of microbial isolates obtained from garri and lafun samples were carried out based on cultural, morphological, microscopic, and biochemical tests such as coagulase test, catalase test, oxidase test, indole test, citrate test and triple sugar iron, MR-VP test were carried out for identification and confirmation of bacterial isolates as described by (Cheesebrough, 2006 and MacFaddin, 2021).

The identification of fungal isolates was performed based on morphological characteristics, including colony pigmentation, sporulation pattern, and mycelial

structure following standard mycological procedures as described by (Cheesbrough, 2006).

Antibiotic Susceptibility Testing
Antibiotic susceptibility testing of the bacterial isolates was performed using the standard disc diffusion method. Sterile agar plates were evenly inoculated with the bacterial culture using a sterile swab to obtain a uniform lawn of growth. Commercially prepared antibiotic discs were aseptically placed on the surface of the inoculated agar plates and incubated under appropriate conditions at 37°C for 24 hours. After incubation, the zones of inhibition around each antibiotic disc were measured. The diameter of the inhibition zones was used to classify the isolates as susceptible, intermediate, or resistant to the tested antibiotics based on standard interpretative guidelines.

RESULTS AND DISCUSSION
Microbial Load of Total Aerobic Plate Count, Coliform, and Yeast (CFU/g)
The results presented in Table 1 showed the total aerobic plate count (TAPC), coliform count, and yeast count of microbial populations associated with yellow garri (YG), white garri (WG), and lafun (LF) samples. The total aerobic bacterial count recorded across all samples ranged from 6.6×10^4 CFU/g to 2.1×10^5 CFU/g. The highest bacterial load was observed in LF2 (2.1×10^5 CFU/g), followed closely by YG1 (1.9×10^4 CFU/g) and LF1 (1.8×10^4 CFU/g). In contrast, the lowest count was recorded in WG1 (6.6×10^4 CFU/g). This variation suggests that lafun samples generally harboured higher microbial loads compared to garri, which may be attributed to differences in processing techniques, fermentation duration, moisture content, and post-processing handling practices. Lafun, being a fermented and less heat-processed product, provides a more favorable environment for microbial proliferation than garri, which undergoes roasting that reduces microbial load. Samples YG1 and YG2 showed no coliform growth, indicating better sanitary quality of these samples. While samples LF1 and LF2, and WG1 and WG2 ranged from $4.1x10^4 – 7.6x10^4$. The absence of coliforms in yellow garri samples may be attributed to effective roasting and lower moisture content, which inhibit the survival of enteric bacteria.

The yeast count showed no growth (NG) for sample YG1(NG). The highest yeast count was observed in YG2 (8.0×10^4 CFU/g), followed by WG1 (7.4×10^4 CFU/g).
The presence of yeast in these samples is not unexpected, as yeasts are commonly associated with fermented starchy foods and play a role in cassava fermentation processes. However, excessive yeast growth may contribute to spoilage and undesirable sensory changes.

The results revealed that for TAPC white garri samples exhibited the highest microbial loads, while yellow garri showed relatively lower counts. This trend can be attributed to differences in processing methods, as yellow garri undergoes roasting, which significantly reduces microbial load, whereas lafun is less heat-treated and retains higher moisture content that supports microbial proliferation. The result obtained from the study is in agreement with the findings by Adegoke *et al.* (2021) and Omemu and Bankole (2022), who reported microbial loads within $10^4 – 10^6$ CFU/g in cassava products, emphasizing that traditional processing methods influence microbial levels. Similarly, Akindele *et al.* (2023) noted that fermented

cassava products with higher moisture content tend to harbour increased microbial populations.

Coliform counts varied significantly, with no detectable growth in yellow garri samples, this suggests better hygienic processing and effective heat treatment in yellow garri. The presence of coliforms in white garri and lafun indicates poor sanitation during handling.

Comparatively, the findings from this present study are consistent with reports by Oluwafemi *et al.* (2020) and Akindele *et al.* (2023), who observed variable coliform contamination in garri, often linked to water quality, environmental exposure, and handling practices. However, the detection of relatively high coliform counts in some samples, particularly white garri, suggests possible lapses in hygiene, making such products potentially unsafe for direct consumption without further processing.

Yeast counts ranged from no growth to $8.0x10^4$ CFU/g, with higher counts observed in some garri and lafun samples. In comparison with previous studies, the yeast counts obtained align with findings by Omemu *et al.* (2021), who reported yeast populations ranging from 10^3 to 10^6 CFU/g in cassava-derived products. This indicates that the yeast levels observed in this study are within acceptable and commonly reported limits, although variations among samples highlight differences in processing and storage conditions. Generally, the result of microbial loads obtained in this study fall within ranges of acceptable limits of $10^2 – 10^7$ CFU/g as stated by NAFDAC (2025).

Table 1 Total Aerobic Plate Count of Bacterial Cells, Coliforms and Yeast Count (CFU/G) from Yellow Garri, White Garri and Lafun Sample

SAMPLE CODE	TAPC BACTERIAL	COLIFORM	YEAST
YG 1	1.9×10^4	NG	NG
YG 2	$1.4 \times \times 10^4$	NG	8.0×10^4
LF 1	1.8×10^4	6.0×10^3	1.2×10^4
LF 2	2.1×10^5	6.2×10^3	3.6×10^4
WG 1	6.6×10^4	4.1×10^4	7.4×10^4
WG 2	8.2×10^4	7.6×10^4	4.6×10^4

Key: **NG** = Not Growth, **YG** = Yellow Garri, **WG** = White, **LF** = Lafun,

Identity of Yeast and Mould from samples analysed

The results presented in Table 2 showed fungal isolates obtained from the ferment food samples: yellow garri, white garri, and lafun analysed. The result revealed a diverse population of moulds and yeasts. The organisms identified included *Aspergillus niger*, *Aspergillus flavus*, *Penicillium spp*., *Mucor spp*., *Saccharomyces cerevisiae*, and *Candida spp*. The predominance of *Aspergillus* and *Penicillium* species observed in this study is consistent with findings from similar studies on cassava products, where these genera were reported as the most dominant fungal contaminants in garri and related foods (Adegoke *et al*., 2010; Amadi *et al*., 2019). These organisms are known for their ability to survive under low moisture conditions typical of dried food products.

The detection of *Aspergillus flavus* in lafun samples agrees with the findings of Amadi *et al*. (2019), who reported that this species is frequently isolated from cassava-based foods and is capable of producing aflatoxins, which pose serious health risks to consumers. Similarly, (Oguntoyinbo and Narbad 2021) emphasized that traditional food processing methods often expose products to toxigenic fungi due to poor hygiene and environmental contamination.

The consistent isolation of *Penicillium spp*. and *Saccharomyces cerevisiae* across all samples obtained in this study aligns with the reports as described by (Omemu, 2011; Sanni *et al*., 2008) who also identified these organisms as common microflora in fermented cassava products. However, their presence may also indicate contamination during post-processing handling and storage.

The occurrence of *Candida spp*., including *Candida albicans* and *Candida tropicalis*, suggests contamination from human handling, water sources, or processing equipment, which is in agreement with findings reported by Oluwafemi *et al*. (2018) in similar food products. Furthermore, the presence of *Mucor spp*. in white garri indicates exposure to moisture and poor storage conditions, supporting observations made by Adegoke *et al*. (2010).

Table 2. Macroscopic Characterization of Yeast and Mould Isolate.

S/N	Sample code	Macroscopic Features	Suspected Organisms
1	YG1	Large, greenish-black, filamentous, flat, powdery	*Aspergillus niger*
2	YG2	Medium, green, circular, flat, velvety	*Penicillium spp.*
3	YG1	Small–medium, white creamy, smooth, raised	*Saccharomyces cerevisiae*
4	YG2	Small, creamy white, circular, convex	*Candida spp.*
5	WG1	Large, whitish-grey, cottony, flat	*Mucor spp.*
6	WG2	Medium, bluish-green, circular, flat, velvety	*Penicillium spp.*
7	WG1	Small, white creamy, smooth, raised	*Saccharomyces cerevisiae*
8	WG2	Small, cream, smooth, convex	*Candida albicans*
9	LF1	Large, dark green, powdery, flat	*Aspergillus flavus*
10	LF2	Medium, grey-green, velvety, flat	*Penicillium spp.*
11	LF1	Small, creamy white, smooth, raised	*Saccharomyces cerevisiae*
12	LF2	Small, white, smooth, convex	*Candida tropicalis*

3.3 Identity of Bacterial Isolates

The results presented in Fig 1 shows the identity and prevalence of organisms isolated from the various samples of white garri (WG1and2), yellow garri (Y1andY2) and lafun (LF1 and LF2) The isolates was identified as *Enterococcus faecalis*, *Citrobacter freundii*, *Salmonella arizonae, Enterobacter cloacae*, *Aeromonas hydrophila*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Aerococcus viridans*, The presence of lactic acid bacteria indicates active fermentation processes, which are beneficial. However, the simultaneous detection of enteric bacteria and pathogens suggests contamination from handling, environment, or processing water. These findings are consistent with Akindele *et al.* (2023), who reported that poor hygiene and environmental exposure during cassava processing contribute significantly to microbial contamination. The detection of *Salmonella* and *Listeria* is particularly significant, as these organisms are associated with foodborne illnesses

indicating potential health risks if products are consumed without further processing.

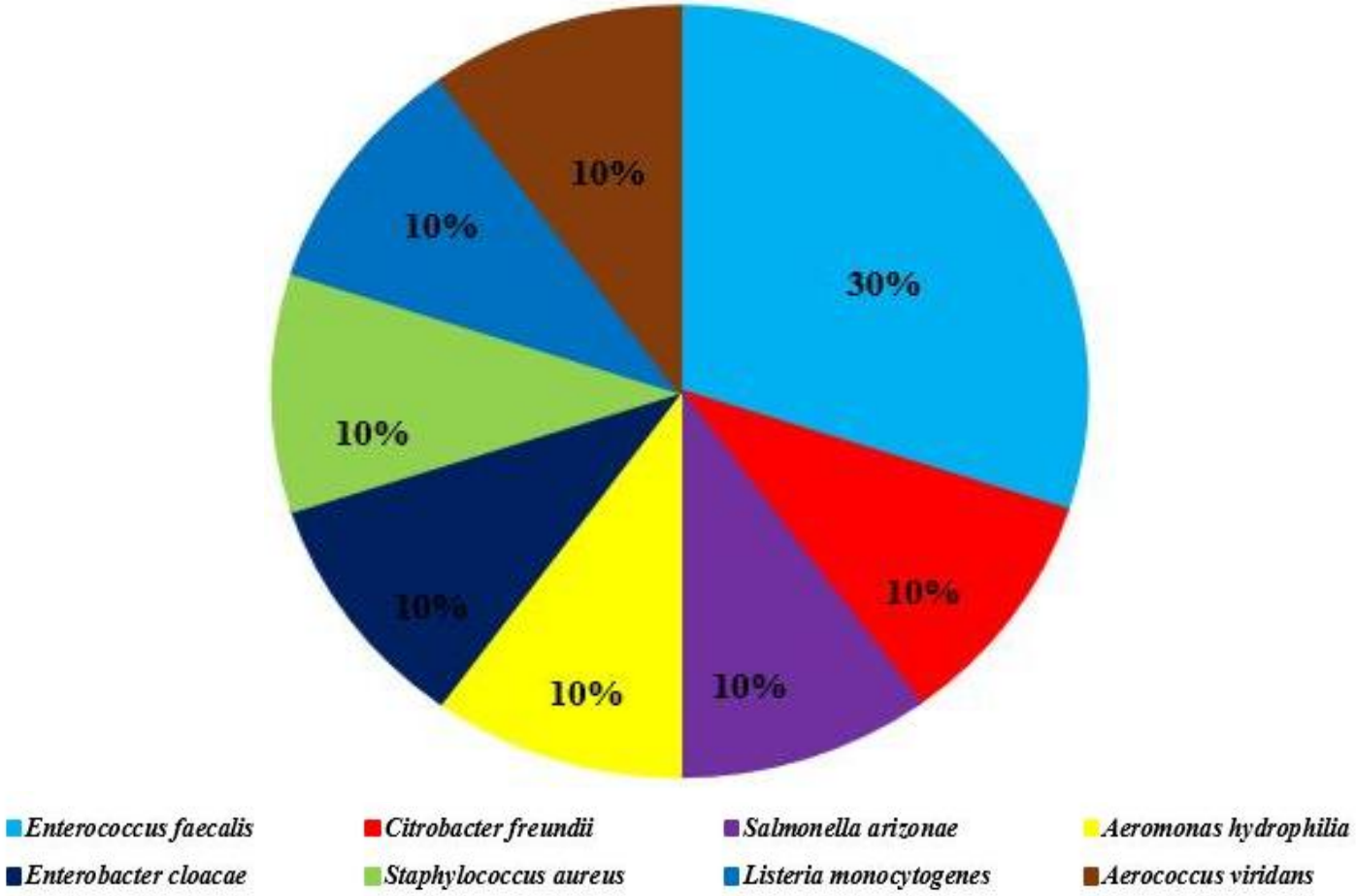

Figure 1. Prevalence of Bacteria Isolated from yellow, white garri and lafun samples.

Antimicrobial Susceptibility Patterns of Bacteria Isolates (Antibiogram)
The results presented in Table 3 shows the antimicrobial susceptibility profiles of bacterial isolates recovered from yellow garri (YG), white garri (WG), lafun (LF) samples, and isolates obtained on MRS medium. The susceptibility pattern was determined using the disc diffusion method, and the response of isolates to different antibiotics was recorded as resistant (R) or based on inhibition zone diameters (mm). Isolates obtained from white garri (WG2) on Macconkey exhibited complete resistance to all the antibiotics tested, including perfloxacin, gentamycin, ciprofloxacin, azithromycin, erythromycin, rifampicin, and levofloxacin. This indicates a multidrug-resistant (MDR) profile, suggesting that the isolates may have acquired resistance traits from environmental exposure or repeated antibiotic contact. A similar observation was reported by Li *et al.* (2024), who noted that fermented foods often harbor bacteria with high antibiotic resistance potential, contributing to the spread of resistance genes in food systems.

Similarly, isolates from yellow garri (YG1) and lafun (LF1) also showed complete resistance across all tested antibiotics, indicating a consistent pattern of multidrug resistance among isolates grown on MacConkey agar. This agrees with findings by Adoh and Enabulele (2025), who reported that bacteria isolated from fermented cassava products exhibited very high resistance levels (up to 100%) to antibiotics such as gentamycin, amoxicillin, and erythromycin. However, isolates obtained from white garri (WG2) nutrient agar showed measurable susceptibility to several antibiotics, including perfloxacin (2.6 mm), gentamycin (2.4 mm), ampiclox (2.6 mm), ciprofloxacin (2.8 mm), rifampicin (2.7 mm), and levofloxacin (2.6 mm). This indicates partial susceptibility, suggesting that some antibiotics, particularly fluoroquinolones, remain effective against certain isolates. This observation aligns with findings by Bamigbade *et al.* (2023), who reported that lactic acid bacteria from cassava fermentation exhibited variable antimicrobial responses, with measurable inhibition zones against selected pathogens.

In a similar pattern, isolates from lafun (LF1) on nutrient agar demonstrated moderate susceptibility to gentamycin, ampiclox, amoxicillin, and erythromycin, although resistance to other antibiotics persisted. This indicates that resistance is widespread but not uniform across all isolates, which is consistent with reports by Okeke *et al.* (2023), who observed variable antibiotic susceptibility among foodborne bacterial isolates depending on environmental exposure and microbial type. The isolates from lafun (LF2) on macconkey agar exhibited partial susceptibility to ofloxacin, perfloxacin, ciprofloxacin, gentamycin, and nalidixic acid, while remaining resistant to other antibiotics. Similarly, isolates from YG1 and LF2 on nutrient agar showed varying degrees of susceptibility to ofloxacin, ciprofloxacin, and streptomycin, with inhibition zones ranging from 0.8 mm to 2.4 mm, indicating moderate antibiotic effectiveness.

These findings obtained from this study are consistent with studies by (Zhang *et al.*, 2023) on fermented foods, where over 90% of isolates were resistant to at least three classes of antibiotics, demonstrating widespread multidrug resistance among food-associated bacteria.

The isolate obtained from MRS medium (lactic acid bacteria group) showed limited susceptibility, with measurable inhibition zones against gentamycin, ampiclox, and amoxicillin, but remained resistant to most other antibiotics. This observation

supports the findings as described by (Fugabun *et al.*, 2022) that lactic acid bacteria (LAB), which are generally considered beneficial, may carry antibiotic resistance genes, posing a potential risk of transfer within the food chain.

The results indicated that bacterial isolates from garri and lafun samples exhibit high levels of multidrug resistance, particularly among isolates recovered on MacConkey agar. While some isolates showed partial susceptibility to fluoroquinolones and selected antibiotics, the overall resistance pattern suggests a significant public health concern.

The findings of this study are in agreement with recent literature, which emphasizes that starchy food products especially the fermented ones can serve as reservoirs of antibiotic-resistant bacteria, potentially contributing to the spread of resistance through the food chain. The presence of such resistant organisms in garri and lafun samples highlights the need for improved hygienic practices, proper processing conditions, and controlled antibiotic usage to reduce contamination and safeguard public health.

The Antimicrobial Susceptibility Pattern of bacterial Isolates (antibiogram) results in table 3 revealed a high level of resistance among isolates to commonly used antibiotics such as Ampiclox, Rocephin, and Septrin, while moderate susceptibility was observed for some antibiotics like Ciprofloxacin and Gentamycin.
This pattern suggests the presence of antibiotic-resistant strains, which is a growing public health concern. The resistance observed may be due to the widespread misuse of antibiotics in humans and agriculture. This finding agrees with recent reports by (Adegoke *et al.*, 2021; Akindele *et al.*, 2023), which documented increasing antimicrobial resistance among foodborne bacteria isolated from traditional foods.
The presence of resistant pathogens in food products poses a significant risk, as infections caused by such organisms may be difficult to treat.

Table 3. Antimicrobial Susceptibility of Bacteria Isolates (Antibiogram)

S/N	SAMPLE CODE	PEF	CN	APX	Z	AM	CPX	AZ	E	R	LEV
1.	WG2	R	R	2.3	R	2.4	R	R	R	R	R
2.	YG1	R	R	2.4	R	2.3	R	R	R	R	R
3.	LF1	R	R	2.2	R	2.5	R	R	R	R	R
4.	WG2	2.6	2.4	2.6	2.5	R	2.8	R	R	2.7	2.6
5.	LF1	R	2.2	2.5	R	2.6	R	R	2.2	R	R
6.	MRS	R	2.1	2.2	R	2.3	R	R	R	R	R
S/N	**SAMPLE CODE**	**OFX**	**PEF**	**CPX**	**AU**	**CN**	**S**	**CEP**	**NA**	**SXT**	**PN**
7.	LF2	1.9	1.9	2.1	R	1.5	R	R	1.1	R	R
8.	YG2	1.8	2.0	2.4	R	1.8	R	R	0.9	R	R
9.	YG1	2.0	0.8	2.1	R	1.4	2.1	R	R	R	R
10.	LF2	2.0	0.9	2.4	R	1.5	2.4	R	0.9	R	R

Key: **R =** Resistant **PEF** = Pefloxacin, **CN** = Gentamycin, **APX** = Ampiclox, **Z** = Zinnacef, **AM** = Amoxacillin, **R** = Rocephin, **CPX** = Ciproflaxcin, **AZ** = Azithromycin, **LEV** = Levoflaxcin, **E** = Erythromycin, **OFX** = Tarivid, **PEF** = Reflacine, **CPX** = Ciproflox, **AU** = Augmentin, **PN** = Ampicilin, **SXT** = Septrin, **NA** = Nalidic Acid, **CEP** = Ceporex, **S** = Streptomycin

CONCLUSION

This study revealed that yellow garri, white garri, and lafun harbour diverse microbial populations, including both beneficial and pathogenic organisms. However, the total microbial count were within the acceptable limit reported in literatures. The detection of coliforms and pathogenic bacteria indicates lapses in hygiene during processing and handling. The presence of fungi, including toxigenic species, highlights the risk of spoilage and mycotoxin contamination. Additionally, the detection of antibiotic-resistant bacteria raises concerns about public health implications. Thus, the findings emphasize that while traditional cassava products remain important dietary staples, their safety largely depends on proper processing, handling, and storage practices.

CONFLICTS OF INTEREST

There is no any conflicts of interest declared by the authors.

REFERENCES

Adebayo, A. O., and Adebola, P. O. (2022). Traditional processing and microbial quality of cassava-based foods in West Africa. *African Journal of Food Science*, 16(4), 97-106. https://doi.org/10.5897/AJFS2022.2178

Adegoke A. A., Tom M., Okoh A., and Steve J. (2010). Studies on multiple antibiotic resistant bacteria isolated from surgical site infections. *Scientific Research and Essays*.5:3876-3881

Adegoke, G. O., Komolafe, A. O., and Akingbala, J. O. (2021). Physicochemical and sensory characteristics of lafun produced from different cassava varieties. *Nigerian Food Journal*, 28(1), 112–118.

Adekanmi, O. J., Ogunbanwo, S. T., and Sanni, A. I. (2023). Microbiological quality and safety assessment of fermented cassava products sold in Nigerian markets. *Journal of Food Safety*, 43(2), e13045. https://doi.org/10.1111/jfs.13045

Adoh, F. O., and Enabulele, S. A. (2025). Processing methods and quality evaluation of traditional cassava flour products in West Africa. *African Journal of Agricultural Research*, 21(1), 33–45.

Akindele, W.O., Adeosun,A.O. and Olarinwa, O.S.(2025).Effects of varying inclusion levels of sundried cassava peels (SCP) on growth performance and economy of production of growing rabbits.Greener Journal of Agricultural Sciences,15(1): 27-33.

Amadi, J. A., Nwokedi, G. I. C., and Ogueke, C. C. (2019). Fermentation and quality characteristics of lafun produced from cassava roots. *Journal of Food Processing and Preservation*, 43(9), e14092.

Bamigbade, G. B., Adeyemi, I. A., and Olatunde, S. J. (2023). Functional and sensory properties of fortified lafun flour blends. *Heliyon*, 9(4), e14852.

Cheesbrough, M. (2006). District laboratory practice in tropical countries (Part 2, 2nd ed.*). Cambridge University Press. 11*(2), 113.

FAO and WHO. (2022). Food safety and traditional fermented foods in developing countries. *FAO Food and Nutrition Paper*. Rome: FAO. *12*(6), 10-34.

Fawole, O. O. and Oso, B. A. (2021). Practical Microbiology*: Laboratory Manual and Research Techniques*. Lagos: University Press. *17*(3), 12-22.

Fugaban, J. I. I., Holzapfel, W. H., and Todorov, S. (2022). The overview of natural by-products of beneficial lactic acid bacteria as promising antimicrobial agents. *Applied Food Biotechnology,* 9(2), 127–143. https://doi.org/10.22037/afb.v9i2.32364

Li, X., Zhang, Y., and Chen, H. (2024). Advances in cassava fermentation technologies and quality improvement of African fermented foods. *Food Bioscience*, 58, 103987.

MacFaddin, J. F. (2021). Biochemical tests for identification of medical bacteria (3rd ed.). *Lippincott Williams and Wilkins*. *4*(7), 9-14.

National Agency for Food and Drug Administration and Control. (2025). Herbal and Fruits infusion and regulations (Schedule 6: *Microbiological Limits*). https://doi.org/14.212/1127-12682.4337

Okeke, C. C., Ojimelukwe, P. C., and Ezeama, C. F. (2023). Nutritional and microbial evaluation of traditionally processed lafun flour. *Food Research*, 7(2), 145–153.

Oguntoyinbo, F. A., and Narbad, A. (2021). Microbial ecology of fermented cassava foods. *Food Microbiology, 96*, 103709.

Omemu, A.M. (2011) Fermentation Dynamics during Production of ogi, a Nigerian Fermented Cereal Porridge. Report and Opinion, 3, 8-17.

Omemu, M. A Adebayo-Oyetoro, A. O., Oyewole, O. B., & Obadina, A. O.,. (2021). Microbiological safety assessment of fermented cassava flour “lafun” available in Ogun and Oyo States of Nigeria. *International Journal of Food Science*, 2013, 845324. https://doi.org/10.1155/2013/845324

Omemu, M. A and Bankole, F. H. (2022). Date palm fruit: Nutritional composition, therapeutic potentials, and industrial applications. *Food Reviews International,* 36(8), 775- 805.

Oluwafemi, F., Akharaiyi, F., and Ezeama, C. F (2018). Microbiological and nutritional qualities of fermented cassava products (lafun and fufu) sold in South-West Nigeria. *African Journal of Food Science*, 12(5), 98–105.

Oluwafemi, F., Akpan, I., and Oladipo, I. C. (2021). Bacteriological assessment of fermented cassava products and associated public health risks. *International Journal of Food Microbiology*, 352, 109287. https://doi.org/10.1016/j.ijfoodmicro.2021.10928.

Sanni, L. O., Adebowale, A. A., Awoyale, W., and Fetuga, G. O. (2008). Quality of gari, lafun and fufu flour produced from cassava roots. *Pakistan Journal of Nutrition*, 7(6), 819–823.

Zhang, Y., Li, X., and Wang, Q. (2023). Recent developments in fermented cassava products: Processing, safety and nutritional quality. *Critical Reviews in Food Science and Nutrition*, 63(18), 5421–543