

Mycological Assessment of Garri Sold in Utako Market, Abuja, Nigeria

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ABSTRACT

Garri is a fermented cassava based product and forms a significant part of people's diet in Nigeria. It is a product of mostly spontaneous fermentation in rural settings and susceptible to unhygienic practices during its processing and handling with potential for contamination with spoilage and potential pathogenic microorganisms like moulds. This study assessed the mycological quality of garri sold in Utako market, Abuja. Twenty (20) sample of garri comprising of ten (10) samples each of white and yellow garri were purchased from vendors in Utako market, Abuja. One millilitre of appropriate dilutions obtained from ten fold serial dilutions of sample homogenates were plated onto sterile Petri dishes containing acidified potato dextrose agar (PDA) using spread plate method. Mould isolates were characterized and identified macroscopically and microscopically. Mould counts ranged from $4.3\log_{10}$ - $4.9\log_{10}$ cfu/g for white garri and from $4.0\log_{10}$ - $4.9\log_{10}$ cfu/g for yellow garri. Moulds were isolated from all garri samples (100%). Isolates were identified as *Aspergillus* spp, *Penicillium* spp, *Alternaria* spp and *Rhizopus* spp. *Penicillium* spp recorded highest frequency of 38% for white garri, while *Aspergillus* spp. and *Alternaria* spp. recorded highest frequencies of 36% for yellow garri. Lowest frequencies were recorded for *Rhizopus* spp. in white garri (8%), whereas *Penicillium* spp. recorded lowest frequencies for yellow garri (9%). Statistical analysis of counts using student's t-test showed no significant differences in mean counts between the groups of samples at 5% level of significance with calculated t-value (0.16) being less than table value (2.26). Findings suggests high frequency of occurrence of moulds in some garri sold in some markets in Abuja at levels beyond acceptable limits set by regulatory bodies suggesting a high chance of exposure to moulds by consumers of the product to potential mycotoxigenic mould species. It is recommended that the enlightenment, training and certification of producers on safe and standard practices of garri processing be enforced by relevant regulatory agencies.

Keywords: Garri, market, Abuja, moulds, mycotoxins

1.0 INTRODUCTION

Fermentation is a biochemical process where organic substrates are transformed into simpler compounds as a result of the enzymatic activity of microorganisms such as moulds, yeasts, and bacteria on these substrates (Adesanya *et al.*, 2021). Fermentation, a cost-effective biotechnological process, serves not only as a natural method for food preservation and the development of novel food products but also significantly contributes value to the human diet by transforming raw substrates into nutritionally enhanced products with improved sensory attributes (Dlamini *et al.*, 2026).

Fermented foods in Nigeria constitute a large proportion of food staples across several cultures. These fermented foods are generally produced through uncontrolled fermentation processes carried out under substandard hygienic and processing conditions. Owing to the ubiquitous nature of microorganisms particularly bacteria and fungi, a good number of traditional fermentation processes yield food products considered unsafe due to presence of potential microbial pathogens (Chai and Chen., 2025; Zakari *et al.*, 2025).

The fungi as a group of microorganisms are ubiquitous, diverse and include groups of organisms like Moulds, Yeasts and Mushrooms. Fungi play vital roles in nature such as decomposition of organic matter, hence their importance in food processing, but these activities sometimes lead to production of harmful substances or mycotoxins with significant threats to food security and human health (Zain, 2020; Razzaghi-Abyaneh *et al.*, 2025)

Mycotoxins are toxic compounds that are naturally produced by certain types of moulds while growing in foods (Kabak *et al.*, 2021). Mycotoxins associated with food have been linked to long-term effects on health, including the induction of cancers and immune deficiency (Iheshiulor *et al.*, 2020, Balwan *et al.*, 2023). Examples of mycotoxin producing moulds include species of *Aspergillus*, *Penicillium*, and *Fusarium* (Zain, 2020). A number of indigenous fermented foods in Nigeria are said to be contaminated with varying levels of mycotoxins (Adekoya *et al.*, 2017; Sanyaolu *et al.*, 2019). It has been documented that Nigeria has experienced high recorded aflatoxin exposure levels in humans as well as the highest estimated number of cases of liver cancer worldwide, resulting from consumption of aflatoxins (Liu and Wu, 2010).

Garri, a roasted granular food product made from fermented cassava (*Manihot esculenta-Crantz*) tubers is a popular food staple across many cultures in Nigeria (Ojar *et al.*, 2026). It is consumed by several millions of people regardless of ethnicity and socio-economic class, making it the commonest meal amongst the rich and the poor (Adeniyi, 2017; Ojar *et al.*, 2026). Garri available in the market can be consumed directly without further processing in the dry form with pea nut, coconut, smoked fish, soaked in water (sometimes with milk and beverage) or processed minimally using boiled water to form stiff paste popularly called “eba” and eaten with various types of African soups (Adeniyi, 2017).

Like many traditionally fermented foods, unhygienic practices have been observed in the processing and handling of garri. Practices such as spreading on the floor and mats after frying, displaying in open vessels in the markets during sales, use of contaminated packaging materials to transfer finished products from rural to urban areas and the use of bare hands during handling and sales may lead to microbial contamination due to deposition of bioaerosols on exposed products and transfer of infectious agent during handling (Ogiehor *et al.*, 2017).

The consumption of garri is prevalent among various age groups in Nigeria hence a large segment of the population is currently exposed to the risks associated with consumption of a product that may be considered hazardous due to its exposure to unhygienic conditions during processing and sale. It has been documented that Nigeria has experienced high recorded aflatoxin exposure levels in humans as well as the highest estimated number of cases of liver cancer worldwide, resulting from consumption of aflatoxins (Liu and Wu, 2010).

Against the above backdrop, this study was aimed at assessing some retail Garri products from an urban market in Nigeria in a bid to offer more information on the safety and species of fungal flora associated with the product to ascertain the potential hazard to which consumers are exposed.

2.0 MATERIALS AND METHODS

2.1 Study Area

Samples in this study were purchased from Utako market, located in the heart of Abuja near Berger Bus-stop and the famous Utako and Jabi parks within the Abuja Municipal Council (AMAC) of the Federal Capital Territory, (FCT), Abuja. The FCT has a population of over 3 million people and serves as a major administrative, commercial and cultural center in Nigeria hence it is inhabited by people from diverse ethnic and cultural backgrounds (Ayobolu, 2025). Utako market is one of several markets in the FCT, where a variety of foodstuff are sold, meeting the

demands of its diverse groups of inhabitants. Abuja, the capital territory of the federal republic of Nigeria, is located within 9.07°N and 7.6°E occupying 1769sqkm. With an average annual rainfall of 1,100 to 1600 mm, the FCT has a tropical savanna climate with rainy and dry seasons stretching from April to October and November to March respectively (Nigerian Meteorological Agency, 2023).

2.2 Sample Collection

A total of 20 samples of Garri consisting of 10 Samples each of white and yellow Garri was purchased from 5 sellers of the product in the month of October (late rainy season) in Utako market, FCT, Abuja, Nigeria. Four samples were purchased from each seller (2 samples each of white and yellow) at separate times. Samples were collected in sterile polythene bags and analyzed within 24h of purchase.

2.3 Isolation and Enumeration of moulds from Samples

The isolation techniques employed by Mukhtar *et al.* (2020) was adopted in this study. Ten grams of each garri sample was added to 90ml of sterile distilled water in a test tube. The contents were then thoroughly shaken manually for about two minutes. Ten fold serial dilutions of the suspensions from 10^{-1} to 10^{-5} were made. About 0.1ml of each dilution was transferred aseptically into sterile Petri dishes containing acidified Potato Dextrose Agar (PDA) using a sterile pipette and then spread over the surface using a sterile glass spreader. The plates were incubated at ambient temperature (28-30°C) and then examined after a period of 3-5 days for the presence of fungal colonies. Colonies were counted and recorded as a total viable colony forming units of moulds per gram (cfu/g) of sample.

2.4 Characterization and Identification of Mould Isolates

Mould isolates were characterized and identified using the method of Al-mohanna (2016). This involved observing both macroscopic and microscopic features. Macroscopic identification of mould was based on the colony, colour, size, and appearance. Microscopic evaluation was done by teasing small portion of the pure mould culture and mounting in lactophenol cotton blue dye on a clean slide, it was then covered with a clean cover slip and observed under the microscope with 10× objective lens and then confirmed with 40× objective lens.

2.5 Data Analysis and Presentation

Data obtained from this study was subjected to descriptive statistics to determine for frequency of occurrence of species (percentage). The student's t-test

was employed to test for significant differences in counts between samples (Mishra *et al.*, 2019). Results are presented in tables and chart.

3.0 RESULTS AND DISCUSSION

3.1 Moulds counts of some Garri samples sold in Utako market, Abuja, Nigeria.

Moulds counts of garri samples analysed in this study are shown in table 1. Counts ranged from $4.3\log_{10}$ - $4.9\log_{10}$ cfu/g for white garri and from $4.0\log_{10}$ - $4.9\log_{10}$ cfu/g for yellow garri. Moulds were isolated from all garri samples (100%). Statistical analysis of values using student t-test of white and yellow garri samples showed no significant difference in mean counts between the groups of samples at 5% level of significance with calculated t-value (0.16) being less than table value (2.26)

Table 2 shows the macroscopic and microscopic characteristics of moulds isolated from the samples. A total of 4 species of moulds consisting of *Aspergillus*, *Penicillium*, *Alternaria*, and *Rhizopus* were identified from the samples in this study based on their macroscopic and microscopic characteristics as shown in table 2.

The percentage occurrence of mould species isolated from white and yellow garri samples in this study are shown in figure 1. In white garri, the highest frequency of occurrence was recorded for *Penicillium* species (38%) while *Rhizopus* species appeared to be the least recovered from white garri (8%). Similarly, *Aspergillus* and *Alternaria* species had the highest frequency of occurrence in yellow garri (36%), while *Rhizopus* species was the least recovered (18%)

Table 1: Mould Count of Retail Garri Samples from Utako Market, Abuja

White Garri (WG) Samples	Mould Count ($\log_{10}$ cfu/g)	Yellow Garri (YG) Samples	Mould count ($\log_{10}$ cfu/g)
S1WG	4.4	S1YG	4.0
S2WG	4.3	S2YG	4.0
S3WG	4.5	S3YG	4.0
S4WG	4.3	S4YG	4.9
S5WG	4.9	S5YG	4.0
S6WG	4.8	S6YG	4.5
S7WG	4.3	S7YG	4.0
S8WG	4.6	S8YG	4.6
S9WG	4.3	S9YG	4.0
S10WG	4.6	S10YG	4.3

Table 2 : Macroscopic and Microscopic Characteristics of Mould isolates from Retail Garri Samples in Utako market.

Sample	Macroscopic description	Microscopic description	Inference
S1WG	Small, dry, green colonies with cotton-like edges	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in circular form	<i>Aspergillus</i> spp.
S2WG	Small, dry, green colonies with cotton-like edges	Septate hyphae, conidia, conidiospore	<i>Alternaria</i> spp.
S3WG	Blue-green, cotton-like colonies with smooth edges	Septate hyphae, unbranched conidiospore	<i>Penicillium</i>
S4WG	Small, dry, green colonies with cotton-like edges	Septate hyphae, conidia, conidiospore	<i>Alternaria</i> spp.
S5WG	Dark green green colonies with white edges	Septate hyphae, unbranched conidiospore	<i>Penicillium</i> spp
	Small, dry, green colonies with cotton-like edges	Septate hyphae, conidia present, conidiospore	<i>Alternaria</i> spp
	White-dark grey colonies with wooly surface	Septate hyphae, unbranched conidiophore with conidiospores on phialides in circular form	<i>Aspergillus</i> spp.
	Small, dry black colonies with slightly raised centre	Septate hyphae, unbranched conidiophore with conidiospores on phialides in circular form	<i>Aspergillus</i> spp
S6WG	Blue-green, cotton-like colonies with wrinkled surfaces, white edges	Septate hyphae, unbranched conidiospore	<i>Penicillium</i>
S7WG	Large cotton-like colonies with black spores embedded in mycelia	Non-Septate hyphae, sporangia sporangiospore	<i>Rhizopus</i> spp.
S8WG	Blue-green colonies with white cotton-like edges	Septate hyphae, unbranched conidiospore	<i>Penicillium</i> spp

S9WG	Small, dry, black, Colonies with slightly raised centres	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in circular form	<i>Aspergillus spp.</i>
S10WG	Blue-green, cotton-like colonies with white edges	Septate hyphae, unbranched conidiophores, conidiospores	<i>Penicillium spp</i>
S1YG	Small, dry, green colonies with cotton-like edges.	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in a circular form	<i>Aspergillus spp.</i>
	Small, dry, green colonies with cotton-like edges	Septate hyphae, conidia, conidiospore	<i>Alternaria spp.</i>
S2YG	Small, dry, green colonies with cotton-like edges	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in circular form	<i>Aspergillus spp.</i>
S3YG	Large, gray-green woolly like colonies with slightly elevated center.	Septate hyphae, conidia, conidiospore present	<i>Alternaria spp.</i>
S4YG	Grey to yellowish brown colonies with cotton – candy like mycelia	Non-Septate hyphae, sporangia sporangiospore present	<i>Rhizopus spp.</i>
S5YG	White- dark grey colonies with wooly surface	Septate hyphae, conidia, conidiospore	<i>Alternaria spp.</i>
S6YG	Cotton – candy like mycelia grey to yellowish brown colonies	Non-Septate hyphae, sporangia, sporangiospores present	<i>Rhizopus spp.</i>
S7YG	Dry dark green colonies with white edges	Septate hyphae, unbranched conidiospore	<i>Penicillium</i>
S8YG	Small, dry, black, Colonies with slightly raised center.	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in circular form	<i>Aspergillus spp.</i>
S9YG	Small, dry, black, Colonies with slightly raised center.	Septate hyphae, unbranched conidiophore with conidiospores on phialides arranged in circular form	<i>Aspergillus spp.</i>
S10YG	Small, dry, green colonies with cotton-like edges	Septate hyphae, conidia, conidiospore present	<i>Alternaria spp.</i>

Keyword:

S1WG = Sample White Garri

S1YG = Sample Yellow Garri

Moulds were isolated all garri samples in this study. Because they can produce spores, moulds are frequently found in the environment, which may account for their occurrence in garri. They have been associated with uncontrolled fermentations as well as ready-to-eat foods (Olopade *et al.*, 2014).

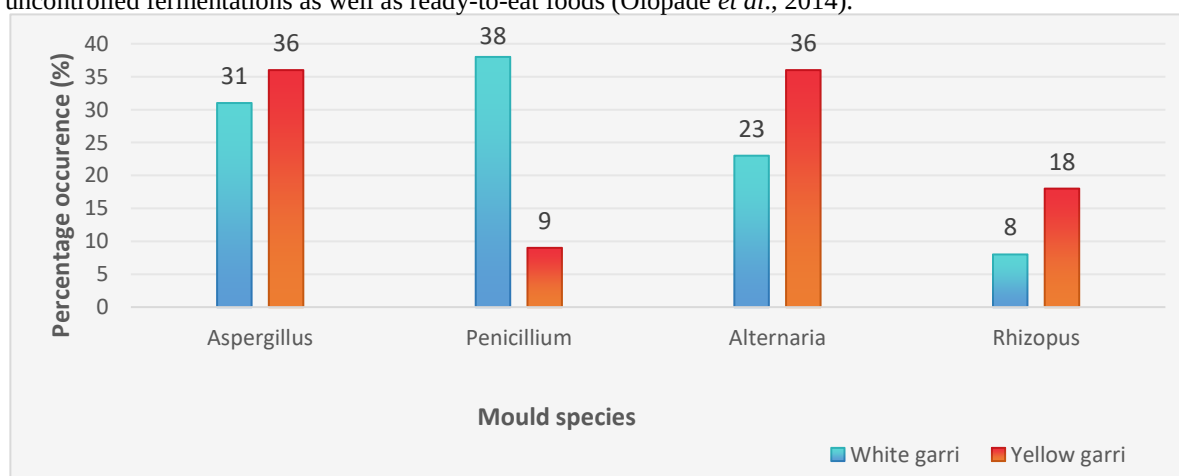


Figure1: Frequency of Occurrence of Mould Species in White and Yellow Retail Garri From Utako Market

Moulds are common contaminants in the environment, and as such could easily contaminate foods where food

safety measures are not strictly followed. They can be easily introduced during local method of processing

and also through exposure to bio-aerosols during sale in the market as suggested in previous researches (Awuchi *et al.*, 2022; Oyeboode *et al.*, 2023). Previous researchers have also established the presence of moulds in garri samples from Nsukka, Zaria and Ikere-Ekiti respectively (Zain, 2020; Okolo and Makanjuola, 2021; Oyeboode *et al.*, 2023)

Regulatory bodies like the African Organization for Standardization (ARSO) have stipulated that mould counts not exceed 10^3 ($3.0 \log_{10}$) (Olopade *et al.*, 2014) in ready-to-eat foods. All samples in this study had mould counts beyond the acceptable limit of $3.0 \log_{10}$. The presence of moulds at levels above acceptable limit could also be attributed to substandard processing conditions which could expose garri to these common contaminants (Oyeboode *et al.*, 2023). Survival of mould spores following processing under substandard conditions associated with traditional processing may also explain the presence of moulds in garri products in this study. Moulds are heat sensitive but are also known to produce spores which can survive in heat processed foods (Adeniyi, 2017).

The presence of species of *Aspergillus* and *Penicillium* is of concern as these are species that both produce mycotoxins known as ochratoxin A. (Zain, 2020, El-sayed, 2022). *Aspergillus* and *Penicillium* recorded highest frequency of occurrence in garri samples in this study. This finding agrees with that of Aguoru *et al.* (2014), Georgia & Oluwafunmilayo, (2016) and Oyeboode *et al.* (2023) who reported *Aspergillus* spp and *Penicillium* spp with highest occurrence respectively. This could be due to these species ability to thrive in relatively low humidity as well as low but sufficient moisture content foods. (Reuveni *et al.*, 1984). The presence of potentially pathogenic mould species in food puts consumers at risks as such species are known producers of metabolites (mycotoxins) with nephrotoxic, hepatotoxic and cytotoxic effect (Bulgaru *et al.*, 2021; Awuchi *et al.*, 2022)

Another source of concern in this study is the possibility that mould isolates from samples may have been actively growing during processing of products analysed, during which long fermentation periods associated with garri processing (4 to 5 days at ambient temperature) may very likely enable mould growth and mycotoxin production. Many mycotoxins have chemical stability and can survive the rigours encountered throughout the food supply chain (Awuchi *et al.*, 2022)

4.0 CONCLUSION

Findings of this study suggests a high frequency of occurrence of moulds in garri products sold in some markets in Abuja (up to 100% for both white and yellow garri). Results of this study also revealed that all white and yellow garri samples which tested

positive for moulds had mould levels beyond the acceptable limit of 10^3 set by regulatory bodies like the African organization for Standardization (ARSO). This suggests a high chance of exposure to moulds by consumers of the popular product including potential mycotoxigenic mould species like *Aspergillus* and *Penicillium*.

5.0 RECOMMENDATIONS

Following the findings of this study, it is recommended that the enlightenment, training and certification of producers on safe and standard practices of garri processing be enforced by relevant regulatory agencies. Consumer awareness on the risks of mould contamination of garri may further encourage compliance by producers. Further studies are required to include hazard analysis and critical control points (HACCP) of garri processing to establish sources of contamination and critical control points to improve quality of the product.

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