

## Fungal Investigation on Sold Bakery Production

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### Abstract

Fungal contamination of bakery products poses significant public health concerns, especially due to the potential production of mycotoxins. This study investigated the fungal contamination of baked product samples sold in the market. A total of 30 bakery product samples were collected and analyzed for fungal presence using standard microbiological techniques. The samples were plated using spread plate method on sabouraud dextrose agar (SDA) and was inoculated at 25°C to 37°C for 72-120 hours. The total fungal count from baked bread product ranged from  $2.4 \times 10^3$  to  $3.0 \times 10^3$  Cfu/mL and the total fungal count from baked cake product ranges from  $2.1 \times 10^3$  to  $2.9 \times 10^3$  Cfu/mL while the total fungal count from baked pastry product ranged from  $2.3 \times 10^3$  to  $3.3 \times 10^3$  Cfu/mL, indicating moderate contamination. *Aspergillus flavus* (30.0%), *Aspergillus fumigatus* (20.0%), *Penicillium sp.* (23.3%), and *Mucor sp.* (26.7%) were identified based on macroscopic and microscopic characteristics. The presence of these fungi suggests potential health risks, as some species produce aflatoxins and other harmful metabolites. The study concludes that poor handling, improper storage, and environmental exposure may contribute to fungal contamination and therefore recommends strict hygiene measures in proper storage practices, routine microbiological screening, and regulatory enforcement to minimize contamination and ensure food safety.

### 1. Introduction

Baked goods are widely consumed due to their affordability, availability, and nutritional value, making them a staple food in both developed and developing countries [1]. Bakery products contribute significantly to a balanced diet and include unsweetened goods (bread, rolls, buns, crumpets, muffins, and bagels), sweet goods (pancakes, doughnuts, waffles, and cookies), and filled goods (fruit and meat pies, sausage rolls, pastries, sandwiches, cream cakes, pizza, and quiche) [2].

However, these products are highly susceptible to contamination by various microorganisms, particularly fungi, due to their rich nutritional and moisture content, which provides an ideal environment for fungal growth [3]. The issue is further exacerbated when baked goods are sold in open markets or stored under improper conditions, leading to spoilage, reduced shelf life, and potential health risks [1]. Fungal contamination of baked goods is a significant concern, as certain fungi can produce mycotoxins secondary metabolites that pose serious health risks to consumers [4]. Mycotoxins such as aflatoxins, ochratoxins, and fumonisins have been linked to immunosuppression, carcinogenic effects, and liver damage [5]. Consequently, the consumption of contaminated

baked goods can result in foodborne illnesses, particularly in regions where food safety regulations are not strictly enforced [6].

Bakery products contribute significantly to a balanced diet and include unsweetened goods. They provide essential nutrients like carbohydrates, proteins, and, in some cases, vitamins and minerals, playing a key role in meeting daily caloric needs. However, these products are highly susceptible to contamination by various microorganisms, particularly fungi, due to their rich nutritional and moisture content, which provides an ideal environment for fungal growth [3]. Fungal contamination not only affects the aesthetic quality of baked goods but also significantly impacts their safety. *Aspergillus*, *Fusarium*, and *Penicillium* species are commonly found on baked products, where they can produce mycotoxins such as aflatoxins, ochratoxins, and fumonisins, which are known for their toxicity and carcinogenic properties [1]. These mycotoxins have been linked to a variety of health issues, including immunosuppression, liver damage, and even cancer, particularly with long-term exposure [5]. As a result, fungal contamination of baked goods remains a critical concern for public health, especially in regions with insufficient food safety regulations [6].

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The increased frequency of fungal contamination in bakery products is associated with factors such as improper storage conditions, high humidity, and inadequate food handling practices [7]. The sale of baked goods in open markets, especially in tropical climates, increases the risk of fungal growth and contamination due to the favorable environmental conditions. Additionally, consumer preferences for preservative-free or organic baked goods, while beneficial in terms of health, can increase the likelihood of microbial spoilage.

## 2. Materials and Methods

### 2.1 Study Area

The study was conducted in the Microbiology laboratory, Faculty of Science, University of Abuja. The University of Abuja Microbiology Laboratory is equipped with the necessary facilities for microbial analysis, including an incubator, microscopes, and sterilization equipment, which are essential for the successful isolation, identification, and quantification of fungal species. Geographically, the University of Abuja is located between latitude 9.0765°N and longitude 7.3986°E and it is situated on the plains of the Guinean savannah in central Nigeria [8].

### 2.2 Sample Size

The number of samples collected for this research work was thirty (30), and this were collected evenly from three bakery products which are Bread, Cake and Pastry.

### 2.3 Collection of Samples

Ten (10) samples were each collected from bakery products which are Bread, Cake and Pastry making thirty (30) samples in total. The baked samples were collected from bakery vendors at University of Abuja market in a sterile container and were transferred to the laboratory (Microbiology laboratory of University of Abuja, Abuja) where the proper experiment was carried out.

### 2.4 Materials and Reagents

The following materials and reagents were used: Clean plastic bags (sealable), Sabouraud dextrose agar (SDA), sterile water, Petri dishes, test tubes, microscope, incubator, glass slides and coverslips, lactophenol cotton blue.

### 2.5 Sterilization of Materials

Materials such as test tubes, conical flasks, beakers, and forceps were sterilized by autoclaving. The medium, distilled water used for serial dilution and all the glass equipment used in carrying out the experiment were sterilized in the autoclave for 15 minutes at 121°C at a pressure of 15 lb. The inoculating loops used were sterilized before and after use by flaming over a lit Bunsen burner till it was red hot, allowed to cool by shaking it close to the lit Bunsen burner and used under aseptic condition. The working surface used during experiment were swabbed before and after use with cotton wool soaked in 70% ethanol [9].

### 2.6 Media Preparation

All media was prepared in accordance with the manufacturer's protocol. Media used was Sabouraud dextrose agar (SDA). The

media was autoclaved at 121°C for 15 minutes. The cooled were poured into Petri dishes and then allowed to cool and solidify. These were used for the isolation, identification, growth and maintenance of microorganisms.

### 2.7 Serial Dilution

Ten (10) fold serial dilutions was carried out at three (3) dilution steps. Three (3) test tubes was prepared each contain a 9 mL of sterile water. After that one gram (1g) of the sample was taken and add to the first to the first test tubes making it the first dilution 10<sup>-1</sup>, 1 mL then taken from the first test tubes 10<sup>-1</sup> and added to the second test tube (10<sup>-2</sup>) and 1 mL was then taken and added to third test tube making it a 10<sup>-3</sup> dilution.

### 2.8 Culturing and Plate Count

After serial dilution 0.1 mL was then taken from each 10<sup>-3</sup> dilution of each sample and inoculated on the Sabouraud dextrose agar media plates at 25°C to 35°C for 72 to 120 hours.

The fungal isolates were isolated and enumerated by growing them on Sabouraud dextrose agar plate which was used for total fungal count. The number of fungi colonies were counted on the Sabouraud dextrose agar (SDA) plates.

### 2.9 Isolation of Pure Culture

The sub-culturing of fungal isolates was carried out by transferring individual visible colonies formed from the primary isolate to already prepared and sterilized SDA plates. The distinct colonies formed were sub-cultured by picking a little portion of the colony formed from the active periphery using a sterilized straight wire and spot inoculating it on a freshly already prepared SDA plate. The colony was picked by digging into the agar in order to take some aerial part which contains the spores and mycelia. Spot inoculation was done by stabbing the picked colony dip into the fresh agar; this was done at the center of the agar. This procedure was performed under aseptic condition near a lit Bunsen burner and the which loop was flamed till it was red hot and allowed to cool near the flame before and after each use. It was incubated at 25°C to 35°C for 72 to 120 hours [9].

### 2.10 Identification of Fungal Isolates

Morphological observation was based on colonial colour, texture and the spreading rate of each colony on the Sabouraud dextrose agar, the microscopic studies of each type was done by making a smear and staining with lactose phenol cotton blue stain and this revealed the somatic and reproductive structures of the microorganism.

## 3. Results

### 3.1 Fungal Plate Count from Baked Products Samples

Table 1 shows the colony forming units of fungal isolated from baked products samples. The total fungal count from baked bread product ranges from 2.4 x 10<sup>3</sup> to 3.0 x 10<sup>3</sup> CfU/mL. The total fungal count from baked cake product ranges from 2.1 x 10<sup>3</sup> to 2.9 x 10<sup>3</sup> CfU/mL while the total fungal count from baked pastry product ranged from 2.3 x 10<sup>3</sup> to 3.3 x 10<sup>3</sup> CfU/mL.

Samples ID	Bread (Cfu/mL)	Cake (Cfu/mL)	Pastry (Cfu/mL)
1	2.4x10 <sup>3</sup>	2.1x10 <sup>3</sup>	2.3x10 <sup>3</sup>
2	2.7x10 <sup>3</sup>	2.4x10 <sup>3</sup>	3.3x10 <sup>3</sup>
3	2.9x10 <sup>3</sup>	2.6x10 <sup>3</sup>	2.8x10 <sup>3</sup>
4	2.5x10 <sup>3</sup>	2.8x10 <sup>3</sup>	2.5x10 <sup>3</sup>
5	2.6x10 <sup>3</sup>	2.3x10 <sup>3</sup>	2.4x10 <sup>3</sup>
6	3.0x10 <sup>3</sup>	2.5x10 <sup>3</sup>	2.8x10 <sup>3</sup>
7	2.5x10 <sup>3</sup>	2.8x10 <sup>3</sup>	2.5x10 <sup>3</sup>
8	2.6x10 <sup>3</sup>	2.9x10 <sup>3</sup>	2.3x10 <sup>3</sup>
9	2.7x10 <sup>3</sup>	2.5x10 <sup>3</sup>	2.3x10 <sup>3</sup>
10	2.4x10 <sup>3</sup>	2.4x10 <sup>3</sup>	2.8x10 <sup>3</sup>

**Table 1: Fungal Plate Count from Baked Products Samples**

### 3.2 Microscopic Characteristics of the Fungal Isolates

Table 2 shows the macroscopic observations focused on the visible

features of the fungal colonies grown on agar plates. These features include color, texture, shape, elevation, and margin.

Isolate	Color	Texture	Margin	Shape	Elevation
A	Brownish	Powdery	Regular	Circular	Slightly raised
B	Blue-green	Velvety	Regular	Circular	Flat
C	Green with white edges	Fluffy	Irregular	Circular	slightly raised
D	Grayish white	Fluffy, cottony	Irregular	Irregular to circular	Umbrella-like (due to sporangiophores)

**Table 2 : Microscopic Characteristics of the Fungal Isolates**

### 3.3 Microscopic Characteristics of the Fungal Isolates

Each isolate was stained with the appropriate fungal stain and observed under a microscope. The results of the microscopic

examinations are summarized in Table 3, which provides a description of each isolate's microscopic features.

Hyphae	Conidiophore/ Structure	Spores/Conidia	Special Features	Inference
Septate, hyaline	Long, smooth-walled, and unbranched	Radiating chains of spherical conidia	Biserrate arrangement of phialides	<i>Aspergillus flavus</i>
Septate, hyaline	Short, smooth, and unbranched	Round, small conidia	Conidial heads are columnar, with uniseriate phialides	<i>Aspergillus fumigatus</i>
Septate, hyaline	Branched conidiophores with characteristic brush-like appearance	Chains of round or oval conidia	Conidia are formed in basipetal succession	<i>Penicillium sp.</i>
Aseptate, broad hyphae	Sporangiophores are long, unbranched, and bear sporangia at their tips	Round sporangiospores	Presence of large sporangia with columella (central dome)	<i>Mucor sp.</i>

**Table 3: Microscopic Characteristics of the Fungal Isolates**

### 3.4. Distributions of Occurrence of Fungal Isolates

Table 4 shows the frequency of distribution of fungal isolated from baked cake. Thirty fungal isolate were found across baked cake samples. Nine (9) were *Aspergillus flavus* with a percentage of

30.0%, *Aspergillus fumigatus* were six (6) with 20.0% *Penicillium sp.* were seven (7) with 23.3% and the total number of *Mucor sp.* were eight (8) with 26.7%.

Isolates	Frequency	Percentage %
Aspergillus flavus	9	30.0
Aspergillus fumigatus	6	20.0
Penicillium sp.	7	23.3
Mucor sp.	8	26.7
Total	30	100

**Tables 4: Frequency of Occurrence of Fungal Isolates**

## 5. Discussion, Conclusion and Recommendations

### 5.1 Discussion

The presence of fungal contaminants in bakery products is a significant public health concern, as these organisms can lead to food spoilage and mycotoxin production, posing risks to consumers [10]. The results from this study indicate varying levels of fungal contamination in baked cake samples, with total fungal count from baked bread product ranging from  $2.4 \times 10^3$  to  $3.0 \times 10^3$  CfU/mL and the total fungal count from baked cake product ranges from  $2.1 \times 10^3$  to  $2.9 \times 10^3$  CfU/mL while the total fungal count from baked pastry product ranged from  $2.3 \times 10^3$  to  $3.3 \times 10^3$  CfU/mL. These findings align with previous studies that reported similar levels of fungal contamination in baked goods, particularly in environments with poor hygiene practices and suboptimal storage conditions [11].

The macroscopic characteristics of the fungal isolates revealed distinct colony features, including brownish powdery, blue-green velvety, green with white edges fluffy, and grayish-white cottony textures. These variations in morphology are indicative of different fungal genera commonly associated with food products, as reported in prior research [12]. The microscopic examination confirmed the presence of *Aspergillus flavus*, *Aspergillus fumigatus*, *Penicillium* sp., and *Mucor* sp., which are known spoilage fungi in bakery products [13]. The high occurrence of *Aspergillus flavus* (30.0%) is of particular concern due to its ability to produce aflatoxins, potent mycotoxins that have been implicated in foodborne illnesses and carcinogenic effects [14].

The detection of *Aspergillus fumigatus* (20.0%) is notable as this species is a known opportunistic pathogen capable of causing respiratory infections, particularly in immune-compromised individuals [7]. *Penicillium* spp. (23.3%) was also identified, which is consistent with findings from recent studies highlighting its role in the production of mycotoxins such as patulin and ochratoxin A [15]. Additionally, the presence of *Mucor* sp. (26.7%) is significant, as it has been linked to mucormycosis, a rare but serious fungal infection [16].

The relatively high fungal counts observed in this study suggest potential post-baking contamination or inadequate storage conditions, which favor fungal growth. Factors such as humidity, temperature, and packaging methods play a crucial role in the proliferation of these fungi [17]. Studies have emphasized the importance of maintaining proper hygiene practices

during production, storage, and distribution to mitigate fungal contamination in bakery products [18].

### 5.2 Conclusion

This study highlights the presence of fungal contamination in commercially sold baked cakes, total fungal count from baked bread product ranging from  $2.4 \times 10^3$  to  $3.0 \times 10^3$  CfU/mL and the total fungal count from baked cake product ranges from  $2.1 \times 10^3$  to  $2.9 \times 10^3$  CfU/mL while the total fungal count from baked pastry product ranged from  $2.3 \times 10^3$  to  $3.3 \times 10^3$  CfU/mL. The predominant fungal isolates identified were *Aspergillus flavus* (30.0%), *Aspergillus fumigatus* (20.0%), *Penicillium* sp. (23.3%), and *Mucor* sp. (26.7%). The presence of these fungi in bakery products raises significant food safety concerns, particularly due to the potential production of aflatoxins, patulin, and other mycotoxins, which pose health risks to consumers.

This study suggests that fungal contamination may be attributed to poor hygiene during processing, improper storage conditions, and environmental exposure. Given the potential health implications of consuming contaminated baked products, it is crucial to implement strict food safety measures, including good manufacturing practices (GMP), routine microbiological screening, and proper storage conditions to minimize fungal growth.

### Recommendations

Based on the findings of this study, the following recommendations are proposed to minimize fungal contamination in baked cake products and ensure consumer safety:

Bakery operators should implement strict hygiene measures, including regular cleaning and disinfection of baking equipment, storage areas, and work surfaces to prevent fungal contamination.

Cakes and other baked products should be stored in dry, well-ventilated environments to reduce moisture accumulation, which favors fungal growth. Ingredients used in baked products production, such as flour, eggs, and dairy products, should be sourced from reputable suppliers and stored properly to prevent fungal contamination at the raw material stage.

Regulatory agencies should enforce routine food safety inspections in bakeries to ensure compliance with food safety standards.

### References

1. Deligeorgakis, C., Magro, C., Skendi, A., Gebrehiwot, H. H.,

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- Valdramidis, V., & Papageorgiou, M. (2023). Fungal and toxin contaminants in cereal grains and flours: systematic review and meta-analysis. *Foods*, 12(23), 4328.
2. Hussain, S., Kaur, R., Singh, S., and Kumar, P. (2022). Recent advances in the quality and safety of bakery products: A review. *Food Science and Nutrition*, 10(6): 1765-1780.
  3. Mohale, S., Katerere, D. R., and Govender, P. (2021). Fungal and mycotoxin contamination of stored foods. *International Journal of Food Microbiology*, 349: 109248.
  4. Mahami, T., Agbenorhevi, J. K., and Oduro, I. (2022). Microbial and mycotoxin contamination of flour-based products in Ghana: A review. *Food Control*, 138: 109042.
  5. Santos, A. R., Oliveira, C. A. F., and Pereira, M. M. (2021). Mycotoxins in bakery products: Occurrence, risk assessment, and control strategies. *Current Opinion in Food Science*, 41: 46-52.
  6. Adhikari, M., Negash, K. H., and Liu, X. (2022). Mycotoxin occurrence, toxicity, and food safety implications: A review. *Food Control*, 131: 108-124.
  7. Zhang, Y., and Li, H. (2022). *Aspergillus fumigatus*: A major concern in food and health safety. *Journal of Fungal Research and Medicine*, 32(1): 55-70.
  8. University of Abuja Post-Graduate Student Handbook. (2015): pp. 5-10
  9. Cheesbrough, M. (2020). District Laboratory Practice in Tropical Countries, Part 2. *Cambridge University Press*. Pp 12-33.
  10. Smith, J., Brown, L., and Williams, C. (2021). Fungal contamination and public health concerns in bakery products. *Foodborne Pathogens and Microbiology*, 37(4): 178-190.
  11. Adebola, O., and Johnson, K. (2022). Fungal contamination in baked goods: Sources and control measures. *Journal of Food Microbiology*, 38(2): 112-125.
  12. Kumar, R., Singh, P., and Mehta, S. (2023). Morphological and molecular identification of fungi in food products. *Current Trends in Microbial Research*, 56(2): 130-145.
  13. Chaudhary, P., Sharma, R., and Gupta, S. (2021). A review on fungal contamination in bakery products. *International Journal of Food Science and Safety*, 29(1): 89-102.
  14. Ali, M., Hassan, R., and Yusuf, T. (2023). Mycotoxin contamination in food: Implications and mitigation strategies. *Food Safety and Hygiene Journal*, 45(3): 205-219.
  15. Olajide, O., Adeyemi, T., and Ogundele, J. (2020). Mycotoxin-producing fungi in processed food: A global health concern. *Journal of Mycology and Food Safety*, 35(2): 156-169.
  16. Nguyen, L., Tran, H., and Vo, P. (2023). The clinical relevance of *Mucor* spp. in food contamination and human infections. *Mycology Research Journal*, 41(1): 78-95.
  17. Rahman, M., Ali, S., and Khan, J. (2021). Environmental factors influencing fungal growth in food storage. *Journal of Applied Microbiology and Biotechnology*, 59(3): 225-238.
  18. El-Sayed, M., and Hassan, A. (2022). Hygienic practices and microbial safety of bakery products. *Journal of Food Quality Assurance*, 47(4): 310-327.

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