

Exploring the Effect of Air Fungal Microbiome on Bakery Products from Bakery Industries in Diobu Metropolis

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Abstract

The study was aimed at exploring the effect of air fungal microbiome on bakery products from bakery industries in Diobu metropolis due to the unhygienic condition of her bakeries. Following this, the air fungal microbiome was determined in relation to the time of exposure of a given product. The study employed standard mycological techniques which involved the exposure of sterile petri dishes containing sabouraud dextrose agar mediato the atmosphere at strategic points of the bakery unit for 30, 60, 90, 120, 150 and 180 minutes respectively. A total of 30 sampling points were investigated from which fungal counts were obtained. Result showed an average fungal yield range of 18-87 spores per minutes and Pearson's correlation coefficient showed an R^2 of 0.9746, which signified a positive correlation exist. Fungal spore was noted dependent on the time of exposure of the food surface / bakery product. Five (5) fungal genera namely; *Asperigillus*sp., *Mucor*sp., *Penicillium*sp., *Candida* sp., *Rhizopus*sp. were identified to have suspended in air. *Mucor*sp. with the highest prevalence was noted a huge contaminant of bakery products and as such questionable in the temperate environ. of the bakery industry. The study therefore suggests that bakery products should not be allowed to stand for a longer period of time before packaging. Basically, products should not be exposed since the atmosphere may contain fungal spores that may contaminate the products. Hence, products should be well protected or preserved to discourage the contamination/multiplication of the *Mucor* species and other fungi spores.

Keywords: air, bakery industries, bakery products, Diobu Metropolis, fungal microbiome

1.0 Introduction

The challenge of most traditional/commercial bakeries in some parts of Diobu cannot be overlooked as the bakeries look dirty as a result of mismanaged use of ovens that are fired by wood (The Tide, 2024). The traditional use of charcoal to heat up oven, unlike the modern method encourages dispersal of debris (flour-dust, crumbs, left-over etc.) within the bakery facility which in-turn creates an unhygienic environment (Quinton, 2021). Following product removal from oven, products mostly, stands longer time in the shelve before packaging due its hot state. At the point of cooling, these products may allegedly get contaminated from exposure to atmosphere due to several hours unattended to (The Tide, 2024). Fungi spore, a contaminant mostly associated with indoor air pollution has been noted threatening and hence cannot be disregarded (Valle et al., 2019). According to Adams et al. (2013), *Saccharomyces cerevisiae*, a baker's yeast which is used for bread making could filter out of the production line into the atmosphere and thereafter fall on surface within the bakery facility (Vesper & Wymer 2013; Mohammed et al., 2019). Consequent upon this, the atmosphere could be implicated in the transition of fungal spore on bakery products herein (Smith & Griffin, 2016; Diao et al., 2019). Quinton (2021) cautioned on hygiene on the basis that bakery industries play vital role in the food sector, were it provides wide range of baked food which are sold to

the general public. Thus, when these products are ingested, fungal present on them, produces mycotoxins which causes various reactions in the body of consumers. (Pinto *et al.*, 2021). On this basis, varied numbers of fungi of diverse types are seen on bread days after production or entry into the market (Magalhaes *et al.*, 2019). Hence, understanding the dynamics of fungi in the air microbiome is essential for assessing air quality and evaluating the potential risks associated with bakery products exposure (Santos *et al.*, 2012). The study sets to provides valuable information regarding the types of fungi present in an overlooked unhygienic bakery in-accordance with the potential impact fungi will have on product considering the duration of product exposure to the allegedly contaminated atmosphere (Pala *et al.*, 2021). Hence, the study will contribute to the understanding of fungal diversity, abundance, and distribution in a bakery environment and their-after proffer solution for the production of wholesome bakery products in the challenged circumstance. The study therefore seeks, to assess the air fungal microbiome in the bakery industries of Diobu metropolis, with the interest to establish the relationship between the fungal load on the bakery product with respect to time of exposure to the challenged atmosphere.

MATERIALS AND METHODS

Description of the Study Area and Laboratory Practices

The bakeries chosen for the study is located in Diobu axis of Port Harcourt City Local Government Area of Rivers State with a coordinates points of 4⁰49'44.527" N / 6⁰58'23.691"E and 4⁰49'44.526" N / 6⁰58'23.701"E. The bakeries are well distributed in Diobu due to the huge commercial activity practice in the area as the bakeries produce consumables. The bakeries established in the area produce and sell bakery products such as bread, cake, meat pile, buns, chim-chimetc. Some bakeries in Diobu depend solely on manual bakery practices with the use of less-fashioned baking equipment and un-kitted workers (man labor).

Preparation of Media/Study Design

The preparation of Sabouraud dextrose media, a media designed for the isolation of fungi involved the scoop and dissolution of 7grams Sabouraud dextrose agar into 1000ml distilled water. Hence, composed of dextrose, peptone, Agar and pH of 5.6. The component was then autoclaved and dispensed at a concentration of 20 volumes each into petri dishes as documented by Chakraborty and Nishith (2008).

The study design employed standard mycological technique, which involved exposure of the freshly prepared media plates in strategic positions in the bakery facility for 30, 60, 90, 120, 150 and 180 minutes. Each sampling points had 10 media plates, for which an average count was obtained from 30 sampling points.

Enumeration of the Air Fungal Biome of the Bakery

Standard mycological air quality techniques as carried out by Chakraborty and Nishith (2008). was used to enumerate the fungal air population on the freshly prepared media. The media plates were then placed strategically, to receive fungal spore over graded period of 30, 60, 90, 120, 150 and 180 minutes respectively. Thereafter the plates were taken to the laboratory, incubated at room temperature (approximately 27°C) for 72 hours. Fungal colonies were thereafter counted and recorded as spore forming unit per minutes (spu/min.).

Fungal Morphology and Identification

The morphogenesis of the isolated fungi was examined and recorded accordingly, as they were sub-cultured. Wet preparations were made from the sub-cultured fungi on a clean greased free slides, covered and examined under the microscope and identified based on their cultural and microscopic appearance using the methods described by Chakraborty and Nishith (2008). Features observed were compared with fungal sample from a pictorial atlas (Barnes et al., 2016). Similarly, macroscopic morphology was observed based on colony appearance on the media plates.

Technique for Data Analysis

The load of fungi obtained with respect to time of exposure were analyzed using the Pearson's product moment correlation analysis. The statistical test was adopted to test the effect of the allegedly contaminated atmosphere in relation to the load of fungal spore deposited on the media plate.

RESULTS

Enumeration of the Fungal Population

Table 1 showed the counts of the fungi at several minutes of media plate exposure. The mean counts of fungi obtained ranged from 18 to 87 sfu/minutes, within an exposure time of 30 to 180 minutes respectively. Counts showed the least fungal spore count was obtained in 30 minutes while the highest fungal count was obtained in 180 minutes of plate exposure.

Table 1 Mean Count of Fungal Population in the Industries

Minutes	Fungal Spore(SFU/Minutes)
30	18
60	36
90	40
120	53
150	68
180	87

Correlation of the Fungal Load to Time of Exposure

Figure 1 showed the correlation analysis of fungal load with respect to the time/minutes of plate exposure. The Pearson's product moment correlation coefficient expressed a R^2 value of 0.9746 as the level of variation. Thus, 97% of the variation in the counts of fungal obtained is depended on the time of exposure of bakery products after baking (before packaging). This implies that correlation exist between time of exposure and fungal load, with a direct proportionality

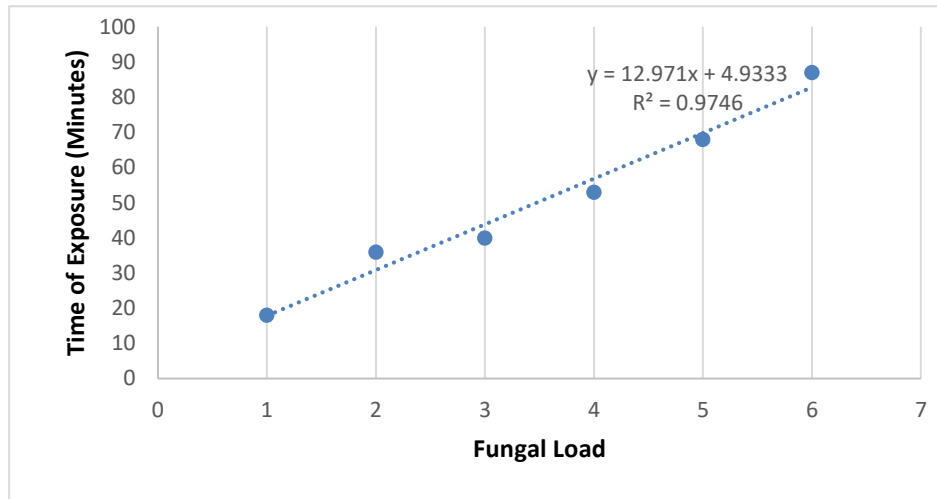


Figure 1: Correlation of the Fungal Load to Time of Exposure Macroscopic Characterization

Table 2 showed the structural and physical characteristics of the fungi obtained. Whitish grey colored structured fungal of large size with slow growth rate and a cottony appearance was noted *Mucor* sp. followed by *Penicillium* sp. which was identified with a purple like blue color, small in size and a woolly texture. *Candida* sp. had a milky colour, small sized colony, with fast growth rate and shiny textured appearance. *Rhizopus* sp. had pale-brown colour, large sized colony with a cottoned textured appearance. *Aspergillus* sp. was reportedly identified yellow coloured, small sized with rapid growth rate and wholly texture.

Table 2 Macroscopic Characterization of the Fungi

Isolates	Structural Description				Identification
	Colour	Size	Growth Rate	Texture	
I	Whitish Grey	Large	Slow	Cottony	<i>Mucor</i> sp.
ii	Purple-like blue	Small	Slow	Woolly	<i>Penicillium</i> sp.
iii	Milky	Small	Fast	Shiny	<i>Candida</i> sp.
iv	Pale-brown	Large	Slow	Cottony	<i>Rhizopus</i> sp.
V	Yellow	Small	Rapid	Wooly	<i>Aspergillus</i> sp.

Percentage Frequency of Fungal Occurrence

Table 3 showed the frequency of occurrence of the identified fungi and their percentages. *Mucor* sp. had the highest frequency and percentage occurrence while the least occurrence and percentage frequency was observed with *Aspergillus* sp.

Table 3 Percentage Frequency of Fungal Occurrence

Fungi	Frequency of Occurrence	Percentage of Occurrence
<i>Mucor</i> spp.	67	47
<i>Penicillium</i> spp.	38	26
<i>Candida</i> spp.	31	21
<i>Rhizopus</i> spp.	7	5
<i>Aspergillus</i> sp.	1	1

DISCUSSION

The study confirmed that at a longer exposure of the media plate, more fungi spore grew exponentially, which is justified by Adhikari et al. (2018). Adhikari et al. (2018) noted high counts of fungal fragments that were suspended in the atmosphere independent of the cultivation time. Thus the counts, of fungi are dependent on the time of exposure as noted in this study and that of Baert et al. (2018). Baert et al. (2018) in justifying his study, rightly, suggested that long time exposure of food to atmosphere encourages microbial growth in a contaminated environment. The characterized fungi isolated in this study showed visible vegetative body of thread-like filaments spores as maybe associated with bakery products thereby compromise the product quality as well as prompt the deterioration of bakery produce (Beuchat, 2019). The listed fungi: *Asperigillus* sp., *Mucor* sp., *Penicillium* sp., *Candida* sp. And *Rhizopus* sp. so isolated may contaminate bakery products and thus lead to infection when the products are consumed. *Mucor* sp., which is the most prevalence is emphasized considering the economic importance of the *Mucor* sp. Beuchat (2019) noted that *Mucor* spp. isolated have health implication as well as economic importance, were losses are incurred and market value of food product reduced. The presence of *Mucor* spp. in the environment which is due to high humidity and cold temperature in building with basement, contradicts the fact that bakery environment is hot (Beaudoin et al., 2022). *Aspergillus* sp. as the least isolated can be a threat to bakery workers and thus, be regarded as occupational risk fungi (Diao et al., 2019) and as such isolated in bakery environment (Kalogeropoulos et al., 2017). *Aspergillus* sp. have been confirmed as an agent of severe respiratory defects such as in cases involved with compromised persons such as allergic Bronchopulmonary-Aspergillosis (Adam et al., 2023). Basically, the fungal *Asperigillus* sp., *Mucor* sp. And *Penicillium* sp. have been confirmed as a food spoilage agent which constitute food poisoning as observed in several consumers' reactions (Tournas, 2014; Adhikari et al., 2018).

Conclusion

The study showed that *Mucor* sp. was the most relatively abundant specie among other fungi which included *Asperigillus* sp., *Penicillium* sp., *Candida* sp. And *Rhizopus* sp. that were isolated from a disregarded unhygienic bakery environment. Thus, the atmosphere of a disregarded unhygienic bakery is said to contain spores of fungi. The fungal were dependent on the minutes or time of exposure of the media plate which alternatively, remains' a suitable surface for diagnosis of disease control. Furthermore, unhygienic bakery environment could serve as a good source of contracting Bronchopulmonary Aspergillosis by workers and visitors. Also bakery is source of *Candida* infection in humans.

Recommendation

The study suggests that bakery products should not be exposed since the atmosphere may contain fungal spores which may contaminate the products. Hence, bakery products should be well protected or preserved to discourage the contamination and multiplication of the *Mucor* species and other fungi spores. In addition, regular monitoring of bakery work environment should be encouraged, for proper diagnosis of ill-health in consumers and bakery workers that may arise.

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