MICROBIOLOGY

Microbiological Quality of Air at Different Sections within Spiritan University, Nneochi, Abia State

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Abstract

Airborne diseases have been described among debilitating ailments that are ravaging the health of mankind, especially individuals whose immune functions are deficient. Screening for the quality of air at different areas that humans frequently visit has been described as essential to achieving global health goals. This study was carried out to evaluate the microbiological quality of air at different confined environments at Spiritan University, Nneochi, Abia State. Microbial quality of air at different sections at the University was evaluated using passive method. Three prepared Petri dishes containing different selective media were exposed for 60 min at 10 selected areas. The microbial isolates were characterized based on their cultural, morphological, and biochemical features while fungal atlas facilitated fungal identification. The outcome of the air sampling revealed the presence of *Pseudomonas aeruginosa* (6, 25.00%), *Staphylococcus aureus* (4, 16.67%), *Escherichia coli* (3, 12.50%), *Streptococcus pneumoniae* (3, 12.50%), *Aspergillus fumigatus* (5, 20.83%), and *Aspergillus niger* (3, 12.50%). The highest microbial load was observed at the University Clinic (83.33 CFU/m^3 for bacteria/4.17 CFU/m^3 for fungi) while the least was observed at the Senate Chamber and Canteen (25.00 CFU/m^3 for bacteria/2.50 CFU/m^3 for fungi). The microbial load in all the sections sampled was within small and medium as stipulated by the European Community Commission (ECC). This study has shown that different bacteria and fungi are found at different sections within Spiritan University, Nneochi, though the microbial load does not pose a threat to the inhabitants. Moreover, more research is needed in order to evaluate the pathogenic potential and susceptibility pattern of the bacterial and fungal isolates.

Keywords: Air quality; Air sampling; Microorganisms; Spiritan University

1 Introduction

Microorganisms have been described as ubiquitous due to their presence in every environment such as hospitals, laboratories, lecture halls, market places, motor parks, homes etc. (Alfanda et al., 2023). In the field of microbiology and other biological and chemical sciences, laboratory is an apartment that had been carefully constructed for the purpose of scientific researches and diagnoses often found in schools or at separate environments (Alfanda et al., 2023). In laboratories, different samples such as clinical, environmental, industrial, and food are analysed by a certified analyst or a trained medical laboratory scientist and microbiologists (Asif et al., 2018). Laboratory provides an avenue for microbial evaluation at different environments such as microbiological media and equipment.

Due to delicate services that are performed in Universities, laboratories and other confined environments, there is need to ensure clean and safe environment in accordance to the standard stipulated by the Department of Occupational Safety and Health (2010) under the Industrial Code of Practice on Indoor Air Quality (ICOP). According to ICOP, laboratories and related confined environments are to be equipped with Mechanical Ventilation Air Conditioning (MVAC) system in order to eliminate airborne pollutants, and to control temperature and humidity. However, most laboratories, offices, and other confined environments lack ventilation system, and few available ones are dilapidated due to poor maintenance (Department of Occupational Safety and Health, 2010).

Research had shown that microbial contaminants in confined environments emanate from samples, humans, and unsanitary practices such as indiscriminate disposal of water generated, thus promoting conducive environment for proliferation of both bacterial and fungal pathogens (Yau et al., 2012; Awad et al., 2018).

It is worthy to note that evaluation of microbiological quality of air in confined environments is paramount to the health of the public, especially individuals within university environment (Alfanda et al., 2023). The presence of bacteria and fungi such as *Staphylococcus aureus*, *Escherichia coli*, *Enterobacter*, *Pseudomonas aeruginosa*, *Penicillium*, *Aspergillus*, *Alternaria*, *Microsporum*, *Trichoderma* among others in the air poses threat to humans due to pathogenic potentials of the aforementioned bacterial and fungal pathogens (Ugranli et al., 2016).

Several debilitating illnesses had been attributed to airborne pathogens such as aspergillosis, rhinitis, pneumonia, allergies, asthma, and conjunctivitis among others caused mainly by inhalation of fungal spores and bacterial pathogens (Yau et al., 2012; Awad et al., 2018).

Research had also revealed that airborne infection had been a major threat to public health globally (Ugranli et al., 2016; Asif et al., 2018). Air as an agent of transmission of infectious diseases is dangerous because everyone in the environment inhales oxygen found in the air for survival and this shows that the need to ensuring safe inhalation cannot be undermined (Ugranli et al., 2016). Neglecting the impact of air microbes in the spread of infectious disease could expose many individuals to airborne diseases, which are capable of reducing human population (Asif et al., 2018). This clearly indicates that every section in the environment where humans are found is an important source of airborne pathogens and appropriate measures are to be employed in order to protect the health of individuals in the society, especially those within laboratory setting and University (Asif et al., 2018).

Several researchers have worked on microbiological quality of air at different areas in the environment such as Ugranli et al. (2016) Asif et al. (2018), Oke et al. (2020) and Alfanda et al. (2023), have worked on the microbiological quality of air at different areas in the environment, but there is inadequate information on microbiological quality of air at University environments within Southeast geopolitical zone, especially in private institutions. Hence, the aim of this study is to evaluate the microbiological quality of air at different sections within Spiritan University, Nneochi, Abia State.

2 Materials and methods

2.1 Study area

The study was conducted at different confined environments within Spiritan University, Nneochi (SUN), Abia State. Nneochi is located in Umunneochi LGA, Abia State, Southeast Nigeria. It is a private

Catholic University located at Ngodo-Isuochi, Umunneochi Local Government Area in Abia State. In the university, academic and non-academic functions are undertaken by different staff using various offices and halls.

2.2 Air sampling (passive method) and culturing

In air sampling, passive method was used as described in the study published by Alfanda et al. (2023). The following media (MacConkey agar, Mannitol salt agar, Nutrient agar, and Potato dextrose agar) were prepared following the instructions of the manufacturer. The prepared and solidified agar plates were exposed at different sections in the university namely the Canteen, Senate chamber, Faculty of Arts, Management and Social Sciences, Faculty of Natural and Applied Sciences, Microbiology laboratory, Faculty of Law, Male hostel, Female hostel, Auditorium and Clinic. All the agar plates were left open for 60 minutes, then covered and incubated at 37 °C for 48 h for bacteria and at 30 °C for 5 days for fungi. The plates were observed for growth and colonies were counted and documented. The colony forming units (CFU) obtained were expressed as CFU/m^3 using Omelyansky's formula (Equation 1):

$$N = \frac{5a \times 10^4}{bt} \quad (1)$$

where N is the number of colony-forming units per cubic metre of indoor air (CFU/m^3), a is the number of colonies, b is the area of the Petri dish (cm^2; dish diameter 100 mm) and t is the time of exposure (min).

2.3 Characterization and identification of the isolates

The isolates were sub-cultured on nutrient agar (Biotech), incubated in inverted position at 37±2 °C for 24 h. The isolates were characterized and identified using their colonial and morphological descriptions and biochemical reactions (Cheesbrough, 2010). The colonial description was carried out to determine the cultural features of the isolates such as colours, margin, surface texture, consistencies and optical properties.

2.3.1 Gram staining

This was carried out using the method described by Cheesbrough (2010). In this process, a thin smear of the culture was prepared on a clean grease free slide (75 mm × 25 mm × 1 mm), air dried and heat fixed by passing through a flame of Bunsen burner thrice. The smear was flooded using crystal violet solution, which was allowed for 60 seconds before rinsing using tap water. Gram's iodine was then applied in like manner for 60 seconds and rinsed using tap water. Absolute ethanol (95% w/w) was used to decolourize the stain for 10 seconds and rinsed using tap water. The smear was then counter stained using safranin solution for 60 seconds, rinsed and air dried. The stained smear with a drop of immersion oil was then observed under the light microscope using oil immersion objective lens.

2.4 Statistical analysis

Statistical software: SPSS Version 22.0 was used to analyse the data and p value <0.05 was taken as significant.

3 Results

Table 1 shows the sanitary standards for non-industrial premises according to the European Community Commission (ECC) for air quality evaluation. The sampling sections and the numbers of bacteria and fungi isolated are presented in Table 2. Microbial growth was observed in all the sections of the University sampled after 60 minutes of exposure. The sampled sections yielded the following bacterial/fungal loads: Senate chamber (25.00/2.50 CFU/m^3), Canteen (25.00/3.33 CFU/m^3), FAMS (29.17/1.67 CFU/m^3), FL (26.67/2.50 CFU/m^3), FNAS (31.67/3.33 CFU/m^3), MCB Lab (33.33/1.67 CFU/m^3), Male hostel (45.83/2.50 CFU/m^3) and Auditorium (41.67/1.67 CFU/m^3). Overall, the highest numbers of bacteria and fungi were isolated from plates exposed at the Clinic (83.33/4.17 CFU/m^3), followed by the Female hostel (50.00/2.50 CFU/m^3), while the lowest bacterial load was observed at the Senate chamber and Canteen (25.00 CFU/m^3 each).

The cultural and morphological features of the bacterial and fungal isolates are presented in Table 3. Two Gram-positive bacteria and two Gram-negative bacteria were isolated while two molds were the only fungal isolates. The cultural features of the bacterial isolates revealed yellowish colonies on MSA, greenish coloration on blood agar, colourless on MacConkey agar, and pinkish non mucoidal colony on MacConkey agar and their morphological features were cocci, rod, and cocci, respectively. Similarly, the cultural features of the fungal isolates revealed blue-green colonies and black powdered colony with distinguishing textures and appearances on SDA while their morphology revealed septate hyphae and conidia head with different arrangement of phialides (Figures 1 and 2).

Table 1. Sanitary standards for non-industrial premises according to the European Community Commission (ECC) for air quality evaluation.

Group of microbe	Range of value (CFU/m^3)	Degree of pollution
Bacteria	<50	Very small
	50–100	Small
	100–500	Medium
	500–2000	High
	>2000	Very high
Fungi	<25	Very small
	25–100	Small
	100–500	Medium
	500–2000	High
	>2000	Very high

Table 2. Sampling sections and distribution of microorganisms.

Sample	Sampling section	Plates exposed	Bacterial colonies	Fungal colonies	Bacteria (CFU/m^3)	Fungi (CFU/m^3)
A	Senate chamber	3	30	3	25.00	2.50
B	Canteen	3	30	4	25.00	3.33
C	FAMS	3	35	2	29.17	1.67

Sample	Sampling section	Plates exposed	Bacterial colonies	Fungal colonies	Bacteria (CFU/m^3)	Fungi (CFU/m^3)
D	FL	3	32	3	26.67	2.50
E	FNAS	3	38	4	31.67	3.33
F	MCB Lab	3	40	2	33.33	1.67
G	Clinic	3	100	5	83.33	4.17
H	Male Hostel	3	55	3	45.83	2.50
I	Female Hostel	3	60	3	50.00	2.50
J	Auditorium	3	50	2	41.67	1.67

FAMS = Faculty of Arts, Management and Social Sciences; FL = Faculty of Law; FNAS = Faculty of Natural and Applied Sciences; MCB Lab = Microbiology laboratory.

Table 3. Cultural and morphological features of the isolates.

Isolate	Cultural feature	Morphological feature	Medium
Bacteria			
Staphylococcus aureus	Yellowish colonies	Gram-positive cocci in clustered shape	MSA
Pseudomonas aeruginosa	Cream, raised colonies	Gram-negative rod, which appears singly mostly	Cetrimide agar
Escherichia coli	Pinkish, non-mucoid, smooth colonies	Gram-negative rods, which appear singly	MacConkey agar
Streptococcus pneumoniae	Greenish discoloration of the agar plates due to alpha haemolysis (partial lysis of blood cells), gray-white colonies, smooth, moist, and translucent/opaque	Gram-positive cocci arranged in chains	Blood agar
Fungi			
Aspergillus fumigatus	Blue-green colonies, colourless reverse pigmentation, powdery, and velvety texture	Septate and clear hyphae with columnar conidia heads with uniseriate (single row of phialides)	SDA
Aspergillus niger	Black seriated, powdered, colourless reverse pigmentation	Branched, septate hyphae and brush like clusters of conidiophores (phialides)	SDA

SDA = Sabouraud dextrose agar; MSA = mannitol salt agar.

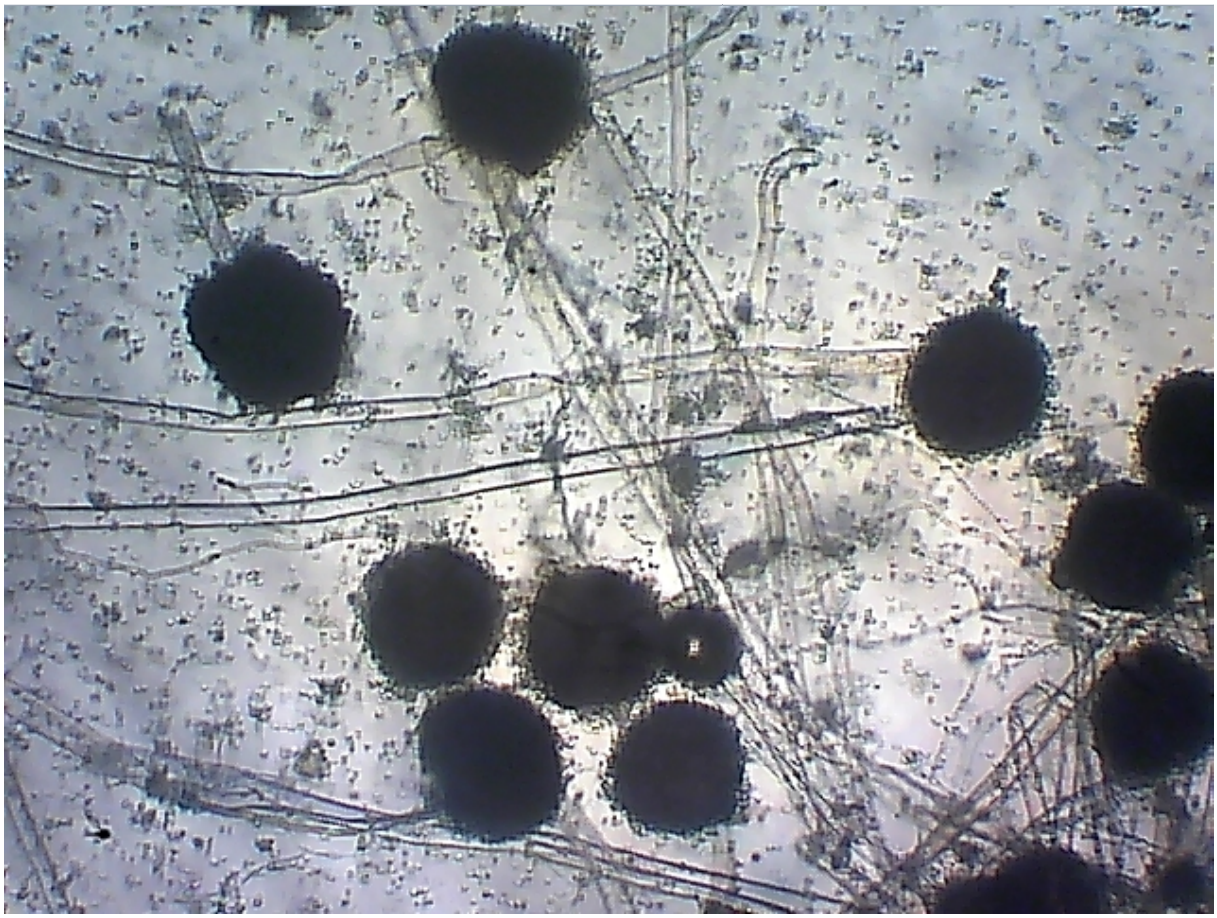


Figure 1. Aspergillus niger.



Figure 2. Aspergillus fumigatus.

4 Discussion

Airborne diseases have been described among debilitating ailments that are ravaging the health of mankind, especially individuals whose immune functions are deficient. Screening for the quality of air at different areas that humans frequently visit has been described as appropriate to achieving global health goal. This study was carried out to assess the air quality at different sections within Spiritan University, Nneochi, Abia State. The highest number of bacteria and fungi observed at the Clinic could be attributed to frequent visit of patients, and research had revealed that common human pathogens such as *Staphylococcus aureus* and *Escherichia coli* are liberated mostly from humans. Similar observations were reported by (7), who screened air quality at tertiary University hospital in Ibadan and (9), who evaluated bioaerosols in Osun State motor parks and markets and reported the presence of *S. aureus*, *E. coli*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Aspergillus* spp., and *Fusarium* spp. Generally, the bacteria and fungi discovered in this study supported the documentation of several researchers (10; 11; 12). The microbial load (expressed as colony-forming units per cubic metre, CFU/m^3) observed at all the sections in the University was within small and medium as stipulated by the European community commission (ECC) for sanitary standards for non-industrial premises, which indicates that the environment has not been heavily contaminated by human pathogens unlike the microbial load obtained by Oke et al. (2026) at tertiary University hospital in Ibadan that yielded 2962.96 CFU/m^3. It is worthy to note that another study at a private institution in Benin, Nigeria obtained low microbial load (7–440 CFU/m^3 and fungal aerosols of 3–45 CFU/m^3) that corresponds to the findings in this study. This further supports the fact that most private Universities in Nigeria are not overcrowded like the State and Federal Universities. The cultural and morphologic-

al features of microorganisms observed in this study conform to the features documented by several researchers (9; 13; 7) who evaluated air quality at different environments such as Universities, hospitals, market places, motor parks etc.

5 Conclusion

This study has shown that different sections or confined environments at Spiritan University, Nneochi contain bacteria and fungi such as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pneumoniae*, *Aspergillus fumigatus*, and *Aspergillus niger*. The microbial load of these microorganisms was small and medium, which indicates that the environments are safe for human inhabitation as stipulated by European community commission (ECC) for sanitary standards for non-industrial premises. Therefore, it is worthy to note that all the confined environments investigated at Spiritan University, Nneochi are safe for inhabitation, though appropriate care ought to be employed due to the presence of potential pathogens in minute microbial load.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

[1] Alfanda AM, Mas'ud M, Mas'ud F (2023). Assessment of the microbial quality of air in some science laboratories of Bayero University Kano Old Campus, Nigeria. *Journal of Pollution Effects & Control*, 11, 78–388.

[2] Amengialue OO, Igbinosa IH, Igbinosa EO (2017a). Microbiological quality assessment of indoor air of a private university in Benin City, Nigeria. *IOSR Journal of Pharmacy and Biological Sciences*, 12(3), 19–25.

[3] Amengialue OO, Omoigberale MN, Okwu GI (2017b). Microbial assessment of indoor air quality in a private university in Benin City, Nigeria. *Journal of Applied Sciences and Environmental Management*, 21(4), 735–741.

[4] Asif A, Zeeshan M, Hashmi I, Zahid U, Bhatti MF (2018). Microbial quality assessment of indoor air in a large hospital building during winter and spring seasons. *Building and Environment*, 135, 68–73. https://doi.org/10.1016/j.buildenv.2018.03.010

[5] Awad AH, Saeed Y, Hassan Y, Fawzy Y, Osman M (2018). Air microbial quality in certain public buildings, Egypt: A comparative study. *Atmospheric Pollution Research*, 9(4), 617–626. https://doi.org/10.1016/j.apr.2017.12.014

[6] Awosika SA, Olajubu FA, Amusa NA (2012). Microbiological assessment of indoor air of a teaching hospital in Nigeria. *Asian Pacific Journal of Tropical Biomedicine*, 2(6), 465–468. https://doi.org/10.1016/S2221-1691(12)60077-X

[7] Cheesbrough M (2010). District laboratory practice in tropical countries, 2nd ed. *Cambridge University Press*, Cambridge.

[8] Department of Occupational Safety and Health (2010). Industrial code of practice on indoor air quality. *Ministry of Human Resources*, Malaysia.

[9] Kim SY, Jheong W, Hwang ES, Kim JH, Jung JS, Lee JW, Chung HM, Kwon M (2016). Airborne bacteria concentration and species identification in residential living spaces. *Journal of Environmental Health Sciences*, 42(6), 438–449. https://doi.org/10.5668/JEHS.2016.42.6.438

[10] Oke IA, Adeyemi AT, Oladipo OA (2020). Comparative analysis of indoor and outdoor air quality in Ogbomoso, Nigeria. *Journal of Environmental Protection*, 11(9), 711–725.

[11] Okunola OJ, Adekola OF, Adewuyi GO (2020). Indoor air quality assessment in selected residential buildings in Lagos, Nigeria. *Journal of Environmental Health Research*, 18(2), 78–85.

[12] Oluwafemi F, Adebayo AA, Adesina BT (2021). Airborne microbial contamination in poultry and livestock production facilities in Nigeria. *Nigerian Veterinary Journal*, 42(3), 189–198.

[13] Ugranli T, Gungormus E, Sofuoglu A, Sofuoglu SC (2016). Indoor air quality in chemical laboratories. *Comprehensive Analytical Chemistry*, 73, 859–878. https://doi.org/10.1016/bs.coac.2016.02.017

[14] Yau YH, Chew BT, Saifullah AZA (2012). Studies on the indoor air quality of pharmaceutical laboratories in Malaysia. *International Journal of Sustainable Built Environment*, 1(1), 110–124. https://doi.org/10.1016/j.ijsbe.2012.07.005