Assessment of Microbial Aerosols in Students Hall of Residence

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Abstract:-

Aim: This study is aimed at assessing the indoor air quality of male students' hall of residence in Usmanu Danfodiyo University, Sokoto, Nigeria.

Methodology: Sedimentation technique using open Petri dishes containing different culture media was employed and sampling was done twice daily, daytime and at night. The microbial isolates were characterized and identified based on macroscopic, microscopic and biochemical characteristics.

Results: It was observed that the microbial counts varied with time and location (hostels) and were more at night than during the day. High range of bacterial colony forming units($2.3x10-3.7x10^2$cfu/m^3) was observed during the day and ($2.9x10^2-4.2x10^2$cfu/m^3) at night. Statistical analysis revealed no significant difference (P>0.05) between the times of collection. The fungal counts ranged from $3.8x10^1$to $6.3x10^1$cfu/m^3during the day and $6.8x10^1$ -$9.4x10^1$ cfu/m^3at night. The female hostels recorded high bacterial and fungal load than the male hostels.However, in the female hostels, there was statistically significant difference (P≤0.05) between the fungal mean counts between the times of sampling. The bacterial isolates obtained were *Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Streptococcus pneumoniae, Proteus mirabilis, Klebsiella pneumoniae* and *Bacillus cereus*, while the fungal isolates included *Aspergillusniger, Aspergillusflavus, Aspergillusoryzae* and *Rhizopusoryzae*.

Conclusion: The results generated in this study clearly suggest that regardless of sampling time and location, indoor environment allows aerosols build up which could potentially lead to infections to the occupants.

***Key words*: Airborne, Daytime, Hostel, Indoor, Night**

I. INTRODUCTION

Air quality of indoor environments is one of the main factors affecting the health, well-being and productivity of people [1][2]. The effect on health rises as exposure to contaminated air increases [3][4]. Problems of indoor air quality are recognized as important risk factors for human health in both low-income and middle- and high income countries. Indoor air is also important because populations spend a substantial fraction of time within buildings. In residences, day-care centers, retirement homes and other special environments, indoor air pollution affects population groups that are particularly vulnerable due to their health status or age [5].Microbial pollution involves hundreds of species of bacteria and fungi that grow indoors when sufficient moisture is available. Exposure to microbial contaminants is clinically associated with respiratory symptoms, allergies, asthma and immunological reactions [5]. These biological contaminants, carried by particles suspended in air, enter human body through breathing and usually cause diseases of the respiratory tract [6]. Biological particles such as animal and insect allergens, viruses, bacteria and fungi can cause allergic reaction or infectious diseases [7][8][2]. They also include a wide variety of microbes and allergens that spread from person to person. There is strong evidence regarding the hazards posed by several biological agents that pollute indoor air. This is due to the fact that people are often exposed to multiple agents simultaneously, to complexities in accurately estimating exposure and to the large numbers of symptoms and health outcomes due to exposure. The exceptions include some common allergies, which can be attributed to specific agents, such as house-dust mites and pets [5].

An indoor environment with excess moisture will enhance the growth of moulds and other biological contaminant [9][10][2]. Fungal spores have long been known as one of the important environmental bio-particles causing dermatitis, respiratory and cardiac diseases along with allergic manifestation in human beings [11][8]. Air borne microbial load in a building can be regarded as significant when identified as causes of illness and discomforts; and insignificant, when their presence makes no impact on the health or general well-being of the building occupants [12][2]. Provision of adequate hostel accommodation to the students' is one of the major problems in Nigerian Universities. Shortage of hostel accommodation particularly results in overcrowding or congestion in a room above specific capacity. Thus, insufficient ventilation, overcrowding, aerosols spread through sneezing and coughing and improper cleaning of hostel, may enhance the transmission of pathogenic microorganisms among the students, since the quality of indoor air in terms of microbial contamination in a given space at a given time period is determined by the quality of air entering the space, the number of occupants in the space, their physical activities and degree of ventilation [10].

Thus, the possibility of these transmissions may justify the purpose of this research. It should be noted, however, that there are no available information on the microbiological quality of indoor air in the study area. The incidence of airborne infections has increased in recent years; because many new buildings are sealed and have self-contained circulating air systems for temperature control [13].The aim of this research was to determine the microbes in indoor air of students' hostels in Usmanu Danfodiyo University, Sokoto in order to find out the quality of the indoor air which is quiet necessary for the health of the students.

II. MATERIALS AND METHODS

Study area

The study area was Usmanu Danfodiyo University, Sokoto, Nigeria. It is located in the north-west part of Nigeria. It was established in 1975 and has a student population of seventeen thousand'. Sokoto has an annual temperature and rainfall varying from 28 to 49^{0}C and 500 to 1300mm respectively. The highest temperature is recorded during the dry season experienced from March to May. The relative humidity varies with the season of the year; it ranges from 24 to 49% [14]. Five hostels were used for the study and these were: Nana Asma'u, Nana Fatima 1(NF1) and 2 (NF2) which are female hostels, Jibril Aminu 1 (JA1) and 2 (JA2) which are male hostels.

Sampling procedure

Simple random sampling method in both the male and female students' hostels was employed. Sedimentation technique using open Petri dishes containing different culture media (Nutrient agar, NA, Mannitol salt agar, MSA, MacConkey agar, MCA, Blood agar, BA and Sabouraud dextrose agar, SDA) were employed and samplings were done twice, one during the day and the other at night when a lot of activities would have taken place in these hostels. The study was carried out at interval of two weeks for a total duration of 8weeks from February to May, 2014. The number of microorganisms expressed as CFU/m^3 was estimated according to the equation [19]:

$CFU/m^3 = a\ x(10000/p)x\ t\ x\ 0.2$

where:

a – Number of colonies on the Petri dish

p – Surface of number of colonies the Petri dish

t – Time of Petri dish exposure.

The University was in session during the study and each hostel has about 400 occupants.

Isolation and characterization of microorganisms

NA, MSA, MCA and BA media were incubated at 37^{0}C for 24hours while the SDA for fungal isolation were incubated at room temperature (30±2^{0}C) for 3-5 days. Macroscopy[15], Gram staining[15]. Biochemical tests[16] were employed in the identification and characterization of the bacterial isolates. The fungal isolates were identified based on colonial morphology and microscopic characteristics using the scheme of[17].

Statistical Analysis

The data generated were analyzed by simple mean value, percentage and test of significance using SPSS output (Statistical Package for Social Sciences) version 20. T-test was used to test the association between the mean counts of the microbial isolates during the day and at night. Level of significance was set at P=0.05.

III. RESULTS

Microbial Counts

Table 1 shows the bacterial counts of indoor air of female students' hostels of Usmanu Danfodiyo University, Sokoto (UDUS) at both day and night. The results revealed that the counts of bacteria varied with time and location (halls). Mean bacterial loads were higher in Nana Asma'u hostel (NAS)($4.0x10^2$cfu/m^3) than Nana Fatima 1 (NF1) and 2 (NF2) Halls. However, statistical analysis showed no significant difference (P≥0.05) in the bacterial mean counts between the halls of residence. Similarly, the mean bacterial count in the female hall of residence was highest at NAS Hall at night than during daytime. Statistical analysis revealed significant difference (P≤0.05) in the values obtained during time of sampling. Furthermore, mean fungal counts of indoor air at the female hall of residence were higher at NAS Hall ($7.2x10^2$cfu/m^3)(Table 2). Similarly, highest fungal count obtained during the time of sampling in female halls of residence was at night. Statistical analysis revealed significant difference (P≤0.05) in the values recorded. Results of bacterial counts obtained from male hostel indicate Jibril Amin2(JA2) to harbor highest count($2.9x10^2$cfu/m^3), although there was no significant difference (P≥0.05) between the halls (Table 3). However, more counts were recorded at night than during the daytime. The mean count of fungi recorded in indoor air male student halls of residence was highest at JA2. Highest count obtained was observed at night. Statistical analysis revealed significant difference between the times of sampling during the study (Table 4).

Identification of isolates and frequency of occurrence

The bacteria isolated were *Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Streptococcus pneumoniae, Proteus mirabilis, Klebsiella pneumoniae, and Bacillus cereus* while the fungi were identified as *Aspergillusniger, Aspergillusflavus, Aspergillusoryzae,* and *Rhizopusoryzae.* The percentage frequency of occurrence of the bacterial and fungal isolates in relation to all the sampled hostels both during the day and night are shown in Figures 1 and 2 respectively. It was observed that the female hostels recorded the higher bacterial and fungal isolates than the male hostels. The results showed that *Staphylococcus aureus*(6.4-8.7%)and *Bacillus cereus*(5.2- 8.7%) were the predominant organisms

isolated in all the hostels both during the day and night. The next most common organism was *Escherichia coli* (1.7-4.6%) while the least was *Klebsiella pneumoniae* (1.2-2.3%) (Fig. 2).The predominant fungi isolated in all the hostels was *Aspergillusniger*(6.6-11.3%) while the least was *Aspergillusoryzae* (0.9-6.6%)(Fig. 3). Results from this study showed Bacillus cereus and Staphylococcus aureus to predominate at day and night time in the female hostels, whereas *Escherichia coli*, *Listeria monocytogenes*, and *Streptococcuspneumoniae* were sparingly present with *Proteus mirabilis* and *Klebsiella pneumonia* to be the least present (Table 3). In the male hostels also, similar pattern of occurrence of bacteria was observed (Table 4).*Aspergillusniger* was found to be the most occurring fungal specie isolated from the female hostel at day and night time followed by *Aspergillusflavus*, *Rhizopusoryazae* and the least was *Aspergillusoryazae* (Table 5). The trend of occurrence of fungal isolates observed in female was similar to that in male hostel (Table 6).

Table 1: Counts of bacteria in female students' Hall (102 x cfu/M3)

	Hall		
	Nana Asmau[NAS]	Nana Fatima1[NF1]	Nana Fatima2[NF2]
Sampling Time			
Day	3.7^{a}	2.3^{a}	2.8^{a}
Night	4.2^{c}	3.5^{c}	3.5^{d}

Values with different superscripts in the same row indicates significant difference (P<0.05)

Table 2: Counts of Fungi in Female Students' Hall (102 x cfu/M3)

	Hall		
	Nana Asmau[NAS]	Nana Fatima1[NF1]	Nana Fatima2[NF2]
Sampling Time			
Day	5.6c	3.8d	5.0e
Night	8.8a	8.1a	6.8a

Values with different superscripts in the same row indicates significant difference (P<0.05)

Table 3: Counts of Bacteria in Male Students' Hall (102 x cfu/M3)

	Hall	
	Jibril Amin1[JA1]	Jibril Amin2[JA2]
Sampling Time		
Day	2.3a	2.6a
Night	2.9a	3.1a

Values with different superscripts in the same row indicates significant difference (P<0.05)

Table 4: Counts of Fungi in Male Students' Hall (102 x cfu/M3)

	Hall	
	Jibril Amin1[JA1]	Jibril Amin2[JA2]
Sampling Time		
Day	6.3a	5.6a
Night	6.9a	9.4b

Values with different superscripts in the same row indicates significant difference (P<0.05)

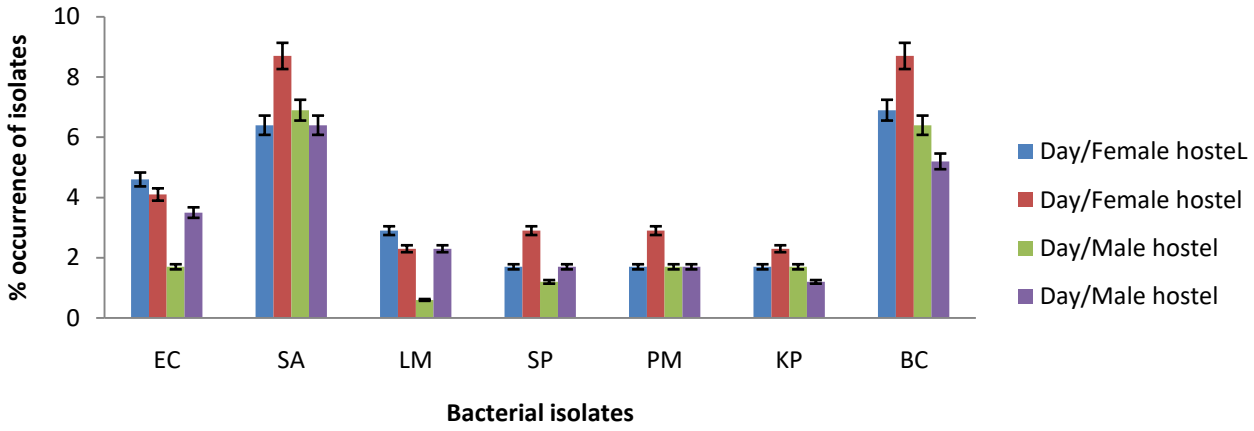

Fig 1: Occurrence of bacterial isolates in indoor air of students hostel in UDUS; EC=*Escherichia coli*, SA=*Staphylococcus aureus*, LM=*Listeria monocytogenes*, SP=*Streptococcus pneumonia*, PM=*Proteus mirabilis*, KP=*Klebsiella pneumonia*, BC=*Bacillus cereus*

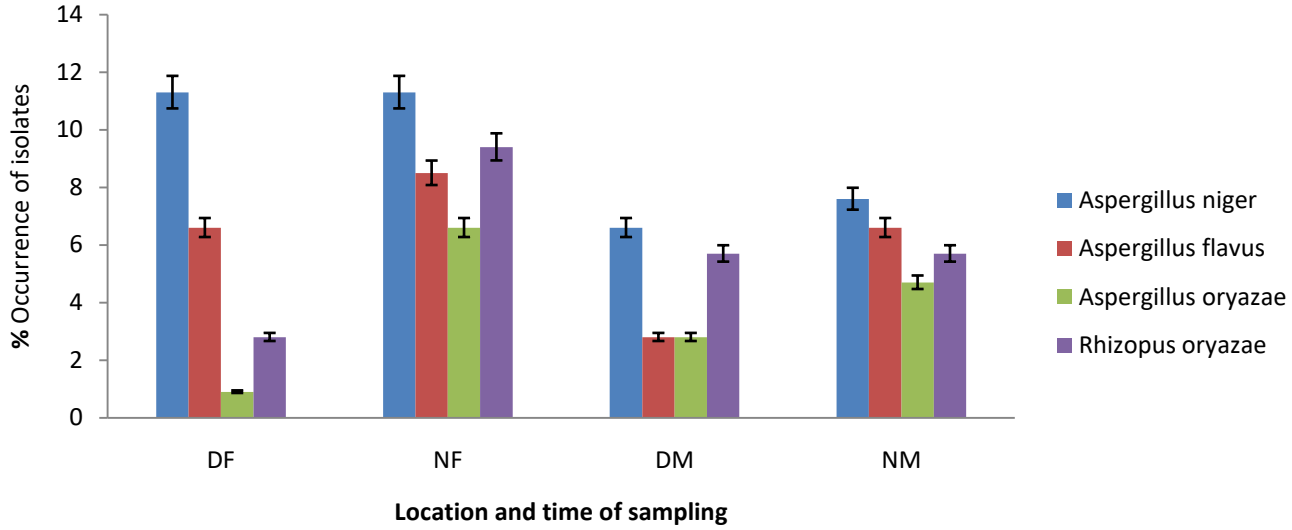

Fig 1: Occurrence of fungal isolates in indoor air of students' hostel in UDUS; DF=Day/Female Hostel, NF=Night/ Female Hostel, DM=Day/Male Hostel, NM=Night Male Hostel

IV. DISCUSSION

In this study, two factors, namely the sampling location and sampling time, individually or combined, were found to influence the microbial rate in indoor air of hostels, which may reflect the rate of cleanliness of these hostels. The results from this study revealed that female students' hostels recorded the higher indoor airborne bacterial and fungal population than the male hostel (Tables 1 and 2). This high population of microbes in the indoor air of the female hostels may be due to the large number of occupants, especially in the afternoon when there are maximum activities by the students. The exchange between indoor and outdoor air raise the microbial population brought from outside the hostels into the main entrance, and this agrees with many studies that reported the role of outdoor microbial concentrations through open windows and doors in raising the microbial rates and homogenization of indoor air of buildings[18][19][20]. The study of airborne bacteria in indoor environment is important to understand the dissemination of airborne microbes particularly the pathogenic ones [18].

The number and type of airborne microorganisms can be used to determine the degree of cleanliness. In this study, seven species of bacterial isolates were identified and these include: *Staphylococcus aureus*, *Klebsiellapneumoniae*, *Escherichia coli*, *Listeria monocytogenes*, *Streptococcus pneumoniae*, *Proteus mirabilis*, and *Bacillus cereus* while the fungal isolates include: *Aspergillusniger*, *Aspergillusflavus*, *Aspergillusoryzae*, and *Rhizopusoryzae*. These airborne micro-flora obtained were similar to those obtained by [21], who reported the isolation of the bacterial isolates,

Staphylococcus aureus, *Staphylococcus epidermidis*, *Escherichia coli*, *Bacillus* sp. *Proteus mirabilis* and *Streptococcus* sp.with *Staphylococcus aureus*being the most prevalent bacterial isolate. In a similar study by [22], *Staphylococcus aureus* was the predominantly isolated bacterium while *Penicillium* spp. was the most predominant fungal isolate. In this study, *Staphylococcus aureus* was the predominantly isolated bacterium while *Aspergillusniger* was the predominantly isolated fungus. At the time of this study, the University was in session and this invariably increases the shedding of microbes and agitation of air.

Great deals of movement in and out of the hostels together with students' activities such as cooking and washing contributed to the high microbial load, proving that humans are a vector for the transport of bioaerosols. *Staphylococcus aureus* as the most frequently isolated bacterium from this study could be due to aerosols transmitted from human body and other inanimate objects because about 40% of human beings harbor *S. aureus* in their nostrils [23]. This species occurs frequently on the skin, nasal and mucous membrane of man [24]. It has been incriminated in various diseases such as urinary tract infections, skin infections, respiratory infections and food poisoning [22]. It is also the only species found in humans that produces the enzyme coagulase, thus, all other species are commonly referred to as coagulase-negative *Staphylococci*[23].Proper control measures such as increase in hygiene are required to combat the spread of by *S. aureus* in these hostels. *Bacilluscereus* is a spore forming organism that can cause serious medical problems, hence proper programme for eliminating it must be put in place. *Escherichia coli* belong to the family Enterobacteriaceae whose normal habitat is the gastrointestinal tract of man and its isolation from samples may indicate contamination due to improper hygienic practices[25]. *Klebsiella*spp. and *Streptococcus* spp. are associated with urinary tract infection among immune compromised individuals[26][27]. Their isolation in this study calls for more adequate control measures. The isolation of *Aspergillusflavus*, a medically important fungus for aflatoxin production, a neurotoxigenic substance, and which can cause lung infection[28] should not be overlooked.

V. CONCLUSION

The results generated in this study clearly suggest that regardless of sampling time and location, indoor environment allows aerosols build up which could potentially lead to infections to the occupants. The consequences based on the quality of indoor-air and indoor-environment problems clearly indicates that much is still to be done in identifying and managing indoor-air deficiencies.

VI. RECOMMENDATIONS

Thus, students should have enhanced practice of good sanitation protocols. Regular cleaning might be among the strict measures necessary to limit microbial dispersals within the hostels or to totally eliminate the microbial load of indoor air of these hostels.

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