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MICROBIOLOGICAL ASSESMENT OF INDOOR AIR IN KANO UNIVERSITY OF SCIENCE AND TECHNOLOGY, WUDIL, KANO STATE

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ABSTRACT
A study of indoor air Microbiological contamination in various rooms of university building of Kano University of Science and Technology, Wudil was carried out in the period of September – October, 2001. Air samples were taken twice a day in the morning and in the afternoon using plate exposure, in all of the sampling places, a multiple growth of the bacteria as well as significant increases of the amount of spores were observed in the afternoon. The predominant bacteria and mould isolated from the investigated air samples were Staphylococcus species, Micrococcus sp., Serratia sp., Aspergillus sp., Penicillium sp., Rhizopus sp. Cladysporium sp., and Alternaria sp. Among the microbes, the presence of pathogenic and strongly allergic microorganisms was detected.
Key words; Indoor air, microbiology quality air, KUST Wudil.

INTRODUCTION

Indoor air quality is one of the most important elements impacting people's health, happiness, and productivity (Soto *et al.,* 2009). The presence of microorganisms such as bacteria, moulds, and viruses affects indoor air quality, and individuals spend 80 percent to 90 percent of their time in interior environments, inhaling on average 14 m^3 of air each day (Wamedo *et al.,* 2012). As a result, people are exposed to a lot of indoor air. As a result, there has been a surge in interest in indoor microbe investigations in some years back (Hospodsky *et al.,* 2012). Jin *et al.* (2017) reported that bacteria, moulds, and yeast are the most common sources of biological pollution in indoor air. They can be toxic as pathogenic live cells, but they can also release compounds that are detrimental to humans. Different types of harmful metabolic products exist, such as mycotoxins (Qian *et al.,* 2012). According to epidemiological research, too high a concentration of microorganisms in the air might be allergenic; nevertheless, even extremely low concentrations of specific microbes can cause catastrophic disorders (Meadow *et al.,* 2014).

The main element leading to the development and spread of airborne microbial contamination is assumed to be the activities of humans and equipment within indoor environments (Bonetta *et al.,* 2010). Talking, sneezing, coughing, strolling, and washing can all cause biological particulate matter to become airborne. Food, house plants and flower pots, house dust, fabrics, carpets, wood material, and furniture stuffing all release spores into the air on occasion (Mandal and Brandl, 2011). Temperature, humidity, air exchange rate, air movement, building structures and location, inadequate design, ventilation system, and interior or redesign are all elements that promote microbe development and proliferation in the indoor environment (Huttunen *et al*., 2008).

According to a WHO review of a number of published studies, there is sufficient evidence for a link between indoor dampness-related factors and a diverse variety of respiratory health effects, including asthma development, asthma exacerbation, current asthma, respiratory infections, upper respiratory tract symptoms, cough, wheeze, and dyspnea (Kalogerakis *et al.,* 2005).As a result, when indoor workplaces are constructed to create a safe environment, microbiological air quality is an essential factor to consider (Gou *et al.,* 2016). Therefore, the work assessed the microbiological quality of indoor air in selected rooms of university buildings located at KUST Wudil where thousands of people spend several hours studying and working in enclosed spaces every day and where microbiological quality of indoor air can influence their health and physical condition.

MATERIAL AND METHODS

Air samples were collected from the University rooms, lecture halls, toilets, living rooms, HOD office, laboratory, canteen, and library using the procedures of the settling plate. Petri dishes containing culture media were exposed in sampling places for a length of sixty second after gravitationally settling directly into Petri dish filled with nutrients agar as described by Khaefi *et al.* (2016). The number of microorganisms represented in CFU/m^3 was calculated using the following formula: CFU/ m^3 = a. 10000/p.t.02

Where

a – The number of colonies on the petri plate

p – The surface of the petri plate

t – The time of petri plate exposure

All samples were taken between the hours of 8 a.m. - 9 a.m. and 2 p.m. - 3 p.m. Petri dishes containing nutrients agar were incubated for 24 hours at 37°C (to determine the total number of bacteria), and petri dishes with Sabouraud Agar medium were cultured for 10 days at 25°C (to enumerate the fungi). The results were expressed as colony forming units per cubic meter of air (CFU/m^3) as described by Gniadek and Macura, (2003).

Three arrays were used to identify bacteria. Micro estimate is the first (description of colony). The second is estimate at a microscopic level (dyeing by Gram staining). The third is biochemical testing based on Bergey's bacterium categorization system (Daisey *et al.,* 2003). The evaluation of morphological aspects of growth on Sabouraud Agar medium as well as microscopic observation were used to diagnose filamentous fungus, according to the filamentous fungi estimation guide (Filipiak *et al.,* 2004).

RESULTS AND DISCUSSION

The predominant bacteria and mould isolated from the investigated air sample were *Staphylococcus* species. *Micrococcus* sp., *Serratia* sp., *Aspergillus* sp., *Penicillium* sp., *Rhizopus* sp. *Cladysporium* sp., and *Alternaria* sp. as shown in figures below.

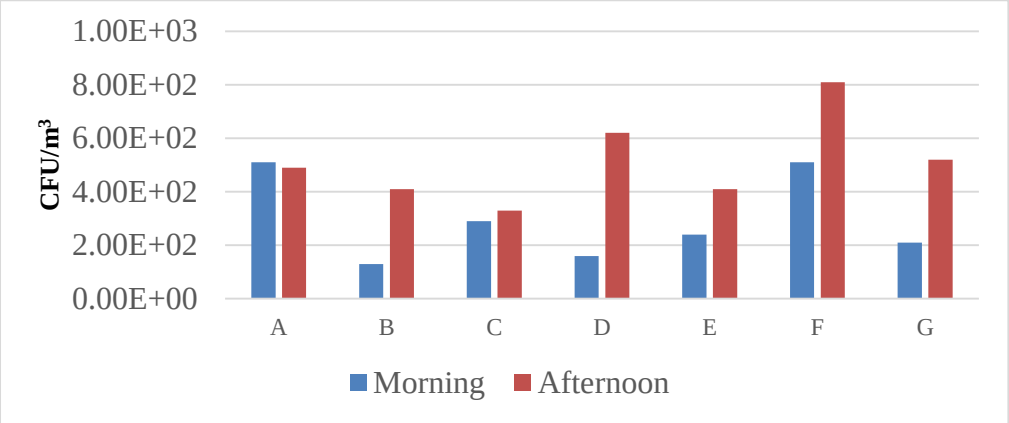

Fig. 1: Air Bacterial Load from the Selected Rooms during the Study

Keys; A - Lecture room, B – Microbiology laboratory, C – Library, D – Reading rooms, E – H.O.D. office, F – Canteen, and G – Toilet.

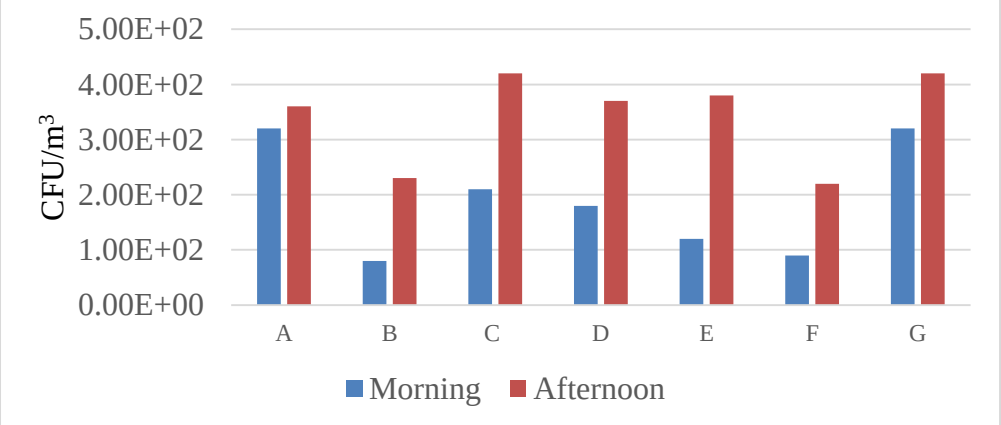

Fig. 2: Air Fungal Load from the Selected Rooms during the Study

Keys; A - Lecture room, B – Microbiology laboratory, C – Library, D – Reading rooms, E – H.O.D. office, F – Canteen, and G – Toilet.

Table 1: Types and Frequency of Occurrence of Microorganisms Isolated from the Selected Indoors

Sampling Codes	A	B	C	D	E	F	G	F (%)
Staphylococcus aureus	+	+	+	+	+	+	+	7(100)
Micrococcus sp.	+	-	+	-	+	-	+	4(57.14)
Serratia sp.	+	+	-	-	+	+	+	5(71.43)
Aspergillus sp.	+	+	+	+	+	+	+	7(100)
Penicillium sp.	+	-	-	+	-	+	+	4(57.14)
Rhizopus sp.	-	+	-	-	+	+	+	4(57.14)
*Cladysporium*sp,	+	+	-	+	-	-	+	4(57.14)
Alternaria sp.	+	-	+	-	-	-	+	4(57.14)
F(%)	7(87.50)	5(62.50)	4(50.00)	4(50.00)	5(62.50)	6(75.00)	8(100)	

Keys; A - Lecture room, B – Microbiology laboratory, C – Library, D – Reading rooms, E – H.O.D. office, F – Canteen, G – Toilet, (-) Absence, and (+) Presence

Microbiological quality of indoor air is determined not only by the overall number of bacteria and fungus present, but also by the presence of certain microorganism species that are critical to the health of those who use the space (Hayes *et al.,* 2020). *Micrococcus* spp., *Bacillus* spp., *Staphylococcus* spp. (e.g. *Staphylococcus aureus*), *Sarcina* spp., and *Serratia* spp. were shown to have the greatest contributions to the bacterial flora composition in studied University rooms. In addition, gram-negative bacteria belonging to the *Escherichia* genus were recovered from toilet air. Quality features of fungal flora isolated from the air of educational rooms revealed that *Cladosporium* spp. (e.g. *Cladosporium herbarum*), *Penicillium* spp. (e.g. *Penicillium chrysogenum*, *Penicillium viridicatum*, and *Penicilluim expansum*), and Aspergillus spp. (e.g. *Aspergillus niger* and *Aspergillus flavus*). In a canteen and a toilet, the genera *Cladosporium herbarum, Alternaria alternata, Mucor* spp., and *Rhizopus nigricans*, predominated.

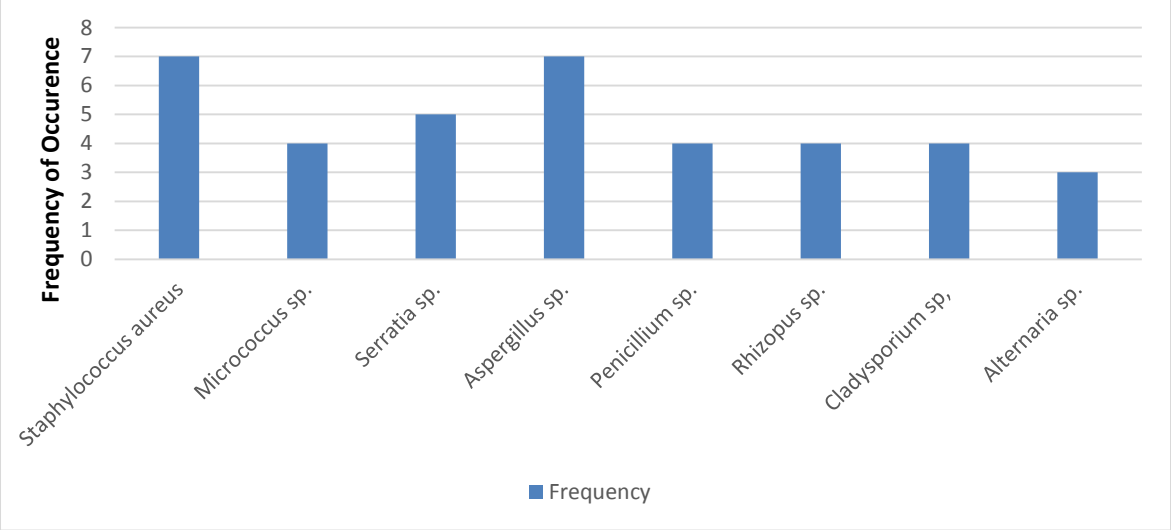

Fig. 3. Frequency of Occurrence of the Isolates during the Study

It's difficult to completely interpret our findings since there's no established reference limit for microbiological quality in indoor air. The so-called residential limit Values (RlV) provided by Gorny and Dutkiewicz at the Who expert Meeting in Berlin in 2002 were, however, one of the significant ideas of reference data. In 2002, the quantity of bacterial flora detected in university rooms barely fit the top limit of these standard values, but in 2003, they occasionally exceeded it (5000 CFU/m^3). The fungal concentration did not exceed the suggested RlV limit (5000 CFU/m^3), but it did exceed the threshold of 250 cfu/m^3 – the limit set by the American Industrial Hygiene Association in 2001 in virtually all cases.

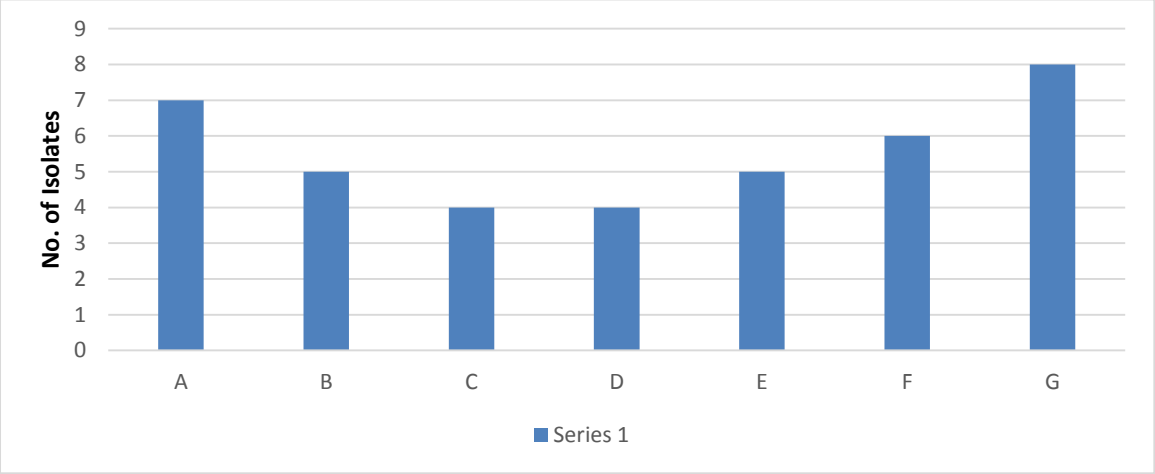

Fig. 4 Bio-burden of Bacteria and Fungi Associated with the Study Indoors
Keys; A - Lecture room, B – Microbiology laboratory, C – Library, D – Reading rooms, E – H.O.D. office, F – Canteen, and G – Toilet.

When looking at the differences in microbe concentrations over the course of the study, it's clear to notice a spike in fungus in the lecture room air and bacteria in the toilets around the start of the day. This occurrence is undoubtedly linked to the emergence of a new important source of microbiologic contamination while students attending lectures (Peterman *et al.,* 2002).

The human body, as well as clothes, provides an ideal environment for microbes to thrive. Other studies have found a robust link between occupant density, human activity, and microbe concentration in indoor air (Fleischer *et al.,* 2006).

Grigg (2018) discovered that more crowded workplaces had the greatest bacterial concentration. The rooms at schools have the highest levels of bacterial contamination. The number of germs was substantially lower during and after instruction (Gniadek and Macura, 2003). In this study, a gradual decrease in microbial contamination was observed after a short period of high microorganisms concentration in the air of investigated rooms, which was associated with a slow drop in microbial contamination in the outdoor air found in parallel studies near university buildings (DeLeon *et al.,* 2013).

CONCLUSION

The microbiological quality of the air in the rooms under investigation was distinct and varied dramatically during the day. The concentration of bacteria and considerably more fungus rose many times in the afternoons. The ventilated lecture room was the lone exception, as the microbiological composition of the air remained consistent throughout the day and even showed a trend to fall. Increased levels of fungal flora in well ventilated rooms may be a cause of major health concerns for individuals who live there.

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