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http://hdl.handle.net/2324/1906117

出版情報：Proceedings of International Exchange and Innovation Conference on Engineering & Sciences (IEICES). 3, pp.11-14, 2017-10-19. 九州大学大学院総合理工学府
バージョン：published
権利関係：

IEICES

3nd International Exchange and Innovation Conference on Engineering & Sciences
Kyushu University, Fukuoka, Japan
October 19-20, 2017

Assessment of Indoor Microbial Environment of Labs and Faculty Offices at a University in Gaza, Palestine

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Abstract: *Bacteria and fungi grow indoors when sufficient moisture is available, causing indoor air pollution. The aims of this study were to determine the total viable bacterial count and fungi levels at the labs and faculty offices of the Islamic University of Gaza (IUG). Twenty-six air samples were collected from the IUG labs and faculty offices using air samplers. The results show that the highest bacterial count was observed at the Medical Science Labs with 1365 colony-forming unit (CFU)/m^3 while the highest fungal count was detected at the Environment Science Labs with 425 CFU /m^3. The majority of the monitored labs and offices have higher bacterial and fungal levels than the WHO standards of 500 CFU/m^3. Lab users should wear face masks to reduce any potential health impacts due to the microbial pollution.*

Keywords: Bacteria; Fungi; Gaza; Indoor air; Microbial; Pollution.

1. INTRODUCTION

Indoor air quality is an important environmental element that influence our health. Human beings breathe 10 m^3 air every day, and they spend 80–95% of their live indoors. The indoor air pollution can result in health problems and even may increase human mortality [1]. The indoor environment contains a complex mixture of live and dead micro-organisms, fragments, toxins, allergens, volatile organic compounds, etc. [2].

As people spend most of their time in closed environments, concern on air contaminants in such places is justifiable. Bacteria, fungi and virus, may form biological air contaminants, and their distribution may vary depending on the environment, even on areas within the environment. Heating, ventilation and air conditioning systems may also be microbial sources [3].

There are more evidences that exposure to biological agents in the indoor environment can have adverse health effects. Recently, a report on indoor air quality, especially on dampness and mold, by the WHO provided sufficient epidemiological evidences that inhabitants of damp or moldy buildings, both homes and public buildings, are at an increased risk of respiratory symptoms, respiratory infections and exacerbations of asthma [4].

A variety of factors can affect the indoor air quality of a building including the physical layout of the building, the building's heating, ventilation and air condition. In addition, the outdoor climate, the people working in these buildings and contaminants inside and outdoor the buildings also should be considered as influential factors [5].

Microbial pollution involves hundreds of species of virus, bacteria, and fungi that grow indoor when sufficient moisture is available. The presence of many biological agents in the indoor environment is due to dampness and inadequate ventilation. Excess moisture may result in increased chemical emissions from building materials and floor covers [2], which influence fungal and bacterial numbers indoor. In the hot and humid summer, the number is high, while it is low in cold and dry winter [4].

Several health issues have been associated with fungal and bacterial species in the indoor environment. They include rhinitis, upper respiratory symptoms, asthma and other effects such as allergic skin reactions, tiredness and headaches. Temperature and relative humidity appear to be major factors influencing the levels of fungi and bacteria in the indoor environment. Mold formation and dampness can be reduced if a sufficient ventilation is supplied, so any potential health risk caused by fungi and bacteria indoors can be reduced [6].

In this research, fungi and bacteria in labs and faculty offices in the Islamic University of Gaza (IUG), Gaza City, Palestine, were sampled and analysed.

2. MATERIAL AND METHODS

2.1. Study Area

A cross-sectional prospective study was conducted to assess bacteria and fungi in research labs and faculty offices of a university in Gaza City, Palestine, which is with more than 20,000 students and 1400 staffs.

A total of 26 samples were collected from different labs and offices in the university (Table 1); 8 samples were collected from the environment department, 6 from biology, and 5 from chemistry department. Sampling was carried out over a month (April_ May 2013)

Table 1. Sampling Points and Number of Samples

Locations	# of Samples	
	Labs	Offices
Biology	5	1
Chemistry	4	1
Environment	7	1
Physics	3	0
Medical	3	1
Sub-total	22	4
Total	26	

2.2. Materials

Culture media used for counting bacteria and fungi were as follows:

A - Dichloran Rose Bengal Chloramphenicol (DRBC) agar (Oxoide-UK)
DRBC agar is used for the enumeration of yeasts and molds; colonies of molds and yeasts should be apparent within 5 days of incubation. Colonies of yeast appear pink due to Rose Bengal.

B - Nutrient agar (NA; HiMedia- India) for bacterial counting

2.3. Sampling and Measurement

The following devices were used; air sampler, autoclave, incubator, colonies counter and auto ranging multimeter. Samples which were collected from the labs and offices of IUG for over a period of one month as follows:

An air sampler (Sampl'air-AES CHEMUNEX, France), as shown in Fig. 1a, was used to collect air samples. Petri dish was put on the top of the device and a pre-determined volume of air (100 L) was collected. NA was used to collect samples for bacterial count, which was later transferred to the laboratory in an icebox, and incubated for 24 h at 37 °C before the grown colonies were counted [7].

(a) NA Agar (b) Air sampler

Fig.1. (a) Nutrient Agar plate and (b) Air sampler

Dichloran Rose Bengal Chloramphenicol agar as shown in Fig. 2 was used as the culture medium for fungi. It was also transferred to the laboratory in an icebox and incubated for 5 d at 25 °C before grown colonies were counted [8].

(a) DRBC Agar (b) Colonies Counter

Fig 2. (a) Dichloran Rose bengal Agar plate and (b) colony counter

Humidity and temperature of each laboratory were measured simultaneously using Auto Ranging Multimeter (Digital Multimeter MASTECH MS8209, China).

3. RESULTS AND DISCUSSION

3.1. Bacteria

The mean bacterial count of 26 samples collected from the university labs and offices was 1048 CFU m^{-3}. As shown in Table 2. The highest mean bacterial count was at the labs of Medical Science Dept. (1365 CFU m-3) and the lowest was at Biology labs (780 CFU m^{-3}). The high levels of bacterial count could be due to the crowdedness of Medical labs and in these laboratories; microbes and parasites are being analysed for clinical purposes.

Table 2. Total Bacterial and Fungal counts

Locations	N	Mean	Std. Dev	Min	Max
		CFU m-3		CFU m-3	CFUm-3
Bacterial Count					
Environment Science	8	947.5	750.5	190	2320
Biology	6	780	315.4	530	1300
Chemistry	5	1122	511.6	570	1780
Medical Sciences	4	1365	933.4	340	2280
Physics	3	1306.6	502.9	940	1880
Total	26	1048	624.4	190	2320
Fungal Count					
Environment Science	8	425	410.1	100	1120
Biology	6	283.3	126.4	70	390
Chemistry	5	378	206.4	170	680
Medical Sciences	4	245	205.5	60	520
Physics	3	356.6	180.1	180	540
Total	26	347.6	263.7	60	1120

The results in Table 3 shows a high rate of failure to comply with WHO standard as shown in Table 3. This depends on the level of hygiene, aeration, sunlight, the use of disinfectants and antiseptics, number of students, labs design, and soon.

Table 3. Comparing Bacterial and Fungal counts to WHO Standards

Location	N	< 500 CFU/m³		> 500 CFU/m³	
		N	%	N	%
Bacterial Count					
Environment Science	8	4	50%	4	50%
Biology	6	0	0	6	100
Chemistry	5	0	0	5	100
Medical Sciences	4	1	25	3	75
Physics	3	0	0	3	100
Total	8	4	50%	4	50%
Fungal Count					
Environment Science	8	6	75%	2	25%
Biology	6	6	100%	0	0%
Chemistry	5	4	80%	1	20%
Medical Sciences	4	3	75%	1	25%
Physics	3	2	66%	1	34%

Table 3 also shows the bacterial counts and percentage of air samples that were compared to WHO standards. The WHO standard states that bacteria of > 500 CFUm^{-3} is considered to be polluted. In this study; 81% (n= 21) of the air samples were considered polluted and 19% (n=5) were considered unpolluted. A similar result was reported at a study in Turkey [9]. As shown in Table 2, the maximum levels of bacterial count range from 1300 to 2320 CFU m^{-3} which is in line with the literature [10].

The analysis results of all (100%) the samples that were collected from Biology, Chemistry, and Physics labs failed to meet the WHO standards of 500 CFUm^{-3}. This could be due to high humidity, poor ventilation, and tens of working people. The lowest failure percentage was found at the Environment labs (50%). This may be attributed to the nature of these laboratories.

Figure 3 shows the mean of bacterial counts at laboratories (1088 CFU m^{-3}) and faculty offices (825 CFUm^{-3}). This was expected because the level of cleanness at the faculty office is higher than labs.

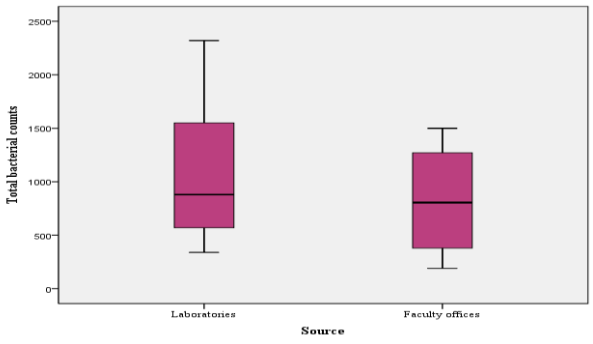

Fig.3. Total bacterial count in air samples at labs and faculty offices

Figure 4 shows that 81.8% of the samples which were collcetd from labs and 25% of the samples collected from faculty offices were found having high bacterial concentration of more than 500 CFUm^{-3}.. This may be due to the higher number of occupants (students and staff) and the occupancy rate at labs.

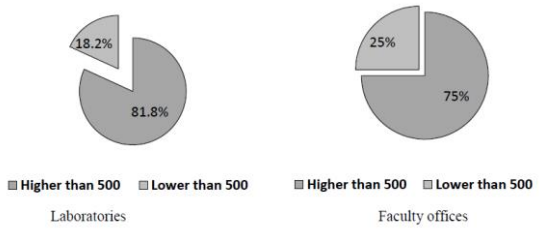

Fig.4. Bacterial counts in air samples in Labs and faculty offices.

3.2. Fungi

The fungal counts of 26 samples had a mean of 347.6 CFU/m^3 as shown in Table 2, the highest mean of fungal count (425 CFU/m^3) was at Environment and Earth Science Department labs and the lowest was at Medical Science Labs Departments (25 CFU/m^3).

Following the WHO standard which states that fungal counts of more than 500 CFU/m^3 is considered to be polluted, 19.2% (n= 21) of the IUG air samples are considered polluted and 80.8% (n=5) are considered unpolluted.Table 3 shows the number and percentage of air samples having fungal count below and above the WHO standards distributed by department, the highest percentage was at Physics Department with 34% and the lowest was at biology department with 0%. These difference were not statistically significant (p =.650).

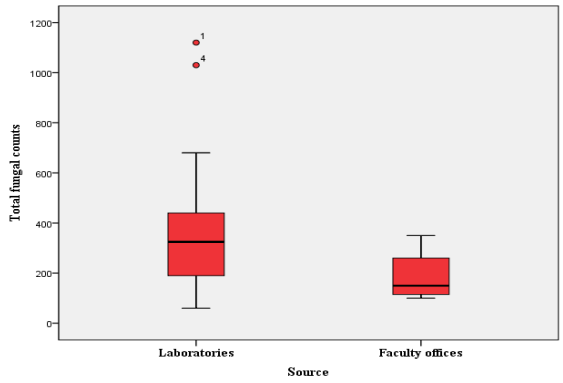

Fig. 5. Total fungal count at labs and faculty offices

The results in Figure (5), shows that the mean of total fungal counts at at the IUG labs was 376 CFU/m^3 which is higher than the total counts at the faculty offices (187 CFU/m^3)

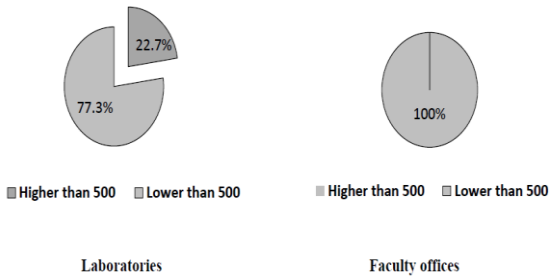

Fig. 6. Fungal counts in air samples in Labs and faculty offices

Figure (6) shows that 22.7% of the labs samples found to have high total fungal count of concentration great than 500 $CFUm^{-3}$ and this may be due the high humidity and low ventilation at the IUG labs.

Regarding the temperature and humidity records, the monitoring results show that the mean temperature at IUG labs was 23.1°C which meets standards of the American Society of Heating, Refrigerating and Air-Conditioning Engineers "ASHRAE" (20-25 °C), while the mean humidity was 65.1% and this exceeded the ASHRAE standards of 40-60%.

4. CONCLUSION

The air samples that were collected from IUG labs and faculty offices found containing high bacterial and fungal counts with a mean concentration of 1048 CFU m^{-3} and 348 CFU m^{-3} respectively. Furthermore, it was found that 81% of the bacterial counts and 19% of the fungal counts were higher than the WHO standards of 500 CFU m^{-3}.

The highest mean bacterial counts were found at the Medical Laboratories Sciences Departments (1365 CFU/m^3) and the lowest was at Biology Departments (780 CFU/m^3). While in terms of fungal counts, the highest level was at Environment lab (425 CFU/m^3) and lowest was at medical lab (245 CFU/m^3). It is recommended to implement periodical monitoring of indoor air quality. In addition, lab disinfection is advised along with a good ventilation to provide fresh air.

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