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MICROBIAL DYNAMICS DURING VARIOUS ACTIVITIES IN RESIDENTIAL AREAS OF LAHORE, PAKISTAN

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ABSTRACT

Bioaerosols are ubiquitous in the atmosphere with their levels affected by a variety of environmental factors as well as type of activities being carried out at any specific time. The present study investigated how indoor activities influence bioaerosol concentrations in five residential houses of Lahore. Agar coated petri plates were exposed face upwards for twenty minutes in kitchens and living rooms during activity and non-activity periods. The temperature and relative humidity levels were noted as well. The bioaerosol concentrations in kitchens during the activity time ranged between 1022 to 4481 cfu/m^3 and in living rooms from 1179 to 3183 cfu/m^3. Lower values were observed during non-activity periods. A paired-t test revealed a significant difference in bacterial loads during activity and non-activity times in both micro-environments ($p = 0.038$ in kitchen and $p = 0.021$ in living room). The predominant species identified were *Micrococcus* spp., *Staphylococcus* spp., and *Bacillus* spp. which are a common constituent of the indoor environment and are known to be opportunistic pathogens as well.

KeywordsAir-borne bacteria, colony forming units, indoor environment

INTRODUCTION

In urban centers people spend a considerable proportion of their day indoor environments such as offices or homes. Among the various contaminants present in the air, bioaerosols comprise a significant proportion (5-34%) (Laumbach and Kipen, 2005). Indoor sources of bioaerosols comprise of human beings, mold, furnishing material and cleaning activities. Bioaerosols (fungi, bacteria, pollens, allergens) along with non-biological particles (smoke, dust particles generated from cleaning and cooking) may lead to serious health problems (Douwes*et al*. 2003). For example bioaerosols have been linked with many hyper-sensitive and infectious diseases (Su *et al*. 2001; Hardin *et al* . 2003; Fabian *et al* . 2005; Kalogerakis *et al* . 2005; Nazaroff, 2014). Household activities and the presence of people have been reported to have significant impact on indoor air quality. Knowledge about the impact of different indoor activities on bioaerosols levels is of value to estimate the risk of exposure as well as in designing intervention strategies to improve air health.

Data is scant regarding indoor air quality in urban centers of Pakistan and fewer on micro-flora of residential micro-environments. The current study was carried out to demonstrate the impact of household activities on indoor microbial air quality in an urban residential built environment in a low income country.

MATERIALS AND METHODS

The study was part of a larger project which investigated indoor air quality of thirty residencies of Lahore, Pakistan. Five houses among them were selected at random to observe the impact of indoor activities on levels of bioaerosols. In kitchens and living rooms bacterial samples were collected through Koch sedimentation (Stryjakowska-Sekulska *et al*. 2007). Petri plates containing Tryptic Soy Agar (TSA) were exposed, face upwards, in each of the selected rooms for a time period of twenty minutes each. Temperature and relative humidity was also noted at the time of exposure. Two plates were exposed during the peak activity time in both rooms while two more plates were exposed when there was no activity. The major activity in both rooms included movement of people whilst cleaning. In the kitchens, stoves were also in use for cooking during the monitoring. In order to minimize the impact of activities upon pollutant levels during non-activity sampling, the plates were exposed an hour later after the last activity had been performed in the room. After exposure, the plates were taken to the laboratory and incubated at 27°C for 24 to 48 hours to allow growth of culturable bacteria. The plates were then examined under microscope and colonies counted. The species were identified by observing the morphological features of the colonies. Colony forming units were calculated by employing the

Omelyansky formula as followed by Bogomolova and Kirtsideli (2009). A paired t-test was run to observe any significance differences between the bacterial concentrations.

RESULTS AND DISCUSSION

The colony forming units in the kitchens varied from 1022 to 4481 cfu/m^3 during activity time. During still conditions, the levels ranged between 471to 1926 cfu/m^3 (Figure 1). Likewise, in the living rooms the concentration ranged between 1179 and 3183 cfu/m^3 during work. In the absence of any activity, these levels fell to vary between 117 and 1454 cfu/m^3 (Figure 2).

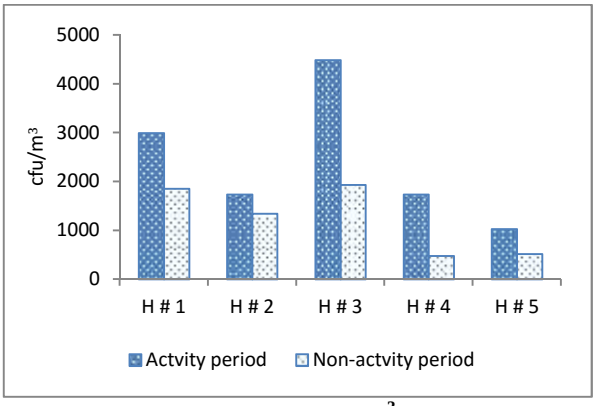

Fig. 1:Levels of bacteria (cfu/m^3) in the kitchens during activity and non-activity periods

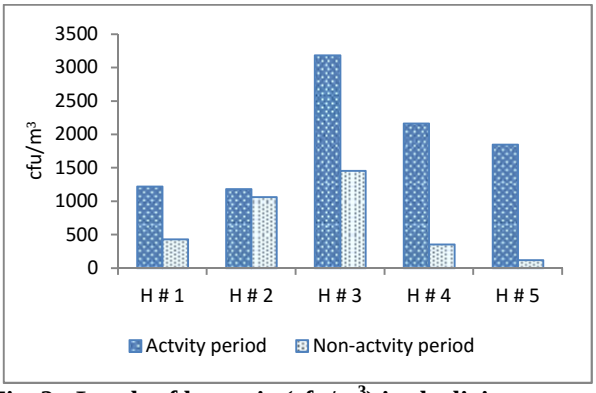

Fig. 2: Levels of bacteria (cfu/m^3) in the living room during activity and non-activity periods

A significant difference was observed in bioaerosols concentrations between activity and non-activity periods in the kitchens ($t(4) = 3.042$, $p = 0.038$). Similarly in the living rooms a significant difference was observed in bacterial loads during activity and non-activity periods ($t(4) = 3.666$, $p = 0.021$).

The indoor biota in this study was identified to consist of *Micrococcus* spp., *Staphylococcus* spp., and *Bacillus* spp. along with some Gram Positive Cocci (GPC) and Gram Negative Rods (GNR). Although these species are a common constituent of the indoor air, they are also known to be opportunistic pathogens and their large quantities in the air can be a health risk (Kowalski, 2006).

Building designs and ventilation strategies play a significant role in airborne microbiological community dynamics in the built environment. All the selected sites in this study were naturally ventilated with air exchange rates varying between 2.6 to 8.4 ACH (Air exchange rate /hour). However no direct relation between ACH and bioaerosol levels could be quantified as passive sampling can only give a rough approximation of air-borne bacterial concentrations (Stryjakowska-Sekulska *et al*, 2007).

A previous study carried out by Colbeck *et al*. (2008) observed bioaerosols concentrations in residential settings of Pakistan to be much higher. They reported concentrations of up to 12300 cfu/m^3 at an urban site while the kitchen in rural site had approximately 506 cfu/m^3 and living room contained 1111 cfu/m^3 within the 0.5 – 2 um size range. In a similar study, Nasir *et al*. (2012) measured bioaerosol concentrations in rural and urban areas of Pakistan using a six-stage Andersen impactor and found the air to be dominated by the respirable fraction (55-99%) which could easily penetrate deeper in the respiratory system. Their findings showed higher levels of bacteria in the two rural sites i.e. 14650 cfu/m^3 and 11616 cfu/m^3 while the urban location had lower levels (9408 cfu/m^3). In our study, all the sites were located in urban areas and the levels of bioaerosols varied in both the kitchens and living rooms during the working and non-working conditions. The highest colony forming units were observed in site # 3 during activity time in both the kitchen and living room i.e. 4481cfu/m^3 and 3183cfu/m^3, respectively.

Although the current study did not measure the size of bioaerosols, long term exposure to such high levels of bacteria can be harmful, particularly for children and the immune-compromised people. Moreover there are no studies to be found on the trends in bioaerosol levels during working and non-working hours. There is need to gather more knowledge on abundance and diversity of microbes in different built environments in order to inform the actual risk of exposure to bioaerosols in enclosed spaces.

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