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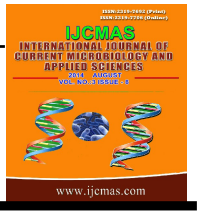

Original Research Article

Microbiological air quality of indoors in primary and secondary schools of Visakhapatnam, India

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Keywords

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A B S T R A C T

Indoor air quality is gaining importance in residential sector whilst it is need of hours to asses indoor air quality in government schools with respect to indoor air microflora. Enumeration of indoor air microflora was carried out in 30 government schools of Visakhapatnam (15 primary and 15 secondary schools) for one academic year (April 2013-April2014) by adopting koch's sedimentation method. Results in this study elucidates that the bacterial concentration was found more in places like classrooms, toilets and canteens and fungal concentration was observed more in libraries, classrooms. Lack of concern in indoor air qualities in the management leads to the growth of bacteria and fungi. The data collected in this study used as reference material for further studies.

Introduction

The quality of air inside the enclosed spaces has become the matter of growing concern in schools today. But unfortunately the studies on indoor air quality in Visakhapatnam were not reported so far. A survey conducted on air pollution in Visakhapatnam states that children in Visakhapatnam especially in the age group of between 5 to 15 years are predominantly suffering with respiratory problems and lung infection due to air pollution (Times of India 2014). Recent statistics on air pollution noticed that air pollutants levels have been rapidly increased from 2009 -2014 in Visakhapatnam (Lakshmana rao 2014).

Children spend a time period of nearly 7 to 8 hours in a day. The school comprises of precise indoor environment as children constitute distinct group of population (Geller et al 2007). Children are more susceptible to indoor air pollutants than adults as they are exposed to unidentified amount of indoor air pollutants in school environments (Faustman et al 2000, Mendal et al 2005).The classrooms are overloaded with students than prescribed, teacher and students stay close together lower the free circulation of air masses in the classrooms. This may alter indoor air quality, which further effects pupils' health.

Major indoor biological air pollutants are bacteria and fungi (molds and yeast).Stryjakowska-Sekulska etal (2007) stated that Indoor air microflora may be detrimental to human health and can induce allergies(Zyska 1999).Incidence of bacteria and fungi in large number in indoor reveals that air may cause irritation of mucous membranes, bad physical condition, tiredness, headaches, decrease of concentration, memory and intellectual work abilities(Mortiz et al 2001). This may leads to dermatosis and respiratory problems including asthma (Filipiak et al 2004). The goal of this study is to assess the indoor air quality in academic institutions particularly in primary and secondary schools of Visakhapatnam.

Materials and Methods

Study Design and Study Sample

The study was carried out for a period of one academic year (June2013-May2014) in 30 schools of Visakhapatnam out of those, fifteen schools are primary schools and other fifteen schools are secondary schools. In the schools the sampling areas are classrooms, office rooms, libraries, canteens and toilets.

Method of air Microflora collection

For enumeration of air Microflora the petriplates were exposed to air for thirty minutes. The sample collection was done in two regular intervals of a day. The first set of medium containing petriplates were exposed at sampling rooms prior to their commencement of class work and the same was repeated in the afternoon for the second set (before the end of the lectures) (Mostafa et al 2012).

For Enumeration of Bacteria EMB Agar medium and for fungi PDA Agar medium plates were used .After exposing to Indoor air, medium containing petriplates were incubated at 37 ± 2 º C for Bacteria and at 18 ± 2 º C for Fungi for a period of 24 to 48 hours(Kavita Naruka and Jyothi 2013). The average of colony forming units(CFU) of both bacteria and fungi was calculated and converted to organisms per cubic meter of air(Stryjakowska Sekulska et al 2007).

$CFU/m^3 = a \cdot 10000 / p \cdot t \cdot 0.2$

Where as
a-The number of colonies on the petriplates
p-Surface of the petriplates
t-The time of petriplates exposure

Results and Discussion

The data of indoor air microbial concentration was collected separately for both primary and secondary schools. The microbial concentration of indoor air differs from sampling area to area and day to day. Incidence of air microflora was found high in afternoon sessions when compared to morning session.

Seasonal variation

In all the seasons, the prevalence of air microbial density was observed high in classrooms and toilets.

Summer season

The range of bacterial concentration from morning to afternoon session at sampling areas of Primary schools in the descending order was libraries>classrooms> toilets>canteens> office rooms and the values are $7.48x10^3$ to $9.23\ x10^3$>$4.42\ x10^3$ to 5.92>$3.81\ x10^3$ to $5.12\ x10^3$ > $3.24\ x10^3$ to 4.68 >$1.82\ x10^3$ to $2.13\ x10^3$ respectively(Figure-1). Four percent increase in bacterial concentration was noticed from morning to afternoon in both classrooms(($2.4\ x10^3$ to $9.6\ x10^3$) and libraries ($2.2\ x10^3$ to $8.8\ x10^3$) of

secondary schools .whilst three percent of bacterial concentration increase was observed from morning to afternoon at other sampling areas like canteens(1.6 $x10^3$ to 4.8 $x10^3$), office rooms(3.5 $x10^3$ to 7.0 $x10^3$) and toilets(4.8 $x10^3$ to 14.4 $x10^3$) respectively(Figure-1).PDA petriplates showed heavy fungal growth on exposure to indoor air in both classrooms and libraries of all sampled schools. The ascending order of fungal concentration in primary schools was 2.48 $x10^3$ to 2.9 $x10^3$< 3.43 $x10^3$ to 4.16 $x10^3$< 4.72 $x10^3$ to 5.71 $x10^3$< 5.73 $x10^3$ to 6.7 $x10^3$ < 6.21 $x10^3$ to 9.23 $x10^3$ <7.67 $x10^3$ to 11.08 $x10^3$ respectively(Figure-2). In secondary schools four percent increase in fungal concentration was noticed both in toilets (3.1 $x10^3$ to 12.4 $x10^3$) and canteens (1.9 $x10^3$ to 4.1 $x10^3$), whereas an increase of three percent was observed at classrooms(3.6 $x10^3$ to 10.9 $x10^3$) and libraries(5.9 $x10^3$ to 17.7 $x10^3$) from morning to afternoon(Figure-2). The fungal concentration was high in both primary schools and secondary schools than bacteria throughout summer season.

Rainy season

In rainy season the prevalence of bacterial concentration was high in comparison with both primary schools and secondary school. In primary schools bacterial density was high in library (8.13 $x10^3$ to 9.78 x 10^3), classrooms (6.74 $x10^3$ to 9.13 $x10^3$) canteens (6.41 $x10^3$ to 7.36 $x10^3$) and toilets (5.13 $x10^3$ to 9.36 $x10^3$) from morning to afternoon(Figure-3) . In secondary schools afternoon an average of three percent increase in bacterial concentration was noticed in classrooms (5.1 $x10^3$ to 15.6$x10^3$) ,toilets (4.8 $x10^3$ to 14.4 $x10^3$) whilst two percent increase of bacterial concentration from morning to afternoon was observed in other sampling areas like libraries(4.6 $x10^3$ to 9.2 $x10^3$), canteens (3.3 $x10^3$ to 6.6 $x10^3$) and office rooms (3.5 $x10^3$ to 7.0 $x10^3$) (Figure-3). The range of fungal concentration at primary school from morning to afternoon in descending order was classrooms (3.43 $x10^3$ to 4.16 $x10^3$) > (3.12 $x10^3$ to 3.56 $x10^3$) > (2.56 $x10^3$ to 3.18 $x10^3$) > (2.19 $x10^3$ to 2.78 $x10^3$)>(1.81 $x10^3$ to 1.98 $x10^3$) respectively(Figure-4).

In secondary schools an average of two percent increase of prevalence of fungal concentration was observed only in toilets (5.13 $x10^3$ to 10.48 $x10^3$), libraries(3.91 $x10^3$ to 7.94 $x10^3$)and in rest of the places the values of fungal concentration are canteen(4.51 $x10^3$ to 6.18 $x10^3$) classrooms (4.16 $x10^3$ to 5.12 $x10^3$) office rooms(2.24 $x10^3$ to 2.73 $x10^3$) respectively(Figure-4). The bacterial concentration was high in both secondary and primary schools than fungi throughout the year.

In winter season

In winter season it was observed that bacterial concentration was stable in all the sampled schools from morning to afternoon. the ascending order of bacterial concentration in primary schools was libraries(1.0 $x10^3$ to 1.53 $x10^3$)< office room (1.04 $x10^3$ to 1.0 $x10^3$) <Toilets(1.25 $x10^3$ to 1.41 $x10^3$) <canteens(1.12 $x10^3$ to 1.34 $x10^3$) <toilets(1.25 $x10^3$ to 1.41 $x10^3$)(Figure-5). The bacterial concentration in secondary schools was classrooms (1.6 $x10^3$ to 2.1 $x10^3$), office rooms (1.3 $x10^3$), toilets (2.1 $x10^3$ to 2.4 $x10^3$), libraries(1.7 $x10^3$ to 2.3 $x10^3$) and canteens(1.6 $x10^3$ to 1.9 x 10^3).(Figure-5) The fungal concentration of primary schools are as follows classrooms(1.21 $x10^3$ to 1.52 $x10^3$), office rooms (0.78 $x10^3$ to 0.93 $x10^3$) toilets(1.0 $x10^3$ to 1.33 $x10^3$) libraries(1.36 $x10^3$ to 1.74 $x10^3$) canteens (1.22 $x10^3$ to 1.31 $x10^3$) respectively(Figure-6).

Figure.1
SUMMER SEASON (Bacteria)

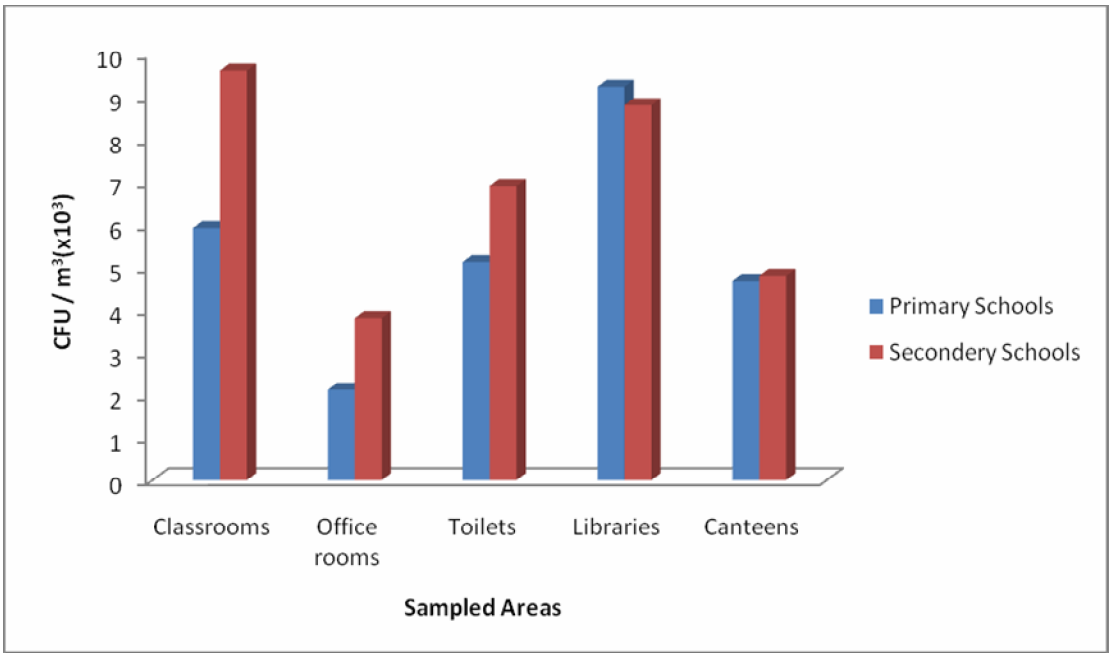


Figure.2
SUMMER SEASON (Fungi)

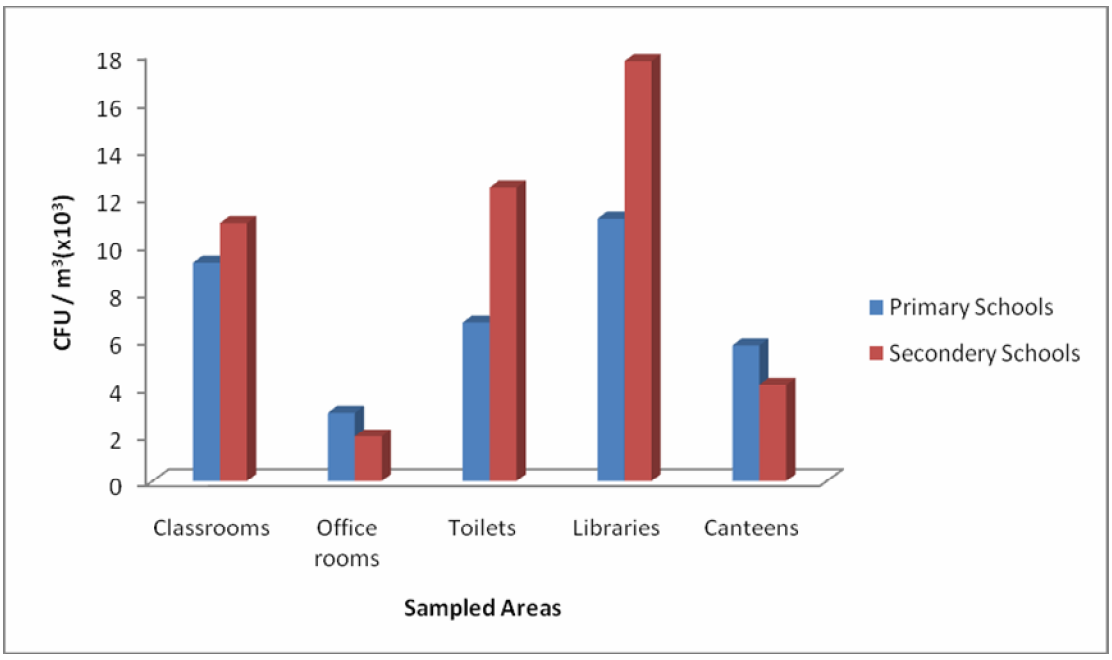


Figure.3
RAINY SEASON (Bacteria)

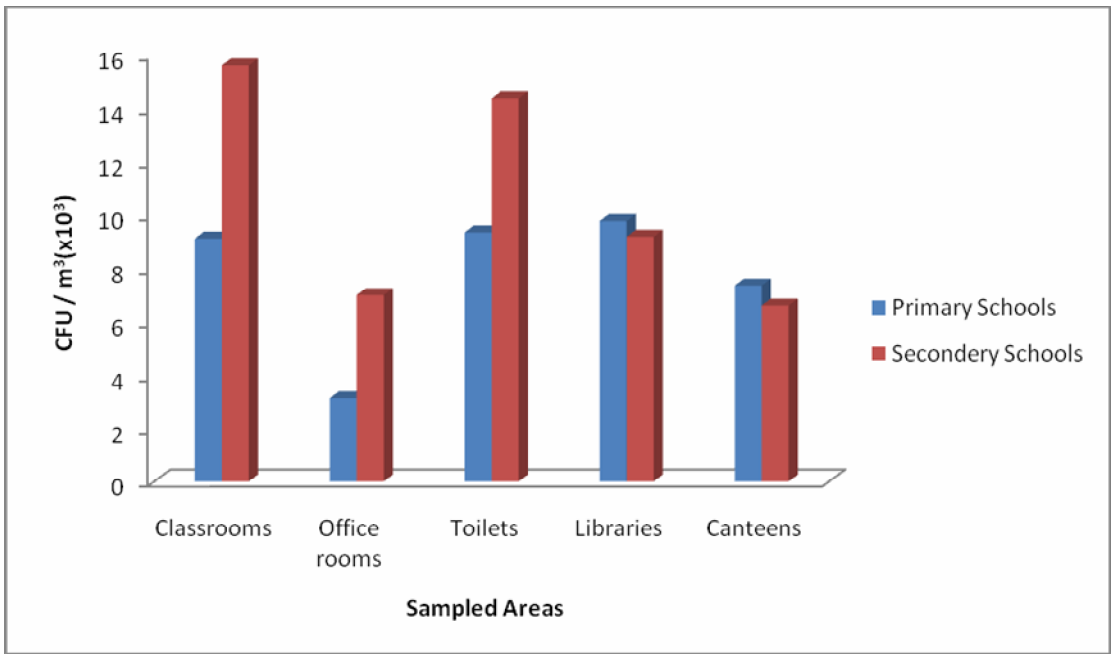


Figure.4
RAINY SEASON (Fungi)

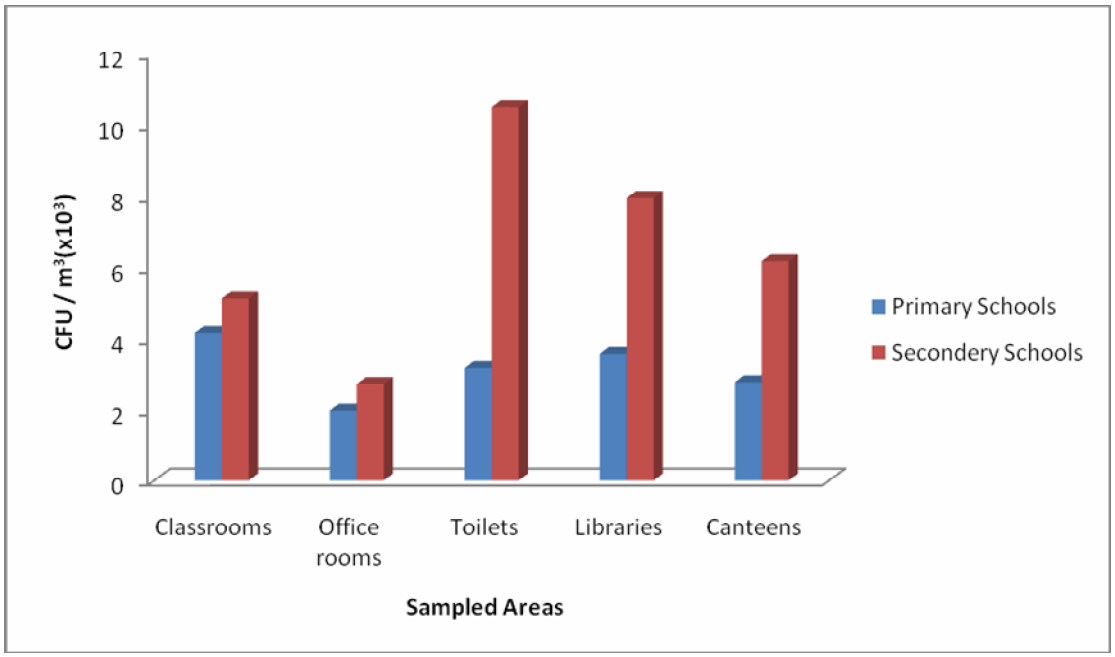


Figure.5

Winter (Bacteria)

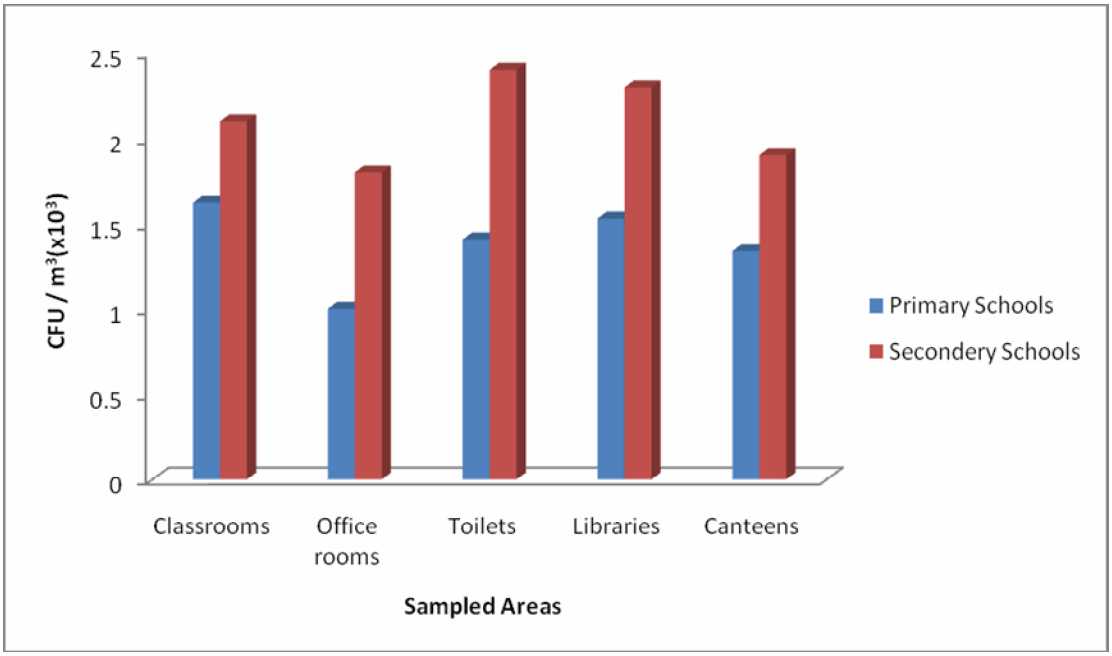
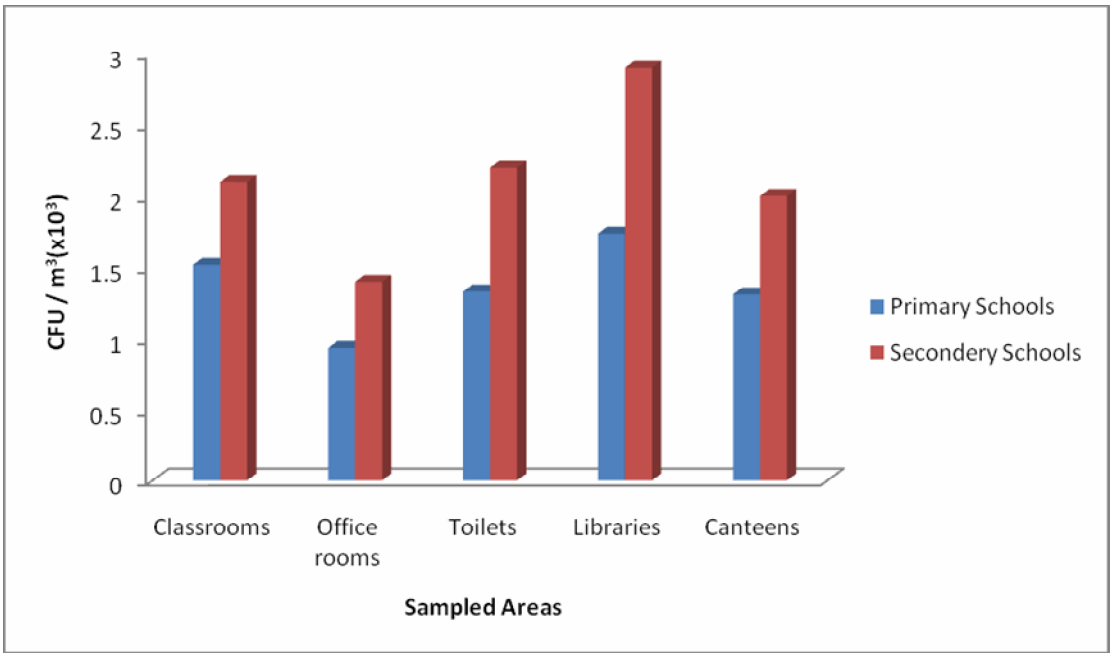


Figure.6

Winter (Fungi)



In secondary schools there is no remarkable increase in fungal concentration from morning to afternoons. The descending order of fungal concentrations are 2.4 $x10^3$ to 2.9 $x10^3$),classrooms(1.9 $x10^3$ to 2.1 $x10^3$), toilets(1.8 $x10^3$ to 2.2 $x10^3$) canteens(1.7 $x10^3$ to 2.0 $x10^3$), office rooms(1.2 $x10^3$ to 1.4 $x10^3$) respectively.(Figure-6).The identified gram positive bacteria were *Bacillus* species, *Staphylococcus species*(*Staphylococcus aureus*) and *Micrococcus* species. Some gram negative bacteria isolated and identified were *Pseudomonas* species, *Escherichia coli* and *Serratia* species. Fungal flora isolated from air of sampled areas showed dominant species like *Aspergillus* species(*Aspergillus flavus*), *Mucor* species, *Rhizopus* species, *Alternaria* species, *Penicillium* species and *Cladosporium* species.

Significance of the results related to research work

The order of prevalence of air microflora from highest to lowest in Classrooms ,Libraries, Toilets and office rooms. Facilities like good ventilation, cleaning of classroom every day, defects in planning of classroom and overburden of students per classroom are responsible for incidence of air microflora in indoor environments of the schools(Karwowska 2003) and (Toivola et al 2002). Toilet sanitation is negligible factor and not sufficient number of toilets are maintained as per with the number of pupils and staff could be reason for more microbial contamination of air in toilets. Most of the school canteens are located near to classroom building. Free outdoor air movement's leads to accumulation of gaseous emission from kitchen and those may find the entry into the classrooms depending of wind direction (Mostafa et al 2012). This may also deteriorates the indoor air quality of class rooms.

Student libraries are small in area, but placing of books almaras / racks was not properly planned and congested in nature. Being coastal environment, more relative humidity, cool conditions are conducive for the growth of more fungi than bacteria in libraries (Augustowska and Dutkiewicz 2006).

In case of office rooms, incidence of air microflora is less when compared to the other study areas for the sake of the aesthetic sense, office room (Principal/Head masters) are always maintained neat & clean (Stryjakowska Sekulska et al 2007). The room fresheners act as an disinfectants but due to the visit of people to office might be the reason for the occurrence of more air microflora in the afternoon than the morning.

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