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Indoor Fungal Flora In Library As Indicator Of Biopollution

M. C. Bhonde[1] and S. A. Kalkar[2]

[1]Department of Botany, Sant Gadge Maharaj Mahavidyalaya, Hingna Dist. Nagpur
[2]Department of Botany, Institute of Science, Nagpur (M.S.) -440001. India.
madhuribhonde@gmail.com surekhakalkar@gmail.com

Abstract
Aeromycoflora of indoor environment of two libraries at Nagpur was studied for the period of one year from Sept 2007 to Aug 2008 in order to study deterioration of paper through fungi. During investigation period from Site I (University library) total 66 aerospora types were observed of which 59 belongs to fungal spores and 7 to other type whereas from Site II (Vasantdada Poly.College Library) total 65 aerospora types were observed of which 58 belongs to fungal spores and 7 to other types. Total 21500 spore/$m^3$and 25590 spore/m^3 were observed in I and II site respectively. Other type includes Algal filaments, Hyphal fragments, Trichomes, Tracheideal elements, Insect parts, Pollen grains and remaining one form the group of unidentified spores. Mainly 4 major groups of fungi viz. Zygomycotina (0.89%, 0.44%), Ascomycotina (11.49%, 9.70%), Basidiomycotina (4.54%, 7.52%) and Deuteromycotina (62.92%, 58.79%) and other types (20.18%, 24.02%) were identified from Site I and Site II respectively. The most widely occurring spores in the order of dominance *were* Aspergilli followed *by Cladosporium, Alternaria, Curvularia, Chaetomium, Nigrospora and Helmithosporium.* The occurrence of fungal spores was correlated with weather parameters. An attempt was made to forecast atmospheric fungal concentration in library. The dominant aeromycoflora can be used as bioindicator of pollution in library.
Keywords: Aeromycoflora / indoor environment / Library /Nagpur /bioindicator / Aspergilli

Introduction

Now a days, air quality of indoor environments has becomes an important health concern. Aerobiology is defined as a discipline of investigation of aerial transport of biological materials Agashe *et. al* (2002). This increased awareness has made to concentrate the study of micro-organisms present in the air is important. The intramural study of mycoflora is of immense importance due to its role in the field of human allergy and plant diseases Ellis and Ellis (1985). Indoor fungal flora constitute a major part of aerospora along with bacteria, viruses, pollen grains and all other aerial plantation of plants and animal origin Begum *et. al* (2001). Libraries are one such indoor environment where working staff, university community, students and common public spent their time with consulting books, reference books, journals, news papers and other monumental works. This study also helpful and important due to microbial deterioration of material like paper, textiles, printed surfaces etc. Pelczar *et. al* (1993). Fungal spores are known to degrade the library materials like paper, leather, adhesive etc. Under the favourable condition these fungal spores grow and reproduce and biodegradation takes place. Along with affecting the library materials the airborne fungal flora may cause pulmonary health risk to the users and employs of the library. Due to low light intensity, humidity and lack of cleanliness the atmosphere of library is very suitable for the fungal growth. All these factors are responsible in the qualitative and quantitative increase of fungal flora inside the library. So, keeping in mind this point of view, a comparative study of intramural mycoflora of two libraries are taken into consideration. The proposed libraries are University Library Nagpur at (Site I) Central West part and Vasant Dada Poly. College Library Nagpur (Site II) from East part.

Material and Methods

The aerobiological survey was carried out by using rotorod air sampler for the period of one year i.e. September 2007 August 2008. To monitor the viable fungal spores present in the air of library environment air sampling was done by Rotorod air sampler. This air sampling device was developed by Perkins (1957) modified by Harrington (1959). It is a portable air sampler which was battery operated with a constant rotating speed of 2300 r.p.m. It rotates constantly two coated sticky brass rods about its axis at a constant high speed.

Collection of data: In the present investigation, adhesive transparent cellophane tape was cut into strips of approximate size which were applied on the sampling surface of the rods. The edges of the tape strips were trimmed to the width of the rods with sharp razor or blade. The cellophane tapes on the arms were coated with melted petroleum jelly.

Preperation of slides and **Identification**: After exposure the tape was carefully removed and placed on the glass slides and mounted in saffranin stained glycerine jelly for microscopic

observations. Identification was done with the help of standard literature, reference slides and books (Tilak, 1989, 2009 and 2010). Identified fungal spores have been tabulated and organized by following the classification of (Barnett, 1960).

Site I - University Library : University Library (RTMNU) is located in the Central -Western part of Nagpur. The library is as old as 100 years. The area is surrounded by agricultural land of Punjabrao Krishi Vidyapeeth, Maharajbagh Zoo, Agricultural College, shopping malls and Government offices.

Site II –Vasant Dada Polytechnic College Library: This College is situated in the Eastern part of Nagpur. The area is thickly populated as well as consists of residential buildings, independent bungalows, shopping towers, schools, colleges, parks, with avenue trees.

Meteorological Data: The record of monthly temperature, relative humidity was maintained by personal instrument (humidity and temperature counting instrument) and rainfall was noted from Sonegoan airport observatory of during the investigation period. The present aerobiological study was carried out for one year to find out the occurrence of allergen from air and their effect on the health of storage material of libraries and human beings.

Result and Discussion

During investigation period Total 47095 spore/m3 concentration was recorded from both the sites out of which 21500 spore/m^3 and 66 aerospora types were recorded from site I and 25595 spore/m^3 and 67 aerospora types were recorded from site II (Table 1). The contribution of taxonomic groups of fungi was Zygomycotina (0.63%), Ascomycotina (10.54%), Basidiomycotina (6.16%), Deuteromycotina (60.34%) and other types (22.30%) from both the sites (Table 2).

During study period, only 3 fungal spores *Circinella, Cunnighamella and Sclerospora* were recorded from Zygomycotina group. Ascomycotina group pertained to total 19 fungal forms during study period. *Chaetomium (*6.72%) which was dominant followed by *Hysterium, Didymosphaeria, Pleospora* and *Melanospora* (0.53%). The percentage contribution of *Chaetomium* was highest in the month of September (0.76%). The Basidiomycotina representated by *Ganoderma*, Smut spores, and Uredospores. During investigation period Aspergilli, *Cladosporium, Curvularia, Alternaria, Helminthosporium, Nigrospora* and *Chaetomium* were the dominant fungal spores during investigation period (Table 3).

Deuteromycotina was the major contributor of the aerospora including 34 types of fungal spores from both the sites. The major contributing genera were Aspergilli 2650 spore/m^3 and 2725 spore/m^3 (23.71%), *Cladosporium* 2370 spore/m^3 and 2520 spore/m^3 (21.57%), *Curvularia* 1920 spore/m^3 and 1625 spore/m^3 (15.64%), *Alternaria* 1365 spore/m^3 and 1590 spore/m^3 (13.03%), *Nigrospora* 1135 spore/m^3 and 1255% (10.54%), *Helminthosporium* 785 spore/m^3 and 845 spore/m^3 (2.77%) and *Chaetomium* 1445 spore/m^3 1435 spore/m^3 (12.70%) at both I and II sites respectively (Table3). During the investigation period *Chaetomium* (6.84% and 6.28%) was recorded from both the sites in the library environment. According to Bagool (1993) *Chaetomium* is known colonizer of paper in libraries. The concentration of Aspergilli group was recorded more in the month of September at both the Sites library respectively. Presence of *Alternaria* spores were also observed by Verma and Khare (1985).

Even in optimum temperature (20-30 ^{0}C) with increase in humidity from moderate to high and occasional rainfall or moist and damp conditions inside seems to favour the growth of these spores in library environment. Other types were recorded as total 10505 spore/m^3 (22.30%) at both the sites of which 4355/m^3 and 6150 /m^3 respectively (Table 2).

The highest catch of Aspergilli was observed in the month of March and the occurrence of *Cladosporium* was recorded more from April to August from both sites. The role of microbial activity in biodeterioration of library materials was reported by Kathapalia (1960). According to Verma and Khare (1987), and Paradkar *et. al.* (1980) Aspergillus, *Penicillum* and *Cladosporium* these three fungi are often implicated in the biodeterioration of library materials. According to Santra and Chanda (1989) spores of *Aspergillus* were found to occur in highest frequency in library environment. During rainy season the records of damages books were made by Patil (1992) at Jalgaon. According to Nielsson and Aas (1976) and Tario *et. al.* (1988) reported that microbes cause deterioration of books besides being responsible for allergy in sensitive human beings working in library environment.

Conclusion

Present one year study of air-sampling was particularly aimed at enlisting the fungal allergens in indoor environment of library at Nagpur. Present work was carried out with rotorod sampler, with varied efficiency. The results of all such methods may lead to some

solid outcome in order to combat with indoor air quality which has become a very serious problem today. This work presents information on the presence of fungal propagules in indoor air and its correlation with meteorological parameters and occurrence of allergy cases. Knowledge about these relationships is of interest on the one hand with regard to the possibility of predicting the presence of fungi in indoor locations from their characteristics, and on the other hand for the evaluation of control measures aimed at reducing the presence of fungi in intramural places and minimizing allergic or other health problems.

Total 14 fungal spore species were enlisted as allergenic after aerobiological studies and clinical testing. It was confirmed that predominant biopollutants were allergenic to occupants of these different indoor locations. The studies are also being helpful allergy patients, allergologists, agriculturists and workers in other related fields. Outcome of such studies can be used in the management of hygiene and health. To combat with the problems associated with allergens in air of indoor environment at various places following recommendations were made-

i. Outdoor allergens should be avoided by not allowing foot wares which are the major source of entry of such matter with other sources too. Proper ventilation, cleaning and air conditioning will also help in reducing the concentration of fungi in air

ii. To use good quality of air purifiers. Air filters should be changed frequently/regularly. Cleanliness should be maintained. Use of disinfectants, Vacuum cleaning recommended.

iii. Use of antimicrobial chemicals like Shirlan, Thymol crystals, Potassium lactate, acetaldehyde, ammonia and others resists or inhibit the growth of fungi and to maintain suitable temperature (about 17-28^0 C) and moderate humidity.

iv. Maintenance of AC/HVAC/etc to control airborne infections and use of pest control methods regularly Moisture control is found to be important in improving air quality, Occupants/servants/ workers in such environment should maintain hygiene. They can use clean clothes/ uniform particularly at workplaces, while working they should use nasal filters or at least cover the face in order to restrict entry of biopollutants.

v. Periodical clinical testing for respiratory ailments of occupants/ workers can be recommended.

Table 1: Percentage contribution of aerospora at two different sites of library (Site I and Site II) during the study period from September 2007 to August 2008

Sr. No	Name of Sites	Total concentration of airspora	Percentage
1	University Library RTMNU(Site I)	21500spore/m^3	45.65%
2	Vasant Dada Poly. College Library (Site II)	25595spore/m^3	54.34%
	Total	47095 spore/m^3	99.99%

Table 2: Percentage contribution of Fungal groups from two different sites of library (Site I and Site II) during the study period from September 2007 to August 2008

Sr.No.	Fungal group	Site I	Site II	Total spore/m^3	%
1	Zygomycotina	185 spore/m^3	115 spore/m^3	300 spore/m^3	0.63%
2	Ascomycotina	2480 pore/m^3	2485 spore/m^3	4965 spore/m^3	10.54%
3	Basidiomycotina	980 spore/m^3	1925 spore/m^3	2905 spore/m^3	6.16%
4	Deuteromycotina	13500 spore/m^3	14920 spore/m^3	28420 Spore/m^3	60.34%
5	Other Types	4355 spore/m^3	6150 spore/m^3	10505 spore/m^3	22.30%
	Total	21500 spore/m^3	25595 spore/m^3	47095 spore/m^3	

Table 3: Percentage contribution of dominant fungi from two different sites of library (Site I and Site II) during the study period from September 2006 to August 2007

Sr. No.	Dominant fungal spores	Site I	Site II	Total	Percentage
1	Aspergilli	2650	2725	5375	23.71%
2	*Cladosporium*	2370	2520	4890	21.57%
3	*Curvularia*	1920	1625	3545	15.64%
4	*Alternaria*	1365	1590	2955	13.03%
5	*Chaetomium*	1445	1435	2880	12.70%
6	*Nigrospora*	1135	1255	2390	10.54%
7	*Helminthosporium*	785	845	630	2.77%

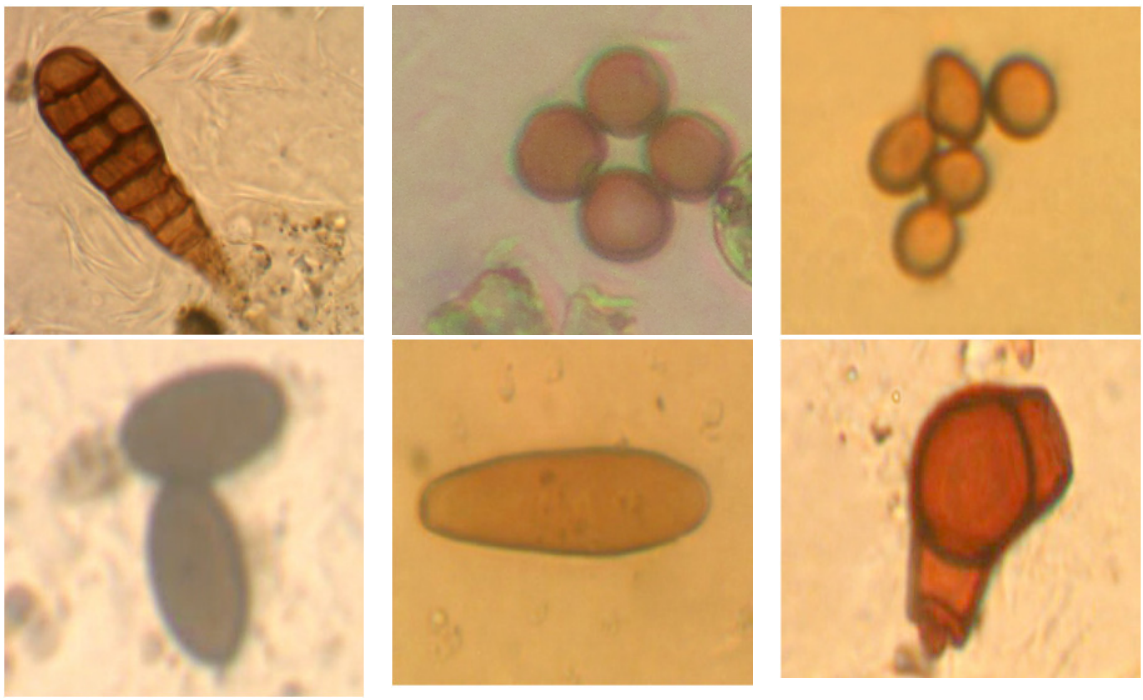
Table 4: Monthly concentration of airborne fungal spores and meteorological parameters during study period from September 2007 to August 2008 from Site I and Site II

Site I University Library

Sr. No	Months	Fungal spores/m³	Average temp (°C)	Relative Humidity (%)
1	**Sept 2006**	**1825 /m3**	**20.2**	**64%**
2	Oct 2006	1780 /m³	22.3	65%
3	Nov 2006	1720 /m³	24.7	61%
4	Dec 2006	1695 /m³	24.5	61%
5	Jan 2007	1850 /m³	26.3	58%
6	Feb 2007	1815 /m³	26.5	60%
7	Mar 2007	1730 /m³	29.6	59%
8	Apr 2007	1750 /m³	31.3	64%
9	May 2007	1675 /m³	28.9	47%
10	June 2007	1870 /m³	25.7	61%
11	July 2007	1895 /m³	27.2	60%
12	Aug 2007	1920 /m³	27.0	65%

Site II: Vasant Dada Polytechnic College Library

Sr. No	Months	Fungal spores/m³	Average temp (°C)	Relative Humidity (%)
1	Sept 2006	1915	27.67	73
2	Oct 2006	2020	26.8	65
3	Nov 2006	1995	22.6	62.5
4	Dec 2006	2050	21.65	61.5
5	Jan 2007	2275	24.6	48.5
6	Feb 2007	2300	24	49.5
7	Mar 2007	2025	27.5	54.5
8	Apr 2007	2140	31.1	51
9	May 2007	2085	32.8	53
10	June 2007	2275	32.3	58
11	July 2007	2265	26.7	77.5
12	Aug 2007	2250	27.8	80.50



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