RESEARCH ARTICLE

INDOOR AIR QUALITY ASSESSMENT BY INVESTIGATION OF AIRBORNE FUNGI

Gayathri N, Kamtekar A and Bagkar P

Department of Biotechnology, Bhavan's College, Munshi Nagar, Andheri (West), Mumbai 400 058

ABSTRACT

Airborne particles are a major cause of respiratory ailments such as allergies, asthma, and pathogenic infections of the respiratory tract in man. Continued exposure to indoor airborne mold and/or mycotoxin causes many multi-system adverse human health effects. Students and teachers spend a major portion of the day in their educational institutions. The present study is aimed at isolating and identifying fungal flora in the dust samples of various indoor environments in Bhavan's College, Andheri (West), Mumbai. The samples collected were inoculated onto Potato Dextrose Agar (PDA) and Sabouraud's agar (SAB) and incubated at room temperature for seven days. Factors such as temperature, relative humidity of the sampling site and the time of exposure were noted. Macroscopic and microscopic analyses of the colonies were carried out. The level of contamination of each site was expressed in percentage of the total number of fungal species obtained from the study. The observations indicate that the indoor fungal concentrations are highly variable as the samples collected from the chosen sampling sites harbor fungi of diverse species. Future investigations are needed to further examine the effects of these exposures on the related health problems and to devise methods to improve the indoor air quality.

Keywords : Air borne fungi, air quality, fungal flora, Bhavan's college

INTRODUCTION

Indoor air is almost never free from allergens, bacteria, dust and fungal spores which originate due to various natural and anthropogenic activities (Al-Doory *et al.,* 1980; Lacey, 1981). Qualitative assessments of indoor fungi are valuable for assisting the evaluations of air quality and health hazards. Quantitative evaluation of fungal concentrations and exposure thresholds aid in evaluating and monitoring the impact of fungi on human health (Shelton *et al*., 2002).

Corresponding Author

Email:bagkarpratik@yahoo.com

Fungal spores, which are ubiquitous, are associated with adverse and diverse health effects ranging from allergies to asthma (Chapman, 2006; Kurup *et al*., 2000). More than 80 genes of fungi have been associated with respiratory tract ailments (Horner *et al*., 1995). Organic dust in the air includes live or dead micro-organisms and allergens in addition to other antigens. Individuals may get sensitized to such bio-aerosols due to repeated continuous exposure.

College is a locale where there is an incessant stream of students and staff who spend more than half of their waking hours in the premises. Inspite of regular and continuous movement of people, the surroundings is always kept clean and neat. Bhavan's College is situated in the Bharatiya Vidya Bhavan's Campus at Munshi Nagar, Andheri (West). The campus of the college, covering a vast area of 42 acres, is one of the biggest in Mumbai. The college is surrounded by

a wide variety of trees, ornamental plants and shrubs. The objective of the present study was to assess the indoor air quality in terms of aeromycoflora in selected areas of the college. The outcome of the study would be a comprehensive resource that can be used for comparative purposes in future studies monitoring indoor air quality in the premises.

MATERIAL AND METHODS

Sampling Location

Samples were collected from six different collection sites - all within the campus of Bharatiya Vidya Bhavan, Andheri (W), Mumbai. The sample sites were chosen keeping in mind the wide variation in their characteristics. The sites were labeled as S1 to S6 as follows: Biotech classroom (S1), Library (S2), Canteen (S3), Biotechnology lab work place (S4), Biotechnology lab preparation room (S5), Botanical garden (S6). S1 is a confined entity which is well ventilated. S2 is repository of books and research journals which are prone to biodeterioration. S3 is a crowded site of day-long activity relating to food. S4 and S5 are aseptically maintained whereas S6 has a lot of greenery. The sampling conditions were 75-80% relative humidity and a temperature of 27-30°C.

Sampling methods

Dust and air samples were collected from the above mentioned locations. Dust samples were collected using sterile cotton swabs. The collected dust samples were immediately transferred to 10 ml of sterile saline, from which 0.1ml was surface spread on Potato Dextrose Agar (PDA) and Sabouraud Agar (SAB) plates individually. Air samples from all the above mentioned sampling locations were collected using Gravity Sedimentation and Solid Impaction methods to isolate fungal spores present in the air. Sterile Petri-plates containing PDA and SAB media were horizontally placed and kept open for 5 minutes for Gravity sedimentation . Hi-Air air sampler system, at a suction rate of 280 L/min, was used to collect the air samples for 3 minutes by solid impaction technique. The agar plates and strips were incubated at room temperature for 7 days and observed regularly for growth of organisms. The fungal growth on the plates was examined macroscopically for color and appearance of the colony and microscopically using lacto-phenol cotton blue. The isolates were maintained on agar slants for future studies. The number of colonies recorded is expressed as colony forming units (CFU) and calculated as follows:

$$CFU/m^3 = \frac{\text{Number of colonies obtained}}{40 \times \text{sampling time in minutes}}$$

$$\text{Relative Distribution} = \frac{\text{No of colonies of genera}}{\text{Total no. of colonies of all genera}} \times 100$$

RESULTS & DISCUSSION:

The plates and strips were observed for seven days for growth of fungal colonies. Visible fungal colonies were observed in all the media 72 hrs of incubation at room temperature. The fungal species obtained in the study were *Aspergillus niger, Fusarium oxysporum, Penicillium ulaiense, Alternaria sp.* and *Rhizopus stolonifer* (Table 1, Figure 1). The fungal diversity as determined by both the methods are represented in figures 2 and 3 and the relative distribution of the observed fungal genera is shown in figure 4.

Table 1: Fungal diversity in the six sampling sites

Sr. No.	Sampling Sites	Observed Fungal Species				
		Aspergillus niger	*Alternaria sp.*	*Fusarium oxysporum*	*Penicillium ulaiense*	*Rhizopus stolonifer*
1.	S1	+	-	-	-	-
2.	S2	+	-	-	-	-
3.	S3	+	-	-	+	+
4.	S4	-	-	-	-	-
5.	S5	+	-	-	-	-
6.	S6	+	+	+	+	+

+ indicates presence and – indicates absence of fungi.

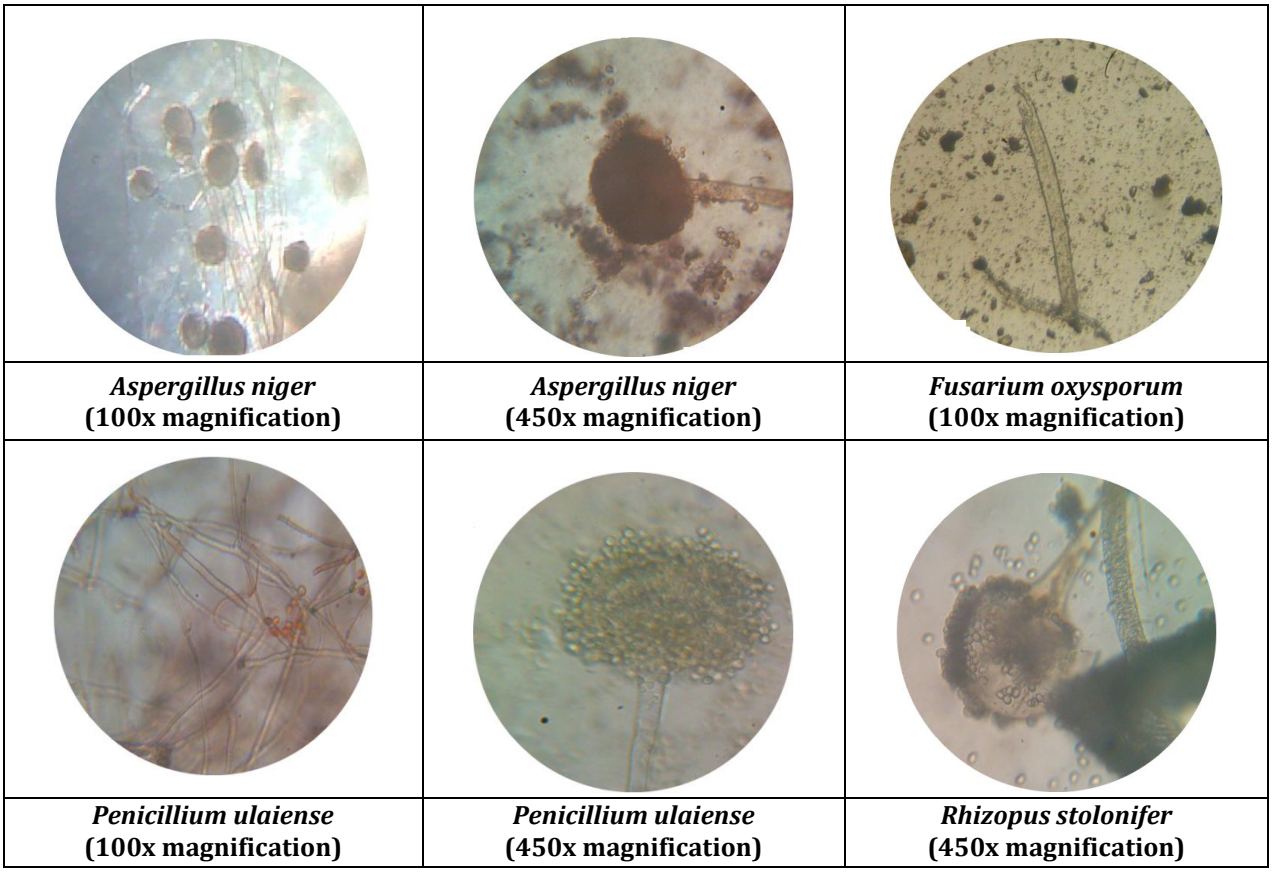

Figure 1: Photomicrographs of the observed Aeromycoflora

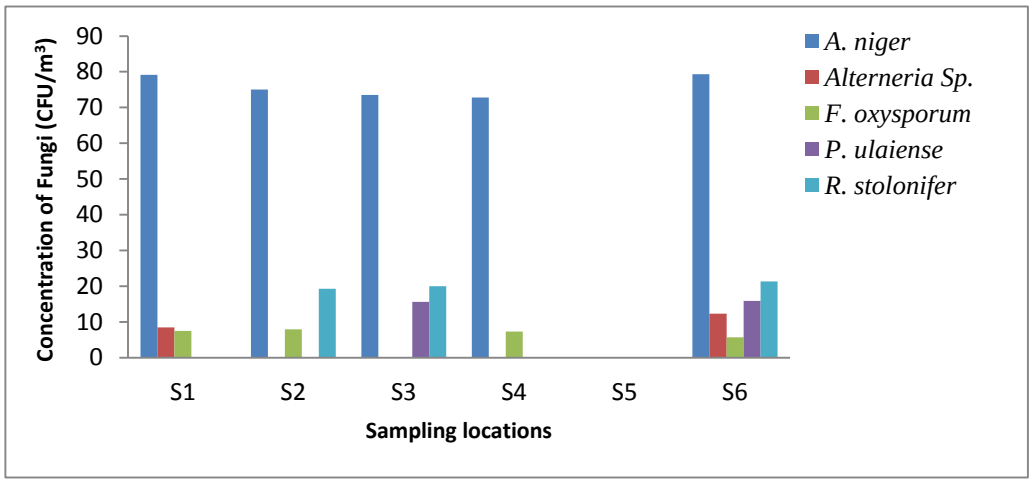

Figure 2: Prevalence of air borne fungi as determined by Solid Impaction method

The ascomycete fungi are the most abundant type in the present study, *Aspergillus niger* being the most abundant fungal species observed in five of the six sampling sites.

Indoor air quality assessment, monitoring and maintenance are important because populations spend a substantial amount of time within the confines of buildings. Sampling requires that measured volume of air containing a representative fraction of the same kind of particles as in ambient air is collected (Burge, 1992). The samples for the study were taken from six different sites which were diverse in nature.

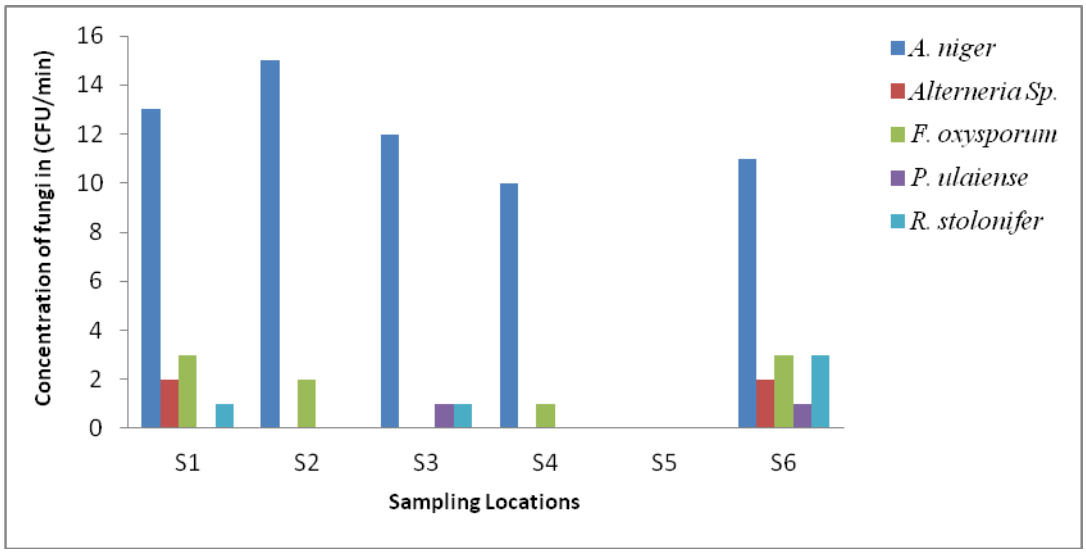

Figure 3: Prevalence of air borne fungi as determined by Gravity Sedimentation method

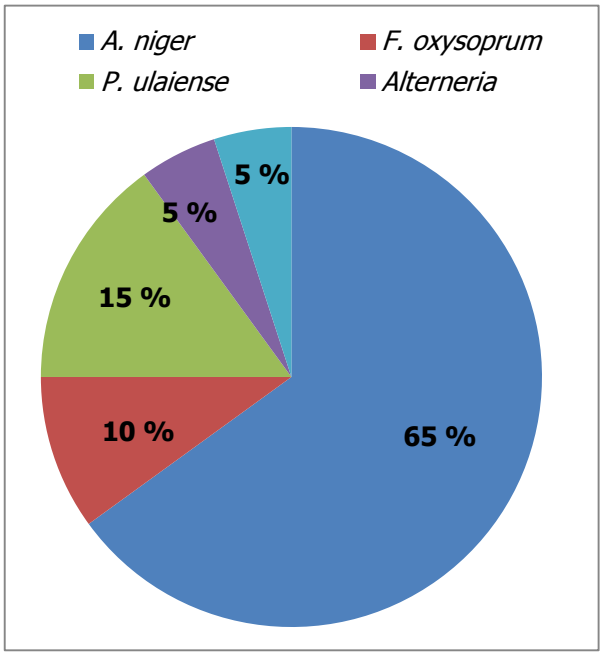

Figure 4: Relative distribution frequency of air-borne fungi.

The Biotechnology classroom is on the first floor of the new building and has very good ventilation whereas the Botanical garden is highly frequented by people throughout the day. This is clearly reflected in the prevalence of elevated spore levels in the latter. Age and type of Building are important predictors of indoor fungal spore concentrations (Fairs *et al.,* 2010) and increased temperature has been associated with elevated indoor fungal spore levels (Ren *et al*., 2001). High prevalence of mycoflora in the canteen and botanical garden is observed in this study. The Biotechnology Lab and the preparation rooms are aseptically maintained using disinfectants and these locations show the presence of no or minimal fungal spores. Where no indoor source of fungal spores is evident, indoor concentrations of individual spore types typically reflect outdoor concentrations and seasonal patterns. (Shelton *et al.,* 2002).

Based on the health hazards they may cause, the fungi isolated in this study can be classified as A and B. *Aspergillus* and *Fusarium* are grouped under Class A which includes fungi or their metabolites that are highly hazardous to health and hence require immediate attention if present in dwellings. *Alternaria* and *Penicillium*, on the other hand, are included under Class B, which may cause allergic reactions to occupants if present indoor over a long period. *A. niger* causes black mold disease in certain fruits and vegetables and some strains of *A. niger* have been reported to produce potent mycotoxins called ochratoxins (Abarca *et al*., 1994). Inhalation of large amounts of spores can be deadly due to serious lung disease aspergillosis. *F. oxysporum*, a soil inhabitant that degrades lignin and complex carbohydrates (Christakopoulos *et al*., 1996; Rodriguez *et al*., 1996),

are also beneficial plant endophytes. In the current study, this species is noted only in the botanical garden. *Alternaria* species and *Penicillium ulaiense* are known plant pathogens and common allergens in humans growing indoors. The former readily cause opportunistic infections in immune-compromised people. *Rhizopus stolonifer,* commonly found on bread surfaces from where it takes its nutrients, is a plant pathogen.

CONCLUSION:

Aerobiological sampling attempts to both identify and quantify allergenic particles in the air. The present study has clearly demonstrated the prevalence of *A. niger*. Only one of the six sampling sites in the study, the botanical garden, shows the presence of five different varieties of fungal spores. Persistent dampness may be the reason for this. It was seen that the vegetative forms and spores of all the isolated fungi cannot withstand 1:200 dilution of local disinfectants and hence can be effectively used against fungal contaminants. Seasonal variations of the air-mycoflora is planned to be studied.

REFERENCES:

Abarca M, Bragulat M, Castellá G, Cabañes F (1994) Ochratoxin A production by strains of *Aspergillus niger* var. niger. *Appl Environ Microbiol*, 60 (7): 2650-2652.

Al-Doory Y, Domson JM, Howard WA, Sly, RM (1980) Airborne fungi and pollens of the Washington D.C. metropolitan areas. *Ann. Allergy,* 45: 360-367.

Burge H (1992) Monitoring for airborne allergens. *Ann. Allergy,* 69: 9-18.

Chapman MD (2006) Challenges associated with indoor molds: health effects, immune response and exposure assessment. *Med Mycol*, 44: S29-S32.

Christakopoulos P, Nerinckx W, Kekos D, Macris B and Claeyssens M (1996) Purification and characterization of two low molecular mass alkaline xylanases from *Fusarium oxysporum* F3. J. Biotechnol, 51: 181-189.

Fairs A, Wardlaw AJ, Thompson JR, Pashley CH (2010) Guidelines on ambient intramural airborne fungal spores. *J Investig Allergon Clin Immunol*, 20 (6): 490-498.

Horner W, Helbling EA, Salvaggio JE, Lehrer SB (1995) Fungal allergens. *Clin. Microbiol, Rev*. 8: 161-179.

Kurup VP, Shen HD, Banerjee B (2000) Respiratory fungal allergy. *Microbes infect*, 2: 1101-1110.

Lacey J (1981) The aerobiology of conidial fungi. In biology of Conidial Fungi. Ed. G.T. Cole and Kendrick, Academic Press, New York pp. 373-415.

Ren P, Jankun TM, Belanger K, Bracken MB, Leaderer BP (2001) The relation between fungal propagules in indoor air and home characteristics. *Allergy*, 56: 419-424.

Rodriguez A, Perestelo F, Carnicero A, Regalado V, Perez R, De la Fuente G and Falcon MA (1996) Degradation of natural lignins and lignocellulosic substrates by soil-inhabiting fungi imperfecti. FEMS *Microbiol. Ecol*, 21: 213-219.

Shelton BG, Kirkland KH, Flanders WD, Morris GK (2002) Profiles of airborne fungi in buildings and outdoor environments in the United States. *Appl Environ Microbial*, 68: 1743-1753.

Cite this article as: Gayathri N, Kamtekar A and Bagkar P (2013) Indoor air quality assessment by investigation of airborne fungi. *Int. J. of Life Sciences,* Special Issue A (1): 47- 51.