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Assessment Of The Indoor And Outdoor Mycoflora Of Schools In Jabalpur City, India

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Abstract: *A survey for viable fungal spores in the indoor and outdoor environments of 60 school buildings in Jabalpur city was carried out with two-stage Anderson sampler from January to December, 2010. Air was sampled monthly at different five zones. 75 fungal spore identified belonging to 23 genera were observed. Out of which the class wise percentage contribution as; zygomycotina (3.22%), ascomycotina (0.83%), deuteromycotina (94.22%) and unidentified spp. (1.73%) was recorded. Deuteromycotina fungi were most dominant to the total fungal flora. Among them Cladosporiumcladosporieds (1666.2 CFU/m^3) followed by Alternariaalternata (981.34 CFU/m^3) and Cladosporiumherbarum (896.62 CFU/m^3) &Penicilliumchrysogenum (896.62 CFU/m^3). Maximum incidence was observed from February (1595.6 CFU/m^3) followed by December (1320.2 CFU/m^3) and November (1235.5 CFU/m^3). Seasonally there was quantitative aerospora change in the incidence was observed. The total indoor and outdoor fungal spore counts have been statistically no significantly difference (t=0.45; P>0.05) using STATA 11.0 base data analysis with Student 't' test.*
Keywords*: Airborne fungi, Indoor & Outdoor, Jabalpur, Schools.*

I. Introduction

Aeromycological survey in indoors and outdoors considerably helped to locate the source, its identification, concentration and seasonal variation. Such information, however, provides basic data for the treatment of sensitive individuals suffering from allergy. Many airborne fungal spores are responsible for allergic diseases[1].

The type and concentration of fungi in buildings differ depending upon the building maintenance, material use in the building, furniture and carpeting, ventilation system, extend of indoor plants, indoor temperature, relative humidity and other abiogenic and biogenic factors including environmental parameters[2-4]. The role of mold concentrations in building environments is important from a clinical point, of view and significant with regards to building hygiene and bio deterioration[5].

More recently, schools have become the focus of indoor air quality (IAQ) issues. Schools are locations where children spend a large amount of their time, second only to time spent indoors at home[6].

The objectives of the present work were comparative study on the occurrence of airborne viable fungal spores present in the indoor and outdoor atmospheres of different schools in Jabalpur.

II. Material and Methods

Aerobiological Sampling- For the purpose of environmental survey of airborne fungi in schools of Jabalpur city, the city was divided into five different zones viz. North, South, Central, East and West Zones to cover maximum schools. Individual zones cover 12 wards so that all the zones comprised of total 60 wards. One year survey was planned for the estimation of fungal flora in different seasons in schools environment. Air sampling was carried out using Anderson two-stage sampler on (SDA) Sabouroud's Dextrose Agar Media in the schools to determine the viable fungal spore's concentration[7].

Isolation and Identification-The exposed petriplates were incubated at 27^{o}C±1^{o}C and developed colonies were examined after 3-5 days based on their colony characteristics, colour and shape of the colonies developed. Fungal were identified macroscopic and microscopic characters. The identification of different microbes was confirmed by slide culture techniques and consulting standard literature[8-12].

Statistical Analysis- We analyzed the data obtained by Student't' test using the software STATA (version 11.0). Microsoft office Excel 2007 had been used for other statistical analysis and graphical representation.

III. Results

The chief purpose of the present work was to study the monthly incidence of airborne fungi, seasonal variation and influence of meteorological parameters in indoor and outdoor fungi of Jabalpur city. During the study period, a total number of 10,173 fungal colony forming units (CFU/m^3)were isolated from both indoors and outdoors of the schools, of which indoor environments contributed to 51.05% and the outdoor environments

to 48.95%. Incidence of airborne fungal species, their CFU/m^3 contribution and annual occurrence recorded in each environment of the schools are given on table- 1.

In qualitative analysis, altogether 75 fungal species belonging to 23 genera were isolated from both indoor and outdoors. Among these, 6 species of 2 genera belong to zygomycotina, 2 species of 1 genera belong to ascomycotinaand 67 species of 20 genera belong to deuteromycotina were isolated and identified from indoor and outdoors respectively. Among the total number of identified fungal species, *Aspergillus* was represented by 15 species viz., *A. candidus, A. clavatus, A. flavipes, A. flavus, A. fumigatus, A. glaucus, A. nidulance, A. niger, A. parasiticus, A.* sp., *A. tamari, A. terreus, A. ustus, A. versicolor* and *A.wentii* followed by 10 species of *Alternaria*viz., *A. alternata, A. brassicicola, A. citri, A. dianthi, A. longipes, A. soloni, A.* sp., *A. tamari, A. tenius* and *A. Triticiae*,6 species of *Penicillium* viz., *P.* sp., *P. chrysogenum, P. citrinum, P. funiculosum, P. nigricans* and *P. notatum*and 5 species of *Curvularia* viz., *C. brachyspora, C. lunata, C. pallencens, C.* sp. and *C. tinius*fig.-1.

Monthly incidence of fungal spores with the month of February (16.32%) contribution of the maximum spore in indoor air. Other months, especially December (15.09%) and October (11.25%) were recorded more. Less number of fungal spores is recorded in the month of August (2.86%). The month of February (15.02%) contribution of the maximum spore in outdoor air. Other months, especially November (13.53%) and December (10.77%) were recorded more. Less number of fungal spores is recorded in the month of April (3.54%). The highest concentration in indoor environments (5192.63 CFU/m^3) and lowest concentration in outdoor environments (4980.83 CFU/m^3) fig.-2.

The comparison of the fungal flora recovered from indoor and outdoor revealed no major differences. All the zones put together, 59 from indoors and 65 outdoors were recorded. The analysis revealed that the difference of mean concentration of fungi in 2010 between indoor and outdoor is not significantly different ($t=0.45;P>0.05$).

Based on comparative analysis of the occurrence of dominant fungal species with their contribution in indoor and outdoorof the schools, *Cladosporiumcladosporieds* (16.38%) contributed maximum in both indoor and outdoor followed by *Alternariaalternata* (9.65%) and *Cladosporiumherbarum* (8.81%). Data of the annual occurrence revealed that *Cladosporiumcladosporieds* was the highest with (17.40%) in indoors and (15.31%) in outdoors, and *Alternariaalternata* recorded higher in indoor (11.56%) than outdoor (7.65%).

Seasonal occurrence of fungal spores in indoor and outdoor is given in, which shows that the winter season contributed the maximum (46.02%) followed by summer (32.63%) and rainy (21.34%) in indoor. And in outdoor the winter (44.64%) followed by summer (34.44%) and rainy (20.90%). Over all, winter contributed the maximum fungal spores.

In the present study, zone wise colony forming units (CFU/m^3) concentration of fungal species was also analysed, out of total aeromycoflora, North zone (2058 CFU/m^3), South (1896 CFU/m^3), Central (1945 CFU/m^3), East (2178 CFU/m^3) and west zone (2097 CFU/m^3) were recorded. East zone fungi showed maximum contribution to the total fungal flora followed by West zone and North zone were recorded. South zone fungi showed minimum contribution to the total fungal flora.Class wise percentage contribution as; zygomycotina (3.22%), ascomycotina (0.83%), deuteromycotina (94.22%) and unidentified spp. (1.73%) was recorded fig.-3.

In Jabalpur, the highest fungal spore concentrations were detected in the winter season when the temperature and humidity provide the optimum conditions for the development of fungi. The decrease in spore concentrations in the rainy season may be related to the, which are not optimum conditions for the growth of fungi.

Table-1, Showing the CFU/m^3 and their % contribution to the totalnumber of Fungal spores in Indoor and Outdoor of Schools

FUNGAL ISOLATES	**INDOOR**		**OUTDOOR**	
	CFU/m^3	**%**	**CFU/m^3**	**%**
(A) ZYGOMYCOTINA				
Mucormucedo	70.6	1.36	74.13	1.49
*Mucor*sp.	14.12	0.27	10.59	0.21
Rhizopusnigricans	42.36	0.82	31.77	0.64
Rhizopusoryzae	17.65	0.34	17.65	0.35
*Rhizopus*sp.	24.71	0.48	14.12	0.28
Rhizopusstolonifer	7.06	0.14	3.53	0.07
(B) ASCOMYCOTINA				
Chaetomiumglobosum	14.12	0.27	49.42	0.99
*Chaetomium*sp.	7.06	0.14	14.12	0.28
(C)DEUTEROMYCOTINA				
Alternariaalternata	600.1	11.56	381.24	7.65
Alternariabrassicicola			7.06	0.14
Alternariacitri	7.06	0.14	7.06	0.14
Alternariadianthi	7.06	0.14		
Alternarialongipes	60.01	1.16	52.95	1.06

Alternariasoloni	7.06	0.14		
*Alternaria*sp.	24.71	0.48	49.42	0.99
Alternariatamari			7.06	0.14
Alternariatenius	7.06	0.14	3.53	0.07
Alternariatriticiae			3.53	0.07
Aspergillus candida			7.06	0.14
Aspergillusclavatus	10.59	0.2	14.12	0.28
Aspergillusflavipes			24.71	0.5
Aspergillusflavus	130.61	2.52	155.32	3.12
Aspergillusfumigatus	120.02	2.31	165.91	3.33
Aspergillusglaucus	28.24	0.54	35.3	0.71
Aspergillusnidulance	56.48	1.09	31.77	0.64
Aspergillusniger	409.48	7.89	451.84	9.07
Aspergillusparasiticus			3.53	0.07
*Aspergillus*sp.	7.06	0.14		
Aspergillustamari			3.53	0.07
Aspergillusterreus	45.89	0.88	38.83	0.78
Aspergillususstus	17.65	0.34	3.53	0.07
Aspergillusversicolor	56.48	1.09	49.42	0.99
Aspergilluswentii			3.53	0.07
*Bispora*sp.			3.53	0.07
Cladosporiumcladosporoides	903.68	17.4	762.48	15.31
Cladosporiumelatum	17.65	0.34	3.53	0.07
Cladosporiumherbarum	458.9	8.84	437.72	8.79
Cladosporiumsphaeruspermum	10.59	0.2	7.06	0.14
Curvulariabrachyspora	3.53	0.07		
Curvularialunata	271.81	5.23	285.93	5.74
Curvulariapallencens	10.59	0.2	31.77	0.64
*Curvularia*sp.			24.71	0.5
Curvulariatinius			3.53	0.07
*Drechslera*bicolor			7.06	0.14
*Drechslera*haweiiensis	109.43	2.11	14.12	0.28
*Drechslera*sp.	52.95	1.02	49.42	0.99
Epicoccumnigrum	24.71	0.48		
*Epicoccum*sp.	3.53	0.07	7.06	0.14
Fusariummoniliformae	24.71	0.48	81.19	1.63
Fusariumoxysporium	84.72	1.63	112.96	2.27
Fusariumsoloni			7.06	0.14
*Fusarium*sp.			24.71	0.5
Helminthosporiumoryzae	3.53	0.07	17.65	0.35
*Helminthosporium*sp.	17.65	0.34	7.06	0.14
Monodictysfluctuata	10.59	0.2	10.59	0.21
Nigrosporaoryzae	21.18	0.41	24.71	0.5
*Nigrospora*sp.	24.71	0.48	42.36	0.85
Nigrosporaspaerica	7.06	0.14		
*Penicillium*sp.	35.3	0.68	52.95	1.06
Penicilliumchrysogenum	437.72	8.43	458.9	9.21
Penicilliumcitrinum	109.43	2.11	158.85	3.19
Penicilliumfuniculosum			3.53	0.07
Penicilliumnigricans	458.9	8.84	317.7	6.38
Penicilliumnotatum	45.89	0.88	31.77	0.64
Phomaherbarum			7.06	0.14
*Phoma*sp.	3.53	0.07		
Rhizoctaniabatalicolor	21.18	0.41	45.89	0.92
*Scopulariopsis*sp.	31.77	0.61	28.24	0.57
*Scytalidium*sp.	74.13	1.43	67.07	1.35
Stachybotrysatra	3.53	0.07		
*Stemphylium*sp.	7.06	0.14		
Torulaellisi			21.18	0.43
*Torula*sp.	7.06	0.14		
*Trichoderma*sp.	3.53	0.07		
Trichodermaviridae	7.06	0.14	21.18	0.43
Unidentified spp.	91.78	1.77	84.72	1.7
Grand Total	5192.63	100	4980.83	100

IV. Discussion

Theaeromycoflora of the 60 schools that were taken in to consideration for study had a distinct structural and location difference. In case of the schools building is more than two decades old without proper ventilation and maintenance. Thus in the process most of the class rooms remain humid for several months in the year, representing a typical sick building syndrome.

Singh and her coworkers[13] recorded 39 fungal species, among which *Cladosporium*ranked first followed by *Aspergillus* and *Penicillium* in Delhi. Agashe and Anuradha[14] also opined the dominance of

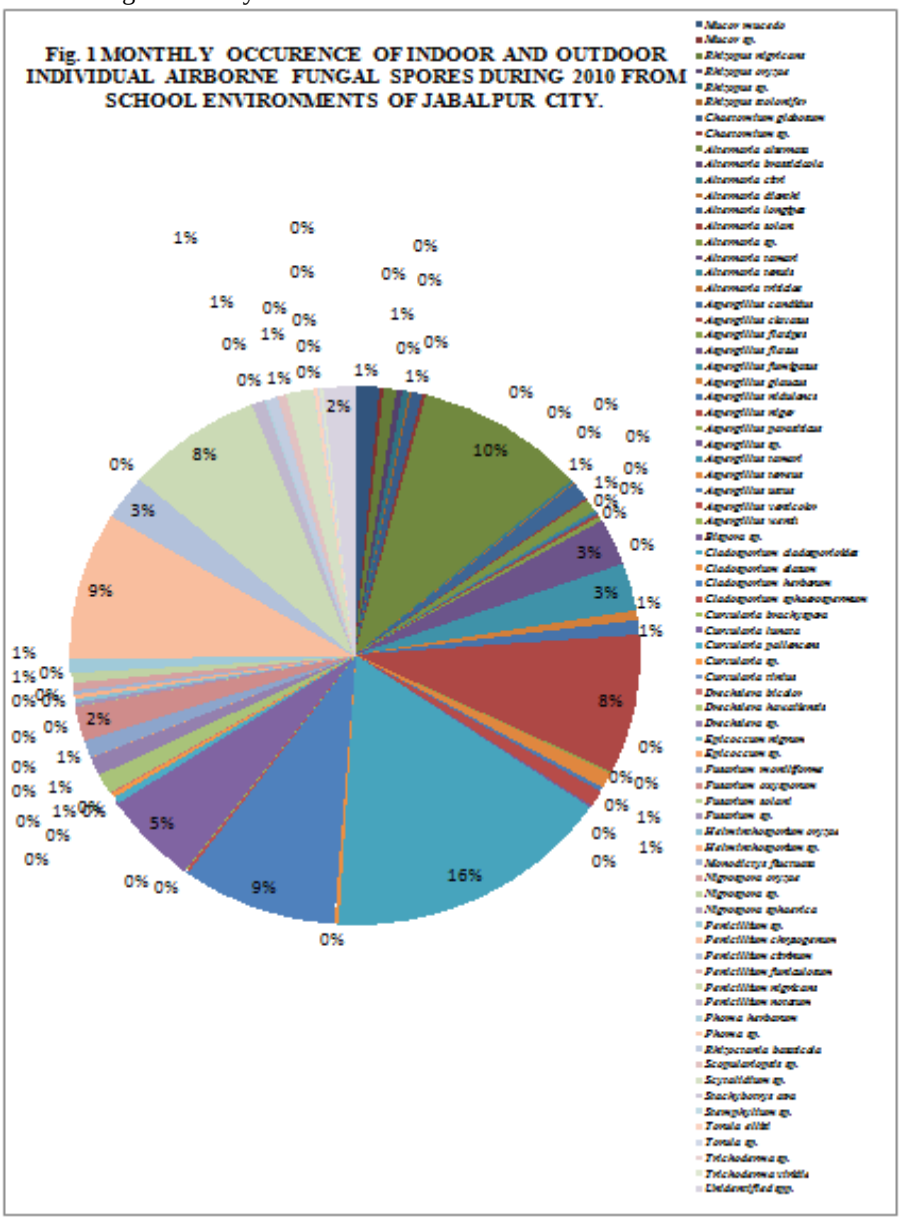
Cladosporium followed by *Aspergillus* and *Alternaria* during their work in Bangalore. Cellulose degrading fungi, *Trichoderma* and *Chaetomiumglobosum* recorded in the present study are well known fungi to be available in the books and papers[14,15]. *Aspergillusniger* and *Aspergillusfumigatus* cause respiratory infection leading to bronchopulmonary aspergillosis[16,17]. *Aspergillusflavus*, a well known fungus for production of aflatoxin, causes asthma in workers of indoor environments[18]. *Penicillium*spp. are known for allergencity and are the cause allergic alveolities[19]. Although*Alternariaalternata* was not abundantly recorded, it is accounted asa human allergens for sporosisinducer, an agent for hay fever and other pathologies[20].

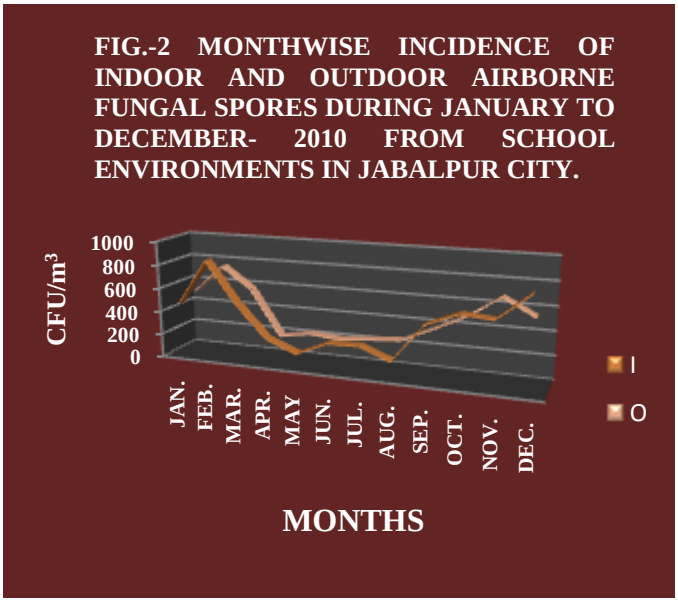
This study revealed exhibition of marked seasonal periodicity by the fungal propagules in the atmosphere of Jabalpur city.

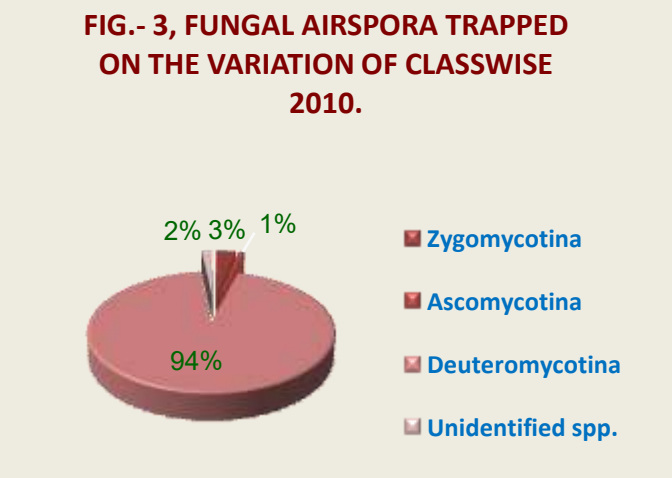
Peak monthly spore count was observed in February followed by October to December count was the least in April and August months more similar monthly profile has been reported by Rao and Mallaiah[21]. Peak counts of fungal spores were observed in December in Thailand[22], two peaks in February- March and October-November in Malayasia[23].

V. Conclusion

The one-year air monitoring in schools of Jabalpur revealed presence of rich fungal flora throughout the year. *Alternaria, Aspergillus, Curvularia, Cladosporium* and *Penicillium* were the dominant fungal spore groups. All dominant spores are reportedly allergic though the threshold concentration of these spores to become the potential allergens is not yet defined.







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