

MONTHLY VARIATION IN AIR BORNE FUNGAL PROPAGULES OF DHAKA METROPOLITAN CITY

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Abstract

In an average, 6648 fungal colony forming units were settled within five minutes on one square meter area at morning and evening from the air of Dhaka Metropolitan city during February, 2013 to January, 2014. Among the identified fungi, *Aspergillus* was one of the most dominating genera in all the stations during the above mentioned period. The second was *Cladosporium* followed by *Penicillium*, *Alternaria*, *Curvularia*, *Fusarium*, *Pestalotia*, *Colletotrichum*, *Tricho-derma*, *Rhizopus*, *Nigrospora*, *Chaetomium*, *Syncephalastrum*, *Arthrinium* and *Bipolaris*. In the dry winter (December-February), *Alternaria*, *Bipolaris*, *Cladosporium*, *Curvularia* and *Drechslera* showed its peak. In the rainy monsoon (June - September), *Aspergillus*, *Fusarium*, *Penicillium*, *Pestalotia* and *Trichoderma* showed their peak.

Introduction

The atmosphere contains air borne viruses, bacteria, protozoa, pollen grains, different propagules and vegetative cells of algae, fungi, lichens, bryophytes and pteridophytes. Among these, fungal spores play a significant role in childhood asthma, allergies, mycotoxicity, biodeterioration and infections of humans and animals^(1,2). Air borne fungi are considered to act as indicator of the level of atmospheric bio-pollution⁽³⁾. Numerous plant diseases such as rust, smut, mildew, leaf spot, etc. are caused by air borne fungi⁽⁴⁾.

Presence of fungal spores in the air varied from season to season remarkably because of the variation of weather conditions. Warm and dry weather favors the development, sporulation and dispersal of conidia of *Cladosporium*, *Epicoccum* and *Alternaria* and the greatest daily concentration of conidia of these genera usually occurs at morning and evening. It also varies with the vegetation types around the study area. The greatest concentration of *Alternaria* spores was noted at the harvesting time⁽⁵⁻⁷⁾. Surveys on these aspects have been made in different countries of the world following impaction or sedimentation method⁽⁸⁻¹¹⁾. The sedimentation method is still quite popular in India and some other countries. The method is cheap and simple and is also recommended by Polish Standard ^(12,13).

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In Bangladesh, study on aerobiology and air borne bio-particle has been done and 12068 fungal colonies were recorded from indoor and outdoor of the Dhaka University Campus⁽¹⁴⁻¹⁵⁾. But no investigation on air borne fungi has been carried out particularly in Dhaka Metropolitan City where 14.5 million people breathe. Therefore, the present investigation was undertaken to study the monthly distribution pattern of mycoflora in the air of the Dhaka Metropolitan city.

Materials and Methods

Five different locations of the Dhaka Metropolitan city (23°42'0" N and 90°22'30" E) were selected for the sampling of air borne fungi. These locations were Sher-e Bangla Agricultural University, Gulistan, Dhaka Medical College, Sadar ghat and DOHS Mohakhali. Culture plates containing PDA medium were exposed for 5 minutes in the morning and evening at monthly intervals. In this investigation, gravity plate sampling method⁽¹¹⁾ was followed for isolation of air borne fungi at the selected locations. The sampling was done during 12 months starting from February, 2013 to January, 2014.

During the selected day of each month, about 20 ml sterile PDA culture media were poured into each pair of Petri plates (9 cm). To check bacterial contamination, a drop of 50% lactic acid was added with each plate under Laminar air flow. Each pair of Petri plates was sealed with scostep. At each selected location, 60 Petri plates containing sterile PDA media were exposed horizontally for five minutes on a 1.5 m tripod stand. After that, the exposed Petri plates were sealed with scostep and taken into the laboratory and incubated at $25 \pm 2^\circ\text{C}$ for five days. The fungal colonies developed on the culture media were examined and identified with the help of standard literature⁽¹⁶⁻²⁰⁾.

Per cent abundance and frequency of the fungal colonies were calculated by adopting the formula of Pathak⁽²¹⁾. Temperature and relative humidity of the selected months at the sampling sites were determined by a digital hygro-thermometer (Mextech-1). Monthly precipitation of the Dhaka city was also collected from the official website of Bangladesh Meteorological Department.

Results and Discussion

Viable fungal spores or mycelial fragments of saprophytes and facultative parasites those settled on culture media formed colonies on PDA medium. A total of 6648 colonies were recorded from 400 culture plates which were exposed for five min from the five different sampling points. Four hundred culture plates make 5.73 m² sampling area, therefore, on an average, ca. 2762 colony forming units (CFU) per square meter settled during five min exposure. Out of this, 66 colonies in the morning and 90 colonies in the evening were sterile mycelia (Table 1). The per cent frequency of sterile fungal colonies were 2.0 and 2.6% in the morning and the evening, respectively (Table 1). Mycelia sterilia

were 9.19% of the total fungi settled on PDA media at the selected tea garden during the summer was reported by Sharma⁽¹¹⁾. Fewer non-spore forming fungi were also found in the present study might be due to the fact that some fungi need specific culture medium and/or physical stimulation for spore formation and some others are rigorously non-spore forming. Moreover, fungal sporulation highly depends on weather condition.

Table 1 shows that the spore forming colonies were distributed into 16 genera viz. *Alternaria*, *Arthrinium*, *Aspergillus*, *Bipolaris*, *Chaetomium*, *Cladosporium*, *Colletotrichum*, *Curvularia*, *Drechslera*, *Fusarium*, *Nigrospora*, *Penicillium*, *Pestalotia*, *Rhizopus*, *Syncephalastrum* and *Trichoderma* under the class Zygomycetes, Ascomycetes and Deuteromycetes. In accordance with Sharma⁽¹¹⁾, anamorphic fungal genera were recorded as a dominant fungal group.

In the morning, the highest number of *Aspergillus* colonies (184) was recorded in the month of September followed by August (169). Least number of colonies (15) of the fungus was observed in the month of January. Similar trend was also noticed in the evening. Maximum count of *Aspergillus* colony (208) was observed in September followed by August (193). The lowest number (14) of *Aspergillus* colonies was recorded in the evening of December 2013 (Table 1).

Among the identified fungi *Aspergillus* (28.8%) was one of the most dominating genera at all the months in both morning and evening air of the city (Table 1). Its collective per cent abundance was 15.8 in *Cladosporium*, followed by *Penicillium* (12.8), *Alternaria* (6.7), *Curvularia* (6.5), *Fusarium* (5.3), *Pestalotia* (3.9), *Drechslera* (2.9), *Trichoderma* (2.3), *Colletotrichum* (2.3), *Rhizopus* (2.1), Sterile mycelia (2.0), *Nigrospora* (1.9), *Arthrinium* (1.7), *Chaetomium* (1.57) and *Bipolaris* (1.7). The abundance of *Syncephalastrum* was the lowest (1.5).

In the evening *Aspergillus* was found in the highest per cent frequency (30.7) which was followed by *Cladosporium* (18.1), *Penicillium* (11.5) *Alternaria* (6.4), *Curvularia* (5.0), *Fusarium* (4.3), *Pestalotia* (3.2), *Colletotrichum* (2.9), Sterile mycelia (2.6), *Trichoderma* (2.3), *Rhizopus* (2.3), *Drechslera* (2.0), *Nigrospora* (1.9), *Chaetomium* (1.8), *Syncephalastrum* (1.7) and *Arthrinium* (1.4). The abundance of *Bipolaris* was the lowest (1.4). This result was in agreement with similar variations that have been reported from India ⁽¹¹⁾. The highest per cent abundance of *Aspergillus* (41.35) in the air of Darjeeling tea garden was followed by *Mucor* (10.34), *Penicillium* (9.19), *Rhizopus* (8.04), *Trichoderma* (5.74), *Curvularia* (3.44), *Nigrospora* (2.29) and *Cladosporium* (1.14) was observed. The variation in aeromycoflora and its abundance with the present study might be due to the difference of weather condition, population concentration and vegetation between the study areas.

Pathak⁽²¹⁾ from Madhya Pradesh, India found abundance of *Aspergillus* and *Penicillium* which were 32 and 9%, respectively by using particle sampler. The abundances of these two fungi were also quite higher in the present investigation.

Table 1. Monthly air borne fungal colonies and climatic factors during February, 2013 to January, 2014 at different sampling sites of Dhaka Metropolitan city.

Fungal genera	Collective number of air borne fungi in 12 months (Morning)												Total colonies	Frequency (%)
	Feb.	Mar.	Apr.	May	June	July	Augt.	Sept.	Oct.	Nov.	Dec.	Jan.		
<i>Alternaria</i>	27	11	22	23	8	7	15	28	16	23	27	14	221	6.7
<i>Arthrinium</i>	3	10	0	6	3	7	0	5	6	7	5	5	57	1.7
<i>Aspergillus</i>	28	26	85	94	108	162	169	184	32	20	19	15	942	28.8
<i>Bipolaris</i>	2	2	0	7	2	4	4	0	5	10	14	5	55	1.7
<i>Chaetomium</i>	4	9	3	0	0	5	5	2	5	8	4	5	50	1.57
<i>Cladosporium</i>	77	24	6	6	4	3	5	18	61	68	108	136	516	15.8
<i>Colletotrichum</i>	5	6	6	7	5	11	0	5	7	11	9	2	74	2.3
<i>Curvularia</i>	24	17	15	17	35	25	22	18	6	8	15	12	214	6.5
<i>Drechslera</i>	8	2	3	4	8	4	11	4	13	12	17	9	95	2.9
<i>Fusarium</i>	7	8	9	12	18	25	32	31	6	11	9	4	172	5.3
<i>Nigrospora</i>	0	13	12	7	2	0	5	8	4	6	3	2	62	1.9
<i>Penicillium</i>	52	36	17	61	6	23	27	89	11	16	42	38	418	12.8
<i>Pestalotia</i>	10	21	18	0	0	17	5	13	14	13	13	4	128	3.9
<i>Rhizopus</i>	4	10	9	7	13	3	3	7	8	5	0	1	70	2.1
<i>Trichoderma</i>	3	4	0	7	4	12	18	6	4	9	1	8	76	2.3
<i>Syncephalastrum</i>	0	5	8	10	5	6	5	1	6	1	0	5	52	1.5
Sterile mycelium	7	13	9	5	7	0	3	3	6	3	6	4	66	2.0
Total colonies	261	217	222	273	228	314	329	422	210	231	292	269	3268	100
Relative humidity (%)	52	46	74	71	83	67	65	69	58	56	54	61		
Temperature (°C)	18	25	28	28	30	27	28	26	25	23	18	17		
Precipitation (mm)	0	6.7	8.3	5.9	16	19	16	13	2	1.3	1.7	0		

(Contd.)

(Contd.)

Fungal genera	Collective number of air borne fungi in twelve months (Evening)												Total colonies	Frequency (%)
	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.		
<i>Alternaria</i>	18	22	24	12	11	15	17	21	14	19	16	27	216	6.4
<i>Arthrinium</i>	3	6	0	6	5	4	4	9	5	0	4	2	48	1.4
<i>Aspergillus</i>	42	38	68	87	113	171	193	208	43	33	14	28	1038	30.7
<i>Bipolaris</i>	3	2	0	0	6	5	1	0	4	12	10	3	46	1.4
<i>Chaetomium</i>	7	5	12	0	6	8	4	4	6	4	1	5	62	1.8
<i>Cladosporium</i>	95	19	11	5	0	0	18	22	61	109	113	159	612	18.1
<i>Colletotrichum</i>	4	6	5	0	9	11	5	7	9	13	22	8	99	2.9
<i>Curvularia</i>	13	9	7	4	11	31	27	15	14	5	22	12	170	5.0
<i>Drechslera</i>	6	2	7	3	7	4	9	2	0	11	14	3	68	2.0
<i>Fusarium</i>	6	12	5	9	11	28	37	17	3	8	5	4	145	4.3
<i>Nigrospora</i>	0	5	4	1	3	0	11	6	6	9	14	6	65	1.9
<i>Penicillium</i>	47	26	16	42	14	21	19	77	26	13	38	51	390	11.5
<i>Pestalotia</i>	12	3	5	0	0	7	22	18	9	8	12	14	110	3.2
<i>Rhizopus</i>	9	5	7	4	2	3	8	5	4	6	9	16	78	2.3
<i>Trichoderma</i>	11	3	0	12	12	8	13	7	5	8	0	6	85	2.5
<i>Syncephalastrum</i>	0	3	8	2	0	4	7	13	5	0	16	0	58	1.7
Sterile mycelium	14	3	5	7	0	10	9	0	17	12	8	5	90	2.6
Total colonies	290	169	184	194	210	330	404	431	231	270	318	349	3380	100
Relative humidity (%)	56	49	76	75	86	69	68	72	60	59	59	64		
Temperature (°C)	19	26	28	31	29	30	26	24	25	23	19	17		
Precipitation (mm)	0	6.7	8.3	5.9	16	19	16	13	2	1.3	1.7	0		

Sedimentation method does not permit exact quantitative determination. Some earlier observations reported that results of sedimentation method are usually higher than numbers obtained with the use of air samplers⁽¹²⁾. However, data collected by sedimentation method allow the drawing of correct conclusions on types of fungi present in the air and can give a rough approximation of fungal concentrations.

Maximum number of *Penicillium* (12.79) colonies were recorded in the month of September (89) followed by May (61) in the morning. Least number (6) of the fungus was observed in the month of June. Maximum count of *Penicillium* colony (77) was observed in September followed by January (51) in the evening. Least number (13) of the fungus was observed in the month of November (Table 1). The highest number of *Penicillium* colonies were isolated from Gulistan in the morning (98) and evening (104). The lowest (74) was recorded from Sadarghat in the morning and DOHS (65) in the evening.

Pathak⁽²¹⁾ recorded *Aspergillus* in the highest per cent frequency (95.85) followed by *Penicillium* (84.80), *Alternaria* (83.30), *Cladosporium* (54.15), *Curvularia* (41.70), *Rhizopus* (41.66), *Fusarium* (39.15), *Mucor* (33.35), *Epicoccum* (33.3), *Phoma* (29.15), *Nigrospora* (21.35) and *Trichoderma* (16.65). The variation in aeromycoflora and its frequencies with the present study might be due to the variation of meteorological parameters of the study areas and methods used in the investigations.

The total number of *Cladosporium* colonies was 516 and 612 in the morning and evening, respectively. *Cladosporium* showed its peak in December morning (108) and evening (113). The lowest (3) was recorded in July morning (Table 1). The highest number of *Cladosporium* colonies were isolated from the Sher-e Bangla Agricultural University (118) in the morning and Gulistan (142) in the evening. In both the times the lowest (84, 98) was recorded from DOHS (Table 2).

The present investigation showed variations in sedimentation of fungi on culture media among the locations. Number of colonies of *Aspergillus*, *Fusarium*, *Penicillium*, *Pestalotia* and *Trichoderma* showed its peak and near during warm rainy monsoon (June-September). *Alternaria*, *Bipolaris*, *Cladosporium*, *Curvularia* and *Drechslera* showed its peak and near to peak during dry winter (December-February) (Table 1).

Cladosporium was the fungal genus most correlated with meteorological parameters. This might be attributed to the size and nature of conidia. *Cladosporium* produces dry conidia in chains easily carried through air. Therefore, dispersion of *Cladosporium* spores was more influenced by meteorological parameters than *Alternaria* spores⁽²²⁾. In accordance with the present study Levetin⁽²⁴⁾ reported that members of dry-air spores (*Cladosporium*, *Alternaria* and *Curvularia*) were found in greatest abundance in the atmosphere characterised by low humidity generally during warmer afternoon hours.

The total number of *Alternaria* colonies was 221 and 216 in the morning and evening, respectively. *Alternaria* showed its peak in the month of September in the morning (28)

Table 2. Number of air borne fungal colonies in the morning and evening at different sampling sites of Dhaka Metropolitan city during February, 2013 to January, 2014.

Fungal genera	Collective number of air borne fungal colonies at five different sampling sites													
	Morning							Evening						
	SAU	Gul	DMC	S.Ghat	DOHS	Total	SAU	Gul	DMC	S.Ghat	DOHS	Total		
<i>Alternaria</i>	38	57	43	48	35	221	37	52	43	48	36	216		
<i>Arthrinium</i>	9	15	18	9	6	57	5	9	17	7	10	48		
<i>Aspergillus</i>	172	242	178	213	137	942	187	268	198	210	175	1038		
<i>Bipolaris</i>	22	8	10	9	6	55	23	5	6	8	4	46		
<i>Chaetomium</i>	7	10	12	15	6	50	9	14	18	12	9	62		
<i>Cladosporium</i>	118	104	97	113	84	516	106	142	137	129	98	612		
<i>Colletotrichum</i>	16	11	14	24	9	74	21	18	22	26	12	99		
<i>Curvularia</i>	33	39	68	42	32	214	24	40	48	36	22	170		
<i>Drechslera</i>	26	12	18	23	16	95	28	10	12	10	8	68		
<i>Fusarium</i>	28	36	34	42	32	172	16	32	28	40	29	145		
<i>Nigrospora</i>	11	14	14	13	10	62	9	22	16	10	8	65		
<i>Penicillium</i>	76	98	82	74	88	418	72	104	68	81	65	390		
<i>Pestalotia</i>	24	32	14	28	30	128	14	22	28	21	25	110		
<i>Rhizopus</i>	15	25	10	11	9	70	12	18	16	20	12	78		
<i>Trichoderma</i>	10	18	13	25	10	76	12	21	15	23	14	85		
<i>Syncephalastrum</i>	10	13	5	9	15	52	10	11	8	17	12	58		
<i>Sterile mycelium</i>	16	12	10	18	10	66	18	26	14	15	17	90		
Total colonies	631	746	640	716	535	3268	603	814	694	713	556	3380		

SAU = Sher-e Bangla Agricultural University, Gul = Gulistan, DMC = Dhaka Medical College Hospital, S.Ghat = Sadar Ghat and DOHS = DOHS Mohakhali.

and January in the evening (27). The lowest (7) was recorded in July morning and evening June (11) (Table 1). The highest number of *Alternaria* colonies were isolated from the Gulistan (57) in the morning and evening (52). In both the times lowest (35, 36) was recorded from DOHS (Table 2).

Table 2 showed that in morning a total of 3268 fungal colonies were isolated out of which maximum number of colonies was *Aspergillus* (942) followed by *Cladosporium* (516) and *Penicillium* (418). The lowest number of fungal colonies were recorded in case of *Chaetomium*. In the evening a total of 3380 colonies were recorded from five different locations. Out of 3380, the highest number was recorded in case of *Aspergillus* (1038) followed by *Cladosporium* (612) and *Penicillium* (390). *Bipolaris* species was the lowest in number (46). The highest number of fungal colonies were recorded in Gulistan area in both the cases of isolation which was followed by Sadarghat (Table 2).

Out of five selected sites maximum number of fungal colonies were recorded from Gulistan (746) which was followed by Sadar ghat (716), Dhaka Medical College (640), Sher-e Bangla Agricultural University (631) and DOHS Mohakhali (535) in the morning. In evening the highest was also recorded from Gulistan (814) followed by Sadar ghat (713), Dhaka Medical College (694), Sher-e-Bangla Agricultural University (603) and DOHS (556). Slightly higher number of fungal colonies were recorded in evening (3380) than morning (3268). This might be due to clum and quite weather condition in the morning (Table 2). This is in agreement with the report from India by Kotwal *et al.*⁽²³⁾

Among the fungi, found in the present investigation *Alternaria*, *Aspergillus*, *Chaetomium*, *Cladosporium*, *Curvularia*, *Fusarium*, *Penicillium* and *Rhizopus* were reported as pathogenic to plants and/or human and strongly allergenic to human. *Bipolaris*, *Colletotrichum*, *Drechslera* and *Pestalotia* were reported as only plant pathogens^(1,4,23). The present study contributes to our knowledge of air borne spores in the Dhaka city. Regular monitoring of air borne fungi can be helpful in the prevention of fungal allergic diseases in the city.

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