International Journal of Applied Research 2017; 3(3): 166-169


**ISSN Print:** 2394-7500
**ISSN Online:** 2394-5869
**Impact Factor:** 5.2
IJAR 2017; 3(3): 166-169
www.allresearchjournal.com
Received: 20-01-2017
Accepted: 21-02-2017

**Mohture VM**
Rashtrapita Mahatma Gandhi Arts and Science College, Nagbhid Dist. Chandrapur. Maharashtra, India

**Kalkar SA**
Government Institute of Science, R. T. Road, Nagpur. Maharashtra, India

**Correspondence**
**Mohture VM**
Rashtrapita Mahatma Gandhi Arts and Science College, Nagbhid Dist. Chandrapur. Maharashtra, India

# Aeromycological investigation in the atmosphere of Nagpur, Maharashtra (India)

## Mohture VM and Kalkar SA

**Abstract**
Fungi are ubiquitous in nature and found almost in all season. Fungal spores are released in the environment when suitable condition is available. Aeromycological study has great importance as air has its direct impact on human beings. The present study was emphasized on occurrence of different fungi during two consecutive years from February 2008 to January 2010. The total number of fungal colonies was calculated to assess the total aerospora of Nagpur by using Potato Dextrose Agar (PDA). Total 21 different fungi were identified during the study period. *Aspergillus niger* (9.87%, 6.34%), *Aspergillus flavus* (2.80%, 1.61%), *Aspergillus fumigatus* (3.73%, 2.27%), *Alternaria alternata* (17.48%, 18.45%), *Helminthosporium sativum* (2.02%, 3.50%), *Helminthosporium* spp. (3.50%, 4.26%), *Fusarium oxysporum* (7.46%, 7.41%), *Curvularia lunata* (15.38%, 15.33%), *Cladosporium cladosporioides* (10.88%, 10.88%), *Cladosporium* spp. (8.08%, 10.79%) and *Nigrospora* spp. (3.73%, 5.08%) were predominantly found during first and second year respectively. Maximum numbers of colonies were identified during winter seasons (42.11%, 46.93%) followed by rainy (33.88%, 29.99%) and summer season (24.01%, 23.08%). The occurrence of fungi was correlated with meteorological factors.

**Keywords:** Fungi, PDA, Meteorological factor

## Introduction
The study of aeromycoflora of particular region provides the clear view about interaction of fungal spores in the form of disease on plants as well as occurrence of allergy in human being. If the specific fungal allergen is identified, the most effective therapy is specific hyposensitization, as complete avoidance is impossible [1]. So, it is of great clinical value to know the identity of the dominant airborne fungi in a particular area, as the fungal population varies from one place to another. Fungal spores are one of the dominant components in the air and on account of their dimensions (several micrometers), they are classed as a bioerosols [2]. Their occurrence is dependent on environmental conditions. The release of fungal spores in the atmosphere is dependent on the wind [3-5]. Size of fungal spores fascilates them to cover enormous distances with air currents [6]. Fungi live as saprophytes on organic material or as parasites (mainly plant pathogens), so the majority of fungal spores in the air outdoors come from farms, forest stands and decomposing plant matter [7]. The report from all over the world now clearly showed that fungal spores play a significant role in the etiology of respiratory allergic disorders. When sensitive individual inhaled the aerial fungal spores, allergic symptoms are noticed. Fungal spores lack chlorophyll therefore they live as a saprophyte or parasite in nature. In order to identify the dominant fungi, an aeromycology investigation has been conducted in the atmosphere of Nagpur.

## Material and Methods
**Aeromycological survey:** The present aeromycological survey was carried out at two different sites of Nagpur viz. semiurban (Wanjra) and urban area (DR. Panjabrao Deshmukh Krishi Vidyapeeth, Nagpur) for a period of two year from February 2008 to January 2010.

**Collection of data:** The petri plate containing PDA were exposed in the air at both the sites. After exposing petri plates were left at room temperature for 7 to 8 days until the colonies matured. The slides were prepared by using lacto phenol cotton blue stain and then were identified by colony morphology and characteristics of sporulation.

The identification of the colonies was done with the help of standard literatures

**Meteorological data:** The meteorological data was obtained from Meteorology Department, College of Agriculture PDKV Nagpur. The record of daily and monthly temperature, relative humidity and rainfall was maintained during the investigation period.

**Result and discussion**

The present study was carried out for consecutive two years i.e. from February 2008 to January 2010 at two different Sites- semiurban (Site I -Wanjra) and urban area (Site II-PDKV area) of Nagpur city. Total 21 different fungi were identified (Table 1) viz. *Aspergillus niger* (9.87%, 6.34%), *Aspergillus flavus* (2.80%, 1.61%), *Aspergillus fumigatus* (3.73%, 2.27%), *Aspergillus* spp. (2.33%, 0.95%), *Alternaria alternata* (17.48%, 18.45%), *Alternaria* spp. (0.78%, Nil), *Helminthosporium sativum* (2.02%, 3.50%), *Helminthosporium* spp. (3.50%, 4.26%), *Fusarium oxysporum* (7.46%, 7.41%), *Fusarium* spp. (1.24%, 1.32%), *Curvularia lunata* (15.38%, 15.33%), *Curvularia* spp. (0.78%, 0.09%), *Rhizopus* spp. (2.41%, 3.41%), *Mucor* spp. (1.01%, 1.14%), *Cladosporium cladosporioides* (10.88%, 10.88%), *Cladosporium* spp. (8.08%, 10.79%), *Penicillium* spp. (1.71%, 1.70%), *Trichoderma* spp. (0.47%, 0.85%), *Torula* spp. (0.54%, 1.23%), *Nigrospora* spp. (3.73%, 5.08%) with unidentified group (3.83%, 3.37%) during two consecutive years. Some fungi predominantly occurred throughout the investigation period.

Maximum numbers of colonies were identified during winter seasons (42.11%, 46.93%) followed by rainy (33.88%, 29.99%) and summer season (24.01%, 23.08%) (Fig.1). Occurrence of more number of colonies during the winter indicated that fungi were very specific to temperature and humidity. *Aspergillus* (including all species) were found to be dominant at both the sites during the two consecutive year of study. *Cladosporium cladosporioides* was the dominant species at both the localities. In Orissa, India *Cladosporium cladosporioides* was dominant species followed by *Pestalotia* sp., *Alternaria alternata*, *Aspergillus awamori* and *Curvularia lunata* [8]

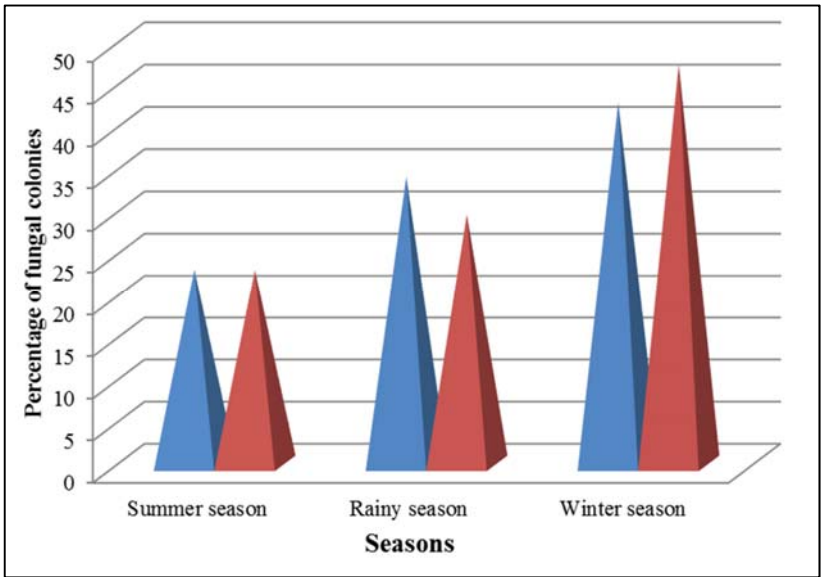


**Fig 1:** Seasonal occurrence of various fungi on PDA during Feb 2008-Jan 2010 from Nagpur.

During this aeromycological study at Nagpur, a total of 2344 colonies (1287 during February 2008 to January 2009 and 1057 during February 2009 to January 2010) were recorded. Fungi showed monthly, seasonal and annual variations in their concentration. The fungal colonies were maximum during February 2008 to January 2009 as compared to those of February 2009 to January 2010. *Aspergillus* (including *A. niger*, *A. flavus*, *A. fumigatus*, *Aspergillus* spp.) was dominant followed by *Cladosporium* (*Cladosporium cladosporioides*, *Cladosporium* spp.), *Alternaria* (*Alternaria alternata*, *Alternaria* spp.), *Curvularia* (*Curvularia lunata*, *Curvularia* spp.). Dominance of *Aspergillus* over *Cladosporium* was reported by various researchers in different parts of India [9-13]. The second most frequent genus was *Cladosporium* in the total aerospora. *Cladosporium* genera contributed maximum to the total aerospora of outdoor environment [14-19]. *Cladosporium cladosporioides* was the most dominant species followed by *Alternaria*, *Aspergillus*, *Curvularia*, *Drechslera*, *Fusarium*, *Epicoccum* and *Penicillium* [20]. *Cladosporium* had a highest median value of culturability (38% and 33% for indoor and outdoor, respectively) followed by *Aspergillus*/*Penicillium* (9% and 2%) among predominant genera of fungi [21].

In the homes of allergic patients specially in Autumn registered the highest presence of *Aspergillus*, *Cladosporium* and *Penicillium* in indoor environment [22]. *Alternaria* was more frequent in summer. While in the outdoor environment, *Penicillium* was more abundant in winter and *Aspergillus* in summer. The largest numbers of isolations were of *Cladosporium* and *Penicillium* during all four seasons, indoors as well as outdoors. The most prevalent species were: *Alternaria alternata*, *Cladosporium herbarum*, *Cladosporium cladosporioides*, *Aspergillus niger* and *Penicillium chrysogenum*.

In indoor and outdoor air of different residential houses in Tekirdag City (Turkey) *Penicillium* (28.61%), *Cladosporium* (16.08%) and *Alternaria* (15.98%) was the most frequent fungal genera. *Penicillium* (40.61%) and *Cladosporium* (15.92%) were the dominant genera of indoor

air while *Alternaria* (20.62%) and *Penicillium* (19.71%) were isolated most frequently from outdoor air [23]. In USA increase in concentration of atmospheric $CO_2$ brought leaf changes which were associated with increased spore production by *Alternaria alternata*, a ubiquitous allergenic fungus [24].

In Yokohama, Japan *Cladosporium* spp. recorded as predominant one, followed by *Alternaria* spp. and *Penicillium* spp. The fungal concentration in outdoor air peaked in September [25]. Rao *et al.* [26] from Karachi, Pakistan recorded 10 fungal species viz., *Alternaria solani*, *Aspergillus candidus*, *A. flavu*s, *A. fumigatus*, *A. nige*r, *A. terreus*, *A. wentii*, *Curvularia clavata*, *Drechslera dematioidea* and *Penicillium notatum* by exposing six plates of culture media (3 Czapek- Dox Agar and 3 Potato Dextrose Agar) for 5-10 minutes.

Two main periods showing high percentage of fungal colonies with peak were the month of October to January and June to September at both Sites. This indicated that winter season and rainy season favored the occurrence of fungi. The fungal population was not found to be homogenous throughout the year and thus showed seasonal variations.

The *Curvularia* and *Alternaria* were dominant pathogenic genera recorded throughout the period of investigation. *Cladosporium* was found more during winter and rainy season and also in some months of summer. Maximum concentration of *Alternaria* was noted during December and lowest during April.

Maximum concentration of fungi was encountered during the period from June to February. These months showed high relative humidity and low temperature. The total number of fungi generally decreases from March to May. Agarwal *et al.* [27] reported the peak period of fungal incidence from September to November and February to April at Delhi. At Gorakhpur the highest fungal incidence was observed during December [28].

It was found that survival of air borne fungi depend on several factors such as wind velocity, distance from the source, time in air, relative humidity and species itself. Viability varies greatly among various group of fungi [29]. Tilak [30] pointed out that conidia of *Alternaria*, *Helminthosporium* and others are well adopted for long distance aerial travel in a viable condition.

The occurrence of fungal colonies in semiurban area was found to be more as compared to urban area. Huge garbage or municipal waste from various part of city was dumped in semiurban area. There was no proper mechanism for further treatment of this waste. This results in huge population of microbial forms specially the saprophytic ones. Because of this huge amount of spore were released in the atmosphere. During winter seasons the concentration of spores was comparatively more as compared to rainy and summer seasons. The rainy days were recorded during winter seasons. This created more humid condition inside the garbage was probably one of the reasons for the occurrence of more number of colonies. The present work will be definitely helpful to aerobiologists, agriculturalist, pathologist, environmentalist, allergologists and researchers in the related fields.

**Table 1:** Occurrence of total air borne fungi on PDA nutrient medium during February 2008 - January 2010 from Nagpur

| Sr. No. | Name of Fungi | Year | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Aspergillus niger* | 2008-2009 | 7 | 9 | 6 | 6 | 3 | 17 | 10 | 14 | 18 | 12 | 15 | 10 | 127 | 9.87 |
| | | 2009-2010 | 6 | 4 | 7 | 3 | 4 | 8 | 6 | 3 | 5 | 4 | 12 | 5 | 67 | 6.34 |
| 2 | *A. flavus* | 2008-2009 | 2 | 5 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 2 | 3 | 3 | 36 | 2.80 |
| | | 2009-2010 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 17 | 1.61 |
| 3 | *A. fumigates* | 2008-2009 | 3 | 6 | 1 | 3 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 5 | 48 | 3.73 |
| | | 2009-2010 | 2 | 2 | - | - | 2 | 2 | 2 | 3 | 2 | 3 | 4 | 2 | 24 | 2.27 |
| 4 | *Aspergillus* spp. | 2008-2009 | 1 | 4 | 2 | - | 2 | 3 | 1 | 2 | 3 | 5 | 4 | 3 | 30 | 2.33 |
| | | 2009-2010 | 1 | 2 | 1 | - | 2 | - | - | - | 2 | 1 | 1 | - | 10 | 0.95 |
| 5 | *Alternaria alternate* | 2008-2009 | 14 | 17 | 10 | 12 | 12 | 21 | 22 | 25 | 28 | 24 | 24 | 16 | 225 | 17.48 |
| | | 2009-2010 | 11 | 17 | 12 | 7 | 14 | 15 | 14 | 15 | 28 | 24 | 21 | 17 | 195 | 18.45 |
| 6 | *Alternaria* spp. | 2008-2009 | - | 1 | 1 | 1 | 2 | - | - | - | - | 3 | 1 | 1 | 10 | 0.78 |
| | | 2009-2010 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | *Helminthosporium sativum* | 2008-2009 | 1 | 1 | 1 | 1 | 1 | 3 | 5 | 1 | 5 | 3 | 2 | 2 | 26 | 2.02 |
| | | 2009-2010 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 7 | 7 | 8 | 3 | 37 | 3.50 |
| 8 | *Helminthosporium* spp. | 2008-2009 | 2 | 4 | 1 | 2 | 3 | 6 | 3 | 3 | 7 | 3 | 7 | 4 | 45 | 3.50 |
| | | 2009-2010 | 1 | 2 | 3 | 2 | 4 | 3 | 4 | 5 | 6 | 7 | 5 | 3 | 45 | 4.26 |
| 9 | *Fusarium oxysporum* | 2008-2009 | 9 | 7 | 4 | 6 | 4 | 7 | 8 | 13 | 13 | 8 | 9 | 8 | 96 | 7.46 |
| | | 2009-2010 | 5 | 8 | 5 | 5 | 4 | 7 | 5 | 6 | 10 | 9 | 7 | 7 | 78 | 7.41 |
| 10 | *Fusarium* spp. | 2008-2009 | 2 | 1 | 1 | - | 2 | 1 | 2 | 2 | 2 | 1 | 2 | - | 16 | 1.24 |
| | | 2009-2010 | - | 2 | 2 | - | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | 14 | 1.32 |
| 11 | *Curvularia lunata* | 2008-2009 | 9 | 16 | 9 | 10 | 10 | 24 | 18 | 21 | 21 | 20 | 26 | 14 | 198 | 15.38 |
| | | 2009-2010 | 8 | 10 | 8 | 8 | 7 | 13 | 12 | 17 | 23 | 19 | 24 | 13 | 162 | 15.33 |
| 12 | *Curvularia* spp. | 2008-2009 | 1 | - | - | - | 1 | - | - | 1 | 3 | 2 | 1 | 1 | 10 | 0.78 |
| | | 2009-2010 | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.09 |
| 13 | *Rhizopus* spp. | 2008-2009 | 2 | 2 | 1 | 4 | - | 2 | 2 | 4 | 3 | 4 | 4 | 3 | 31 | 2.41 |
| | | 2009-2010 | 2 | 1 | 2 | - | 2 | 2 | 2 | 4 | 7 | 5 | 6 | 3 | 36 | 3.41 |
| 14 | *Mucor* spp. | 2008-2009 | - | 2 | - | 2 | - | 1 | - | - | 1 | 3 | 2 | 1 | 13 | 1.01 |
| | | 2009-2010 | - | 2 | 2 | 1 | - | 1 | - | 1 | 1 | 2 | 1 | 1 | 12 | 1.14 |
| 15 | *Cladosporium cladosporioides* | 2008-2009 | 10 | 15 | 4 | 2 | 8 | 13 | 14 | 15 | 18 | 11 | 18 | 12 | 140 | 10.88 |
| | | 2009-2010 | 9 | 12 | 7 | 2 | 2 | 10 | 9 | 8 | 16 | 18 | 12 | 10 | 115 | 10.88 |
| 16 | *Cladosporium* spp. | 2008-2009 | 6 | 5 | 5 | 6 | 6 | 11 | 9 | 7 | 9 | 20 | 14 | 6 | 104 | 8.08 |
| | | 2009-2010 | 7 | 10 | 5 | 3 | 7 | 6 | 9 | 12 | 15 | 17 | 11 | 12 | 114 | 10.79 |
| 17 | *Penicillium* spp. | 2008-2009 | 1 | - | - | 1 | 3 | 1 | 4 | 2 | 2 | 3 | 3 | 2 | 22 | 1.71 |
| | | 2009-2010 | - | - | - | - | 3 | 2 | 2 | 5 | 3 | 1 | 1 | 1 | 18 | 1.70 |
| 18 | *Trichoderma* spp. | 2008-2009 | - | - | - | 1 | 1 | - | 1 | - | - | 1 | 1 | 1 | 6 | 0.47 |
| | | 2009-2010 | - | 1 | - | - | 2 | 1 | - | 2 | 1 | 1 | - | 1 | 9 | 0.85 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | *Torula* spp. | 2008-2009 | - | 1 | - | - | - | - | - | - | - | 2 | 3 | 1 | 7 | 0.54 |
| | | 2009-2010 | - | 1 | 1 | - | - | - | 2 | 4 | 1 | - | 3 | 1 | 13 | 1.23 |
| 20 | *Nigrospora* spp. | 2008-2009 | 2 | 4 | 3 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 6 | 3 | 48 | 3.73 |
| | | 2009-2010 | 4 | 2 | 3 | 1 | 5 | 2 | 4 | 3 | 8 | 9 | 9 | 4 | 54 | 5.08 |
| 21 | Unidentified | 2008-2009 | 7 | 8 | 7 | 2 | 5 | 2 | 4 | 3 | 2 | 4 | 2 | 3 | 49 | 3.83 |
| | | 2009-2010 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 4 | 4 | 4 | 4 | 36 | 3.37 |
| | | Total | 141 | 189 | 121 | 101 | 137 | 200 | 194 | 222 | 290 | 276 | 285 | 187 | 2344 | |
| | Total | 2008-2009 | 79 | 108 | 57 | 64 | 71 | 123 | 116 | 126 | 147 | 142 | 153 | 99 | 1287 | 100.00 |
| | Percentage | | 6.16 | 8.39 | 4.43 | 4.97 | 5.52 | 9.56 | 9.01 | 9.79 | 11.42 | 11.03 | 11.89 | 7.69 | 100.00 | |
| | Total | 2009-2010 | 62 | 81 | 64 | 37 | 66 | 77 | 78 | 96 | 142 | 134 | 132 | 88 | 1057 | 100.00 |
| | Percentage | | 5.83 | 7.66 | 6.05 | 3.50 | 6.21 | 7.28 | 7.38 | 9.11 | 13.43 | 12.68 | 12.49 | 8.33 | 100.00 | |

**Reference**


1. Dobrey AN. Mold sensitivity. Canad. Med. Ass. J. 1962; 87:1310.
2. Buttner MP, Willeke K, Grinshpun SA. Sampling and analysis of airborne microorganism. In: Hurst ChJ (Eds): Manual of Environmental Microbiology. ASM Press, Washington D.C. Edmonds RL: Aerobiology. The Ecological Systems Approach. Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pennsylvania 1979, 1997.
3. Hirst JM. Aerobiology in plant pathology. Grana, 1991; 30:25-29.
4. Ingold CT. Fungal Spores: their Liberation and Dispersal. Clarendon Press, Oxford: 1965, 210-220.
5. McCartney A. Dispersal of spores and pollen from crops. Grana. 1994; 33:76-80.
6. Hjelmroos M. Relationship between airborne fungal spore presence and weather variables, Cladosporium and Alternaria. Grana. 1993; 32:40-47.
7. Sabariego S, Diez A, Gutierrez M. Monitoring of airborne fungi in Madrid (Spain). Acta Bot. Croat. 66 2007; (2):117-126.
8. Panda T, Panda B, Mishra N. Seasonal Incidence of Air Borne Fungi in Coastal Belt of Orissa. J Hum. Ecol. 2009; 26(3):205-207.
9. Subba Reddi C, Atluri JB, Rao AN, Srivandana K. The relation between indoor and outdoor fungal aerospora of some working environments. Ind. J. Aerobiol. 2004; 17(1-2):44-52.
10. Mishra KN, Singh DB, Kumar A. Fungal spore content in the atmosphere of different sites of Obra-Sonebhadra (U.P.). Ind.J. Aerobiol. 2008; 21(1):42-47.
11. Rati E, Ramalingam A. Airborne Aspergilli at Mysore. Asp. Allergy. Appl. Immunol. 1976; 9:139-147.
12. Vittal BPR, Ponnuswamy P. A preliminary study of the atmosphere fungal flora of Madras. Kavaka 1979; 7:79-82.
13. Sullia SB, Khan KR. Airspora of Bangalore city market and its relation to the occurrence of market disease. Advances in pollen spore research. 1980; VII:157-159.
14. Verma KS, Sheorey L. Aero biota of vegetable market at Jabalpur. J Environ. Biol. 1994; 15:325-329.
15. Frey D, Purie EB. Estimate of airborne fungal spores a comparision of slides and culture methods. Mycopath. Mycol. Appl. 1962; 16:295-303.
16. De-Menna ME. A quantitative study of airborne fungus spores in Dunedin, New Zealand. Trans. Br. Mycol. Soc. 1953; 38:119-129.
17. Agarwal MK, Shivpuri DN. Fungal spores their role in respiratory allergy. Adv. in pollen spores res. 1974; 1:78-128.
18. Agashe SN, Nagalaksamma KV, Chatterji M, Anand P. Aeromycoflora of Bangalore (A Preliminary study), Asp. Allergy Appl. Immunol. 1983; 16:49-52.
19. Lisbeth SL. A three year survey of microfungi in the air of Copenhagen 1977-1979. Allergy. 1981; 36:15-22.
20. Rai B, Singh AK. A comparative aeromycological study of unpolluted and polluted air localities. I. Journal Aerobiol. 1988; 1:1-9.
21. Lee T, Grinshpun SA, Martuzevicius D, Adhikari A, Crawford CM, Luo J. *et al*. Relationship between indoor and outdoor bioerosols collected with a Button Inhalable Aerosol Sampler in urban homes. Indoor Air 2006; 16:37-47.
22. De Ana SG, Torres-Rodriguez JM, Ramirez EA, Garcia SM, Belmonte-Soler J. Seasonal distribution of Alternaria, Aspergillus, Cladosporium and Penicillium species isolated in homes of fungal allergic patients. J Investig Allergol Clin Immunol. 2006; 16(6):357-363.
23. Sen B, Asan A. Fungal flora in indoor and outdoor air of different residential houses in Tekirdag City (Turkey): Seasonal distribution and relationship with climatic factors. Environmental Monitoring Assessement. 2009; 151(1-4):209-219.
24. Wolf J, O'Neill NR, Rogers CA, Muilenberg ML, Ziska LH. Elevated atmospheric carbon dioxide concentrations amplify Alternaria alternata sporulation and total antigen production. Environmental Health Perspectives, 118(9):1223-1228.
25. Takahashi T. Airborne Fungal Colony-Forming Units in Outdoor and Indoor Environments in Yokohama, Japan. Mycopathologia. 1997; 139(1):23-33
26. Rao TA, Shaikh AH, Ahmed M. Airborne fungal flora of Karachi, Pakistan. Pak. J. Bot. 2009; 41(3):1421-1428.
27. Agarwal MK, Shivpuri DN, Mukherji KG. Studies on allergenic fungal spores of Delhi, India metropolitan area (Botanical aspects). J Allergy. 1969; 44:193-203.
28. Mishra RR, Kamal. Aeromycology of Gorakhpur III-Seasonal variation in air fungal spora. Mycopathet. Mycol. Appl. 1971; 45:301-310.
29. Kramer CL, Pady SM. Viability of airborne spores. Mycologia 1968; 60:448-449.
30. Tilak ST. Aerial transport of plant pathogens. In: Vistas in plant pathology (Eds. A. Varma and J.P. Verma) Malhotra Publishing House, New Delhi India, 1986; 237-248.