Afyon Kocatepe Üniversitesi
FEN BİLİMLERİ DERGİSİ

7 (1)
191-203

Afyon Kocatepe University
JOURNAL OF SCIENCE

DETECTION OF FUNGI SPECTRUM IN MARITIM TROPICAL AND MARITIM POLAR AIR MASSES ON AFYON, CENTRAL-WEST ANATOLIA, TURKEY

Safiye Elif FIÇICI[1], Okan BOZYURT[2], Muhsin KONUK[1], Mehmet Ali ÖZDEMİR[2], Arzu ÖZKARA[1], Nurhan DOĞAN[3]

[1]Department of Biology, [2] Department of Geography, [3]Department of Biostatistics, Afyon Kocatepe University, Afyon, Turkey

ABSTRACT

In this study, the relationship between two air masses, moved on to Afyon, and their fungal contents were studied. For this, satellite images of the air movement and the fungi specimens of these air masses were evaluated. Fungi specimens were collected and germinated on the agar plates containing malt extract and potato dextrose. In the first air mass, Penicillium was detected predominantly and followed by, Alternaria, Clodosporium, Helminthosporium, Aspergillus, Mucor and Rhizopus. As it was in the first air mass, Penicillium sp. was significantly high in the second air mass, and followed by Alternaria, Helminthosporium, Aspergillus, Clodosporium, Mucor and Rhizopus, respectively. The data were analysed statistically by use of log linear analysis and the results showed that there were statistically meaningful differences among the fungi contents of the air masses studied.

Keywords: Fungi, Air masses, Dust, Weather, Pollution.

AFYON İLİNDEKİ DENİZEL TROPİKAL VE DENİZEL KUTUPSAL HAVA KÜTLELERİNİN FUNGAL SPEKTURUMUNUN BELİRLENMESİ

ÖZET

Bu çalışmada, uydu fotoğrafları ile Afyonkarahisar ilini etkisi altına alan hava kütlelerinin hareketi izlenerek iki farklı hava kütlesinin havanın fungal florasına olan etkisi karşılaştırılmıştır. Örneklerin toplanmasında Malt Agar ve Patates Dekstroz Agar kullanılmıştır. İlk hava kütlesinde Penicillium türlerinin baskın olduğu görülmüştür. Bunu, Alternaria, Clodosporium, Helminthosporium, Aspergillus, Mucor ve Rhizopus takip etmiştir. İkinci hava kütlesinde ise Penicillium türlerinin görülme sıklığı istatistiksel olarak anlamlı olup, bunu sırasıyla Alternaria, Helminthosporium, Aspergillus, Clodosporium, Mucor ve Rhizopus'un takip etiği tesbit edilmiştir. Log linear analiz sonuçları, hava kütleleri arasında fungal konsantrasyon açısından istatistiksel olarak fark olduğunu göstermiştir.

Anahtar Kelimeler: fungus, Hava Kütleleri, Toz, Kirlilik

INTRODUCTION

Biological aerosols, including pollens, spores, protozoa, bacteria, fungi and viruses, are ubiquitous components of atmosphere [1]. The contents of atmosphere are affected by wind direction, precipitation, time of the day, season and atmospheric inversion conditions [2].

The concept of the Sahara has started to gain importance recently in climatology and biology. The dust, from the Sahara, contains various types of microorganism, as well as inorganic materials, and by these contents the global climate is affected, seriously. Bacteria and fungi in the dusts construct iron oxalate when they touch to the water particles within the clouds. This reaction occurs in the daylight. As a result of this, the desert dust is loaded with iron oxalate and it causes raining. Finally it increases the number of alga. The increased number of alga could also change the balance of carbon. As a result of those events some changes in global climate could be seen. In meteorological conditions only 10 μ and smaller dimension of the dust can just be carried to long distance [3]. The air mass, moving from Sahara, firstly towards the north, then turns to the northeast. By the movement of the air, Sahara air masses generally come to Turkey. They especially affect the southwest of Turkey. These types of air masses are common in spring and fall seasons and this period is characteristics for dust storms [4]. The fungi concentrations in the hot Southern climates, especially during dry spells, are really high. Generally, when the ground dries after a period of moisture, the winds can overturn the top layers of soil and disperse large quantities of mould spores. These can be carried a loft into urban areas, where they are drawn into air intakes and building ventilation systems [5]

A number of investigations have dealt with the frequencies of outdoor and indoor fungi. Burton [6] found that available information concerning fungi and air pollutants was sparse compared to lichens and bryophytes, limited to plant pathogens and based largely on short-term SO_2 fumigation studies. Some authors have discussed fungi as potential bio-indicators of air pollution damage in forests since 1986 [7,8].

Approximately 200 surveys were made in various parts of the world of outdoor airborne spores indicated that fungi genera Clodosporium, Alternaria, Penicillium, and Aspergillus are accounted for the highest mean percentages. Around 85% of patients were found to be allergic to moulds would react to one or more of these genera in circulating air [9]. Alternaria sp., Clodosporium sp., and Penicillium sp., are three common fungi, which have been associated with causing asthma and rhinitis. Penicillium spores are 2 to 3 μ and have apparently been responsible for several hypersensitivity pneumonitis epidemics [10].

Moreover, fungi in the air are being proposed as a cause of adverse health effects increasingly. Many of fungi has been reported to cause several types of human health problems, primarily irritations, infections, allergies, and toxic effects. It has also been suggested that toxigenic fungi cause to additional adverse health effects. A field guide published by the American Industrial Hygiene Association recommends that the presence of some toxigenic fungi require urgent risk management decisions. In order to systematically evaluate the relationship between airborne fungi and adverse health effects, the fungal types and their relative frequencies in both indoor and outdoor air need to be known. The more airborne fungal populations means the more indoor fungal populations, and this is important in terms of air quality investigations [5].

Information obtained from fungal air samples can assist in medical and environmental evaluations, determination of remediation procedures, and assessment of health hazards and can be useful in proactive air quality monitoring. Qualitative and quantitative assessments of fungi in air are valuable; however, there are limitations in interpreting results obtained with bio-aerosol samples. For example, there currently are no governmental or industrial standards that specify allowable or acceptable concentrations of indoor airborne fungi in Turkey. There also only limited information is available on fungal types and their prevalence in buildings.

The purpose of the present work was to determine and compare both the types and their relative frequencies of outdoor fungi in different parts of Afyon due to various air conditions. It has an importance of being as a first report in this issue in the region studied.

MATERIAL AND METHODS

In this study, satellite images were obtained from Turkish state meteorological service in two different dates, 6th of October 2003 and 28th of October 2003 (Fig 2-4), which two different air masses came on to Turkey on those days. These two different air masses are very important for this study. Because these air masses are different from each other in terms of temperature, moisture, stability and instability. Each type of air mass has certain types of characteristic of microorganism. Thus two different air masses came on to Turkey on 6th of October 2003 and 28th of October 2003 (Fig 2-4), are analysed for this paper.

The specimens were collected ten times, 5 times in first air mass and 5 times second air mass, from five-stations, (Dumlupınar, base stations due to its central location of the city; Yeşilyol; Harb-iş; Esentepe; ANS). The Petri Plate Gravitational Settling method was employed for the isolation of airborne fungi because of its practical usage and low cost. Rose bengal chloromphenicol agar (RBCA) (Oxoid GM549, Basıngstoke, Hompshıre, England) and Malt Extract Agar (MEA) (Merck, 1.10130, KGaA 64271, Darmstadt, Germany) in petri dishes were used for the isolation of the fungi. Cultures were incubated at room temperature (27±2°C). Plates were inspected firstly on 4th days of incubation and it continued up to 14th days. Subsequently mould colonies were transported to the tubes containing Potato Dextrose Agar (PDA) (Merck, 1.05398, KGaA 64271, Darmstadt, Germany). Light microscope and stereomicroscopes were used for determination of colonial characteristics and morphological structures of fungi. We identified them to the genus category using the book by Barnett and Hunter Barnett and Hunter [11].

Relation between the fungi germinated in the plates and air masses were tested by General log linear analysis by use of the software SPSS 10.0.

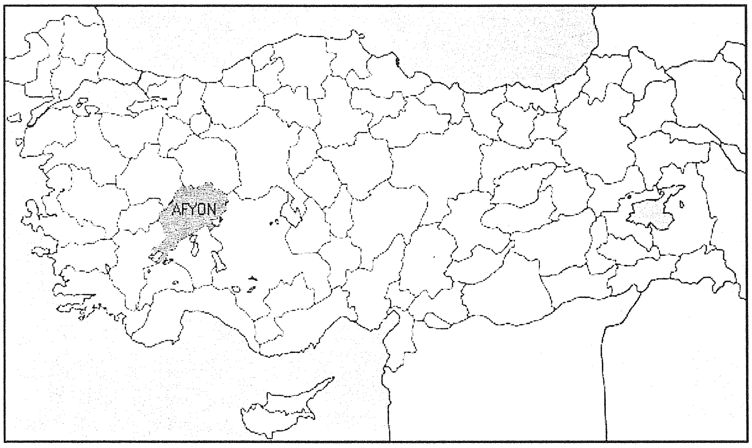

Figure 1. The locality of the research carried out.

Figure 2: Earth's satellite image belonging to 6th October 2003 (www.meteor.gov.tr) [12]

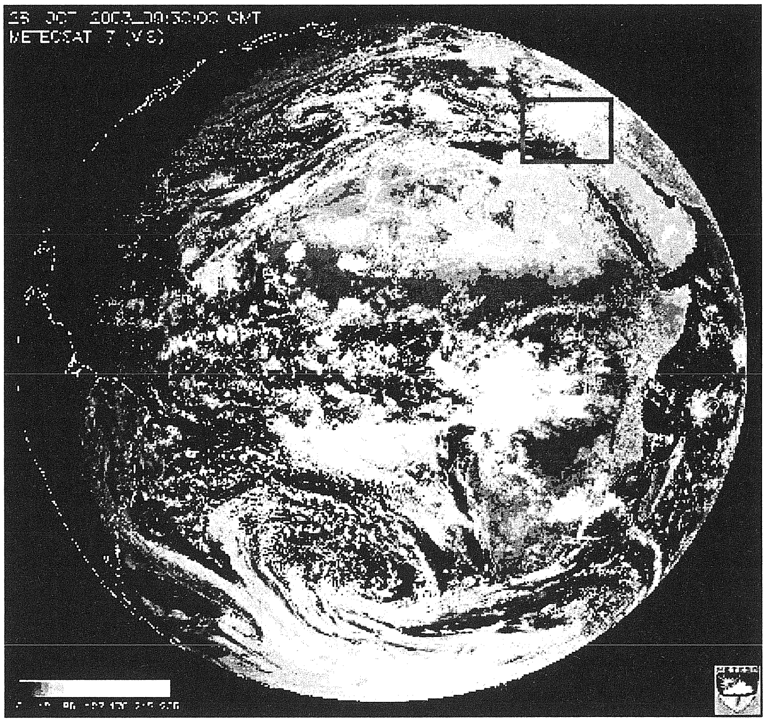

Figure 3: Earth's satellite image belonging to 28th October 2003 (www.meteor.gov.tr) [12]

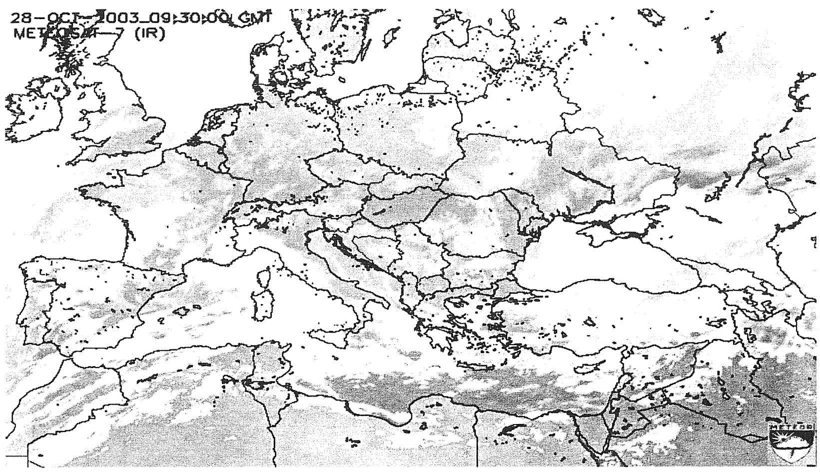

Figure 4: Europe's infrared satellite image belonging to 28th October 2003 (www.meteor.gov.tr) [12]

RESULTS

When we look at the satellite image of 6th October 2003 (Fig 2), The Sahara dust can be seen, clearly, between Turkey and North Africa or over the Mediterranean. The southwest of Turkey was under the effects of the air mass originated to the Sahara. The types of air masses coming from southwest are called southwest sector in climatology. The characters of these types of air mass are, generally, lukewarm and moistured. In this respect, the degree of temperature in Turkey, especially, in the southwest of Turkey was high. For example, the degree of temperature in Afyon, which is city in the southwest of Turkey (Fig 1), was approximately 26 °C. Direction of the dominant wind was southwest.

As it is looked at the satellite image of 28th October 2003 (Fig 3-4), the Sahara dust is not seen over the Mediterranean and southwest of Turkey. On the contrary, a wide of cloud cover is seen all over the Turkey. In this case, the air mass type on the Turkey was needed to be defined. For this, infrared satellite image of that date was taken up from Turkish State Meteorological Service's web site. In this map, the air mass over Turkey clearly seems to coming from Balkans. In those days the degree of temperature decreased, sharply. The degree of temperature in Afyon was around 6 °C. This air mass is called northwest sector. Because, the dominant wind direction was northwest.

During the study, 100 samples were taken from 5 stations. In the first air mass 207, and in the second air mass 123 colonies were isolated. By identification of these specimens, 7 common genera (Alternaria, Penicillium, Clodosporium, Aspergillus, Helminthosporium, Mucor and Rhizopus) were determined (Table 1).

Table 1. First and second air mass fungal distribution of Afyon
P1, ANS; P2, Esentepe; P3, Harb-İş; P4, Yeşilyol; P5, Dumlupınar
(Firs air mass; Maritim Tropical, Second air mass; Maritim Polar)

	first air mass (n = 207)						second air mass (n =123)					
	P1	P2	P3	P4	P5	N (%)	P1	P2	P3	P4	P5	N (%)
Alternaria	7	8	15	5	2	37 (17,88)	4	6	3	4	2	19 (15,45)
Penicillium	20	15	10	7	3	55 (26.57)	6	6	9	3	3	27 (21,95)
Clodosporium	7	8	6	6	1	28 (13,53)	4	3	2	2	2	13 (10,57)
Aspergillus	5	2	2	5	2	16 (7,73)	3	5	3	4	2	17 (13,82)
Helminthosporium	6	5	7	1	3	22 (10,63)	7	5	6	2	2	22 (17,89)
Mucor	3	3	4	2	3	15 (7,25)	1	-	1	1	-	3 (2,44)
Rhizopus	3	2	4	-	1	10 (4,83)	1	-	2	-	-	3 (2,44)
Other	6	4	4	5	5	24 (11,60)	6	4	4	3	2	19 (15,45)
N	57	47	52	31	20	207	32	29	30	19	13	123

In both air masses, the genera germinated as the least, were taken as base genus in the comparison with the others. At the first air mass, has the highest concentration Penicillium (26.57%) especially in ANS, followed by Alternaria (17.88%), Clodosporium (13.53%), Helminthosporium (10.63%), Aspergillus (7.73%), Mucor (7.25%), and Rhizopus (4.83%) (Tablo 1). In this case, Rhizopus was considered as base genus. At the second air mass, Penicillium has the highest concentration (21.95%). This was followed by Helminthosporium (17.89%), Alternaria (15.45%), Aspergillus (13.82%) and Clodosporium (10.57%), Mucor and Rhizopus (2.44%, each) (Table 1).

Table 2. General loglinear analysis of the data obtained.
F1, Alternaria; F2, Penicillium; F3, Clodosporium; F4, Aspergillus; F5, Helminthosporium; F6, Mucor; F7, Rhizopus.
P1, ANS; P2, Esentepe; P3, Harb-İş; P4, Yeşilyol; P5, Dumlupınar

Parameter	Estimate	Z-value	ODDS
First air mass	0.5748	4.67***	1.78
Second air mass	0.0000	-	-
P1	1.1249	4.89***	3.07
P2	1.0006	4.28***	2.72
P3	1.0852	4.69***	2.96
P4	0.5188	2.05*	1.68
P5	0.0000	-	-
F1	1.4604	4.74***	4.31
F2	1.8418	6.17***	6.30
F3	1.1486	3.61***	3.15
F4	0.9316	2.84**	2.54
F5	1.1963	3.78***	3.31
F6	0.3254	0.89^{ns}	-
F7	0.0000	-	-

***; significant at $\alpha = 0.001$, **; significant at $\alpha = 0.01$, *; significant at $\alpha=0.05$, ns; insignificant

Table 3. Correlation between concentrations of fungi.
1, Alternaria; 2, Penicillium; 3, Clodosporium; 4, Aspergillus; 5, Helminthosporium; 6, Mucor.

Fi–Fj	Estimate	ODDS
1-2	- 0.3814	0.68 ns
1-3	0.3118	1.36 ns
1-4	0.5289	1.69*
1-5	0.2642	1.30 ns
1-6	1.135	3.11***
2-3	0.6932	2.00***
2-4	0.9103	2.48***
2-5	0.6456	1.90***
2-6	1.5164	4.55***
3-4	0.2171	1.24 ns
3-5	- 0.0476	0.95 ns
3-6	0.8232	2.28**
4-5	- 0.2647	0.76 ns
4-6	0.6061	1.83*
5-6	0.8708	2.39**

***; significant at $\alpha = 0.001$, **; significant at $\alpha = 0.01$, *; significant at $\alpha=0.05$, ns; insignificant

Loglinear analysis results indicate an advanced diference ($p<0.001$) between two different air masses studied. When the stations were compered, statistically meaningful differences among the stations were also determined in regarding the number of their fungi (Table 2) isolates. As it was compared to Dumlupınar (Table 3), fifth station and considered as base station, the ratio of fungus obtained at ANS campus was 3.07 times much more than that of Dumlupınar. In the same way Esentepe, second station, contains 2.72 Harb-İş, third station, contains 2.96 times, Yeşilyol, fourth station, contains 1.68 times higher. Esentepe and Harb-İş contain fungus as 1.62 and 1.76 times in relation to Yeşilyol's contents.

There were statistically meaningful differences among the fungi genera obtained. All the fungus genera were compared with Rhizopus. According to the results obtained, Alternaria exists as 4.31 times much more than Rhizopus. The other's occurrence ratios against to Rhizopus are as follows; Penicillium 6.3, Helminthosporium 3.3, Clodosporium 3.15, Aspergilus 2.5 fold (Table 3).

When the fungi compared with Mucor, the frequency of Alternaria was found 3.11 times and Penicillum 4. 55 fold higher than that of Mucor. Apart from this, Penicillum was also compared to the other fungus, and the biggest difference was observed between Penicillum and Mucor. (Table 3-4). There was insignificant relationship between Alternaria-Penicillium, Clodosporium-Helminthosporium, and Aspergillus-Helminthosporium (Table 3).

DISCUSSION

Fungi differ significantly, in certain respects, from most other airborn pathogens, such as bacteria, viruses, and protozoa. Fungi do not cause secondary contagious infections; only the person inhaling the fungi is at risk. Fungi can exist outdoors and enter the building through the air intakes. No other respiratory pathogens can exist outdoors viruses and bactera ar carried and transmitted indoors by human or animal hosts, with anthrax being the one exception. For this reason, fungal flora in air and the factor which affect the fungal flora should be known. The different characteristics of air masses in autumn period are effective seriously in the south-west regions of Turkey, especially when they come from central mediterranian, Sahara and Balkans.

The variation of atmospheic fungal flora of Ankara, neigbour the city of Afyon, was studied by Yulug [13]. Yulug found that Penicillium was, the most occurring organism in outdoor air, and followed by Clodosporium, Alternaria, Helminthosporium, Aspergillus, Rhizopus and Mucor. Çolakoğlu [14] obtained 13 genera of airborne fungal spores (Mucor, Rhizopus, Absidia, Aspergillus, Penicillium, Trichoderma, Trichothecium, Stemphylium, Clodosporium, Alternaria, Ulocladium, Aureobasidium and Fusarium) from five different locations of Belgrat Forest in Istanbul. In our study, Penicilium, Alternaria, Clodosporium and Helminthosporium were predominant in the first air mass, and in the second air mass, Penicillum, Alternaria, Helminthosporium and Aspergillus were dominantly growing fungi. Pei-Chih [15] showed that Aspergillus, Alternaria and Fusarium were significantly high in the outdoor enviroment in Kuwait. Takahashi

[16] analyzed the air samples with a Reuter centrifugal air sampling methods and found that Clodosporium spp was predominated and it was followed by Alternaria spp. and Penicillium spp. It was also reported that the concentration of fungi in autdoor air was significantly correlated with climatic factors such as average of the day, temperature, average relative humidity of the month and precipitation [2]. A number of other studies were carried out on the factors affecting fungal concantration in the air of different parts of the world; Katial et al [17], Angulo et al [18], Sabariego [19], Ljungquist [20], Troutt [21], Morin [22], Burch [23] all reported the similar results, in regarding the genera of the fungi, with our search.

REFERENCES

1. Schnell and Tan-Schnell, Kenya Tea Litter:a source of ice nuclei, Tellus, 34:92-95, (1982).
2. Awad, A.H.A,. Air-borne particulate matter and its viable fraction during severe weather conditions in Cairo, Egypt. Trakya Univ. Bilimsel Araştırmalar Dergisi, 4(1): 1-8, (2003).
3. Saydam. C,. İklim Kontrolü, Bilim ve Teknik, 419, 40, ANKARA, (2002).
4. Erol, O., 1993. Genel Klimatoloji, pp. 161-162, Gazi Büro Kitabevi, ANKARA,(1993).
5. Brian, G., Shelton, Kimberly, H., Kirkland, W., Dana Flanders., and George, K, M, Profiles of Airborne Fungi in Buildings and Outdoor Environments in the United States. Applied and Environmental Microbiology., April, p. 1743-1753, Vol. 68, No. 4, (2002).
6. Burton, D.J, Monitoring air filter systems increasesfficiency, effectiveness. Occup Health saf., 55(12):65-5, (1986).
7. Fellner, R., 1989. Mycorrhiza-forming fungi as bioindicators of air pollution. Agriculture Ecosystems and Environment., 28, 1-4, 115, (1989).
8. Marx, E, H., Shafer, S, R, Fungal and bacterial symbioses as potential biological markers of effects of atmospheric deposition on forest health. In: Biologic markers of air pollution stress and damage in forests, Committee on biological markers of air pollution damage in trees, National Research Council, National Academy Press, Washington D.C.Sie,pp:1310-1315, (1989).
9. Binnie, P,W.H, Airborne Microbial Flora in Florida Homes. Proc. 4 th International Conference on Indoor Air Quality, Berlin, West Germany, (1987).
10. Kreiss, K., Hodgson, M, J, Building-associated Epidemics. In: Walsh, P.J., Dudney, C.S., and Copenhaver, E.D., eds. Indoor AirQuality. Boca Raton, Fla: CRC Press. Kaminske, E., Stawicki, S., and Wasowicz, E. 1974. Volatile Flavor Compounds Produced by Molds of Aspergillus, Penicillium, and Fungi Imperfecti. Appl. Microbiol., 27(6):1001, (1984).
11. HL Barnett, BB Hunter. Illustrated Genera of Imperfect Fungi ed 4.St Paul, ASP Press. The American Phytopathological Society, (1999).
12. http://www.meteor.gov.tr

13. Yulug, N., Kustimur, S, [Indoor and outdoor fungal flora of Ankara] Mikrobiyol Bul.., Jul;11(3):355-64, (1997).
14. Çolakoğlu, G, Airborne fungal spores at the Belgrad forest near the city of İstanbul (Turkey) ın the year 2001 and their relation to allergic diseases. Journal of Basic Microbıology., 43:376-384, (2002).
15. Pei-Chih, W., Huey-Jen, S., Chia-Yin, L, Characteristics of indoor and outdoor airborne fungi at suburban and urban homes in two seasons. Sci Total Environ; 253(1-3):111-118, (2000).
16. Takahashi, T, Airborne fungal colony-forming units in outdoor and indoor environments in Yokohama, Japan. Mycopathologia., 139(1):23-33, (1997).
17. Katial, R.K., Zhang,Y., Jones, R.H., Dyer, P.D, Atmospheric mold spore counts in relation to meteorological parameter. Int J Biometeorol., 41 (1):17-22, (1977).
18. Angulo-Romero., J, Mediavilla-Molina, A., Dominguez-Vilches, E, Conidia of Alternaria in the atmosphere of the city of Cordoba, Spain in relation to meteorological parameters. Int J Biometeorol., Jul;43(1):45-9, (1999).
19. Sabariego, S., Diaz de la Guardia, C., Alba, F, The effect of meteorological factors on the daily variation of airborne fungal spores in Granada (southern Spain). Int J Biometeorol., (1):1-5, (2000).
20. Ljungqvist, B., Reinmuller, B, Airborne viable particles and total number of airborne particles: comparative studies of active air sampling. J Pharm Sci Technol., 54(2):112-6, (2000).
21. Troutt, C., Levetin, E, Correlation of spring spore concentrations and meteorological conditions in Tulsa, Oklahoma. Int J Biometeorol., 45(2):64-74, (2000).
22. Morin, O, [Airborne molds in Nantes--effect of climatic factors] Allerg Immunol Paris. Feb:33(2):100-101, (2001).
23. Burch, M., Levetin,E, Effects of meteorological conditions on spore plumes. Int J Biometeorol.; 46(3):107-17, (2002).