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Atmospheric Fungi of Karachi City

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Abstract: Altogether 53 species of fungi belonging to 21 genera present up to a height of 10m were trapped in the atmosphere of Karachi city. Species of *Aspergillus, Alternaria, Penicillium* and *Cladosporium* were the most frequently encountered. A data on the prevalence of atmospheric fungi isolated during 1998-1999 is presented.

Key words: Atmospheric fungi, Karachi, fungi, fungi in Karachi, mycoflora in Karachi

Introduction

Mycoflora present in the atmosphere of a city or country is studied with a view to identify fungal spores responsible for causing plant and human diseases (Kim, 1982; Chapman, 1999; Baratawidjaja *et al.*, 1999). For the purpose of plant disease forecasting, atmospheric fungi is generally studied on seasonal basis. Necessary spraying measures are carried out, if plant pathogenic spores are found in the atmosphere. Fungicidal spraying do not allow the fungal spores to survive, germinate and cause diseases on plants. No such effort for the study of fungal spores present in the atmosphere has been made in Pakistan. Plant disease forecasting and plant disease diagnostic service is needed in Pakistan. There is a long list of plant diseases in Pakistan (Ghafoor and Khan, 1976) which demand attention. Spraying of pesticides is carried at times under the auspices of FAO for the control of locust in South Asia on regional basis, which includes Pakistan.

The city of Karachi and its suburbs is inhabited by 15 million people and there has been a breakdown of conservancy services which has made it one of the dirtiest cities of the world. The soil, water and air of Karachi city have become highly contaminated and polluted resulting in unhygienic condition. This appalling condition has increased the incidence of water and airborne diseases.

Fungi and bacteria contaminate water and pollute air and cause many human diseases (Gregory, 1973). Spores of fungi present in the air also cause a number of allergic reactions (Al-Doory, 1984 and Sanches *et al.*, 1999). Ebner *et al.* (1992) reported that for effective treatment of allergies, knowledge of the airborne fungal spores are of great importance. It is reported that each country has its own fungal groups which cause allergy. Chapman (1999) put emphasis on air sampling data of air spora to determine the cause of allergy. In different regions of the world research works have been carried out on airborne fungi causing fungal allergy (Angullo Romero *et al.*, 1999; Munuera *et al.*, 1998; Vanderbergh *et al.*, 1999).

Fungi cause mycoses (deCastro *et al.*, 1999; Elewski, Hirchmann and Raugi, 2000). Both in India and Pakistan people suffer from bronchitis, rhinitis, dermatitis, urticaria, eczema etc. (Bapat, 1994). There is no data on the occurrence of fungal spores in the atmosphere of Karachi city. A large number of people are reported to be suffering from allergy in the city of Karachi and a record of the skin hospitals of Karachi would indicate gradual increase in the incidence of dermal diseases (Mughal, 2002).

In view of the importance of air spora in the causation of plant diseases and allergic reactions in human beings, it was considered worthwhile to study and obtain a data on fungi present in the atmosphere of Karachi city.

Materials and Methods

For the study of airborne mycoflora glass slides (each of 6x2 cm^2) smeared with glycerine or a drop of sterilized water only on one side were exposed at 1.5, 5 and 10m heights at the Karachi University Campus, Karachi during 1998-99. A series of replicate slides were exposed for 24hrs and brought back to the laboratory for microscopic study. A drop of lactophenol was placed on exposed slides and was covered with cover slips for observation under microscope. The method used for trapping the fungal spores from the atmosphere is devised by Agashe and Alfadil (1989).

For studying the various fungal members present in the atmosphere, the identifying characters of the trapped fungal spores were taken into consideration and calculated on percent basis of the total occurrence of the spores at each altitude.

If on the basis of the morphological characters of the spores it was not possible to identify then replicate samples of such spores as water mounts were transferred and cultivated on potato dextrose agar (PDA) or Sabourad dextrose agar (SDA) media in Petri plates for germination and growth. Incubation for 3-5 days on either of the two media yielded identifiable fungal colonies and spores. For the identification of fungi, spores and colonies arising from spores on selective media were tallied with the description given in authoritative literature such as Manual of Penicillia (Raper & Thom, 1949), Manual of Aspergilli (Thom and Raper, 1945) and Dematiaceous Hyphomycetes (Ellis, 1971).

Results and Discussion

Spores of fifty-three fungal species belonging to 21 genera were trapped and identified from the atmosphere of Karachi city at Karachi University Campus up to 10 m altitude. The relative frequency of each fungal species as a percentage of its contribution to total counts at each altitude during 1998-99 is presented in Table 1.

The spore counts were taken at low altitude (1.5m above ground level) for *Aspergillus niger* (17.61), *A. flavus* (15.22) and for *Alternaria tenuissima* (8.955%). Similarly the highest count at medium altitude (5 m above ground level) were recorded for *A. niger* (19.14), *A. flavus* (15.978) and for *Alternaria alternata* - 6.88%. *Alternaria brassicae, A. brassicola, Aspergillus sulphurous, A. ustus, Cladosporium oxysporum, Fusarium culmorum, F. equiseti, F. longipes, Penicillium* sp., *Rhizopus nigricans* and *Ulocladium* sp., were not recorded from low altitude. *Aspergillus sydowi, A. ustus, Chaetomium globosum, Drechslera nodulosus, Fusarium culmorum, F. equiseti, F. semitectum, Mycelia sterilia, Penicillium* sp. and *Rhizopus nigricans* were not found between the low and high altitude. Spores of *Alternaria brasicae, A. brassicola, Aspergillus candidus, A. glaucus, A. nidulans, A. niveus, Aspergillus sulphurous, A. sydowi, Chaetomium globosum, Drechslera dematioidea, Drechslera* state of *Cochliobolus nodulosus, Mycelia sterilia, Phoma* sp. and *Stemphylum* sp., were not recorded from high altitude (10m height). A good deal of variation is shown in occurrence of fungal species to the extent that some of the fungal species were less than 1% of the total findings at different altitudes (Table 1).

On an overall basis, 36.22% of fungi were recorded from low altitude (1.5m above ground), 39.9% from the medium altitude (5m height) and 23.86% spores were recorded from the top altitude (10m height). The species of *Aspergillus* were the most prevalent fungus in the atmosphere of Karachi and was represented by thirteen species, mainly *Aspergillus niger, A. flavus* and *A. fumigatus* (Table 1).

Table 1: Percent occurrence of fungal spores in the atmosphere

Fungal species	Altitude (m)		
	1.5	5	10
Alternaria alternata	5.67	6.88	1.66
A. brassicae	0.00	0.215	0.00
A. brassicola (Schw.) Wiltshire	0.00	1.705	0.00
A. citri (Ellis and Piercepud) Pierce	4.179	3.44	1.25
A. solani Soroner	7.164	7.526	2.5
A. tenuissima (Kunz ex pers.) Wiltshire	8.955	9.03	4.583
Aspergillus candidus (Link) Thom & Church	1.492	0.215	0.00
A. flavus Link	15.22	13.978	7.08
A. *fumigatus* Fres	4.477	3.44	1.666
A. glaucus Link	0.298	0.215	0.00
A. nidulans (Eidum) Went.	0.597	0.430	0.00
A. niger Von Tiegh	17.61	19.14	7.916
A. niveus (Var.) Blochwitz	0.298	1.075	0.00
A. ochraceous Wilhelm	0.298	0.215	0.00
Aspergillus sp.	0.597	0.430	0.416
A. sulphurous (Fres) Thom and Church	0.00	0.215	0.00
A. sydowi (Bain and Sart) Thom and Church	0.597	0.00	0.00
A. terreus Thom	1.492	0.430	0.416
A. ustus	0.00	0.00	0.833
Aureobasidium pullulans (Debary) Arnaud	0.895	0.215	0.833
Chaetomium globosum Kunze	0.298	0.00	0.00
Cladosporium herbarum Pers Link ex S.F.Gray	0.597	0.860	6.666
C. oxysporum Burk and Curd	0.00	0.215	0.833
C. sphaerospermum Penz	0.895	1.720	10.41
Curvularia clavata Jain	2.686	2.58	1.25
C. lunata (Wakker) Baedign	0.895	2.795	0.833
Drechslera dematioidea Bubuk and Wroblewski	0.298	0.430	0.00
Drechslera state of *Cochliobolus nodulosus*	0.597	0.00	0.00
D. poae (Baudys) Shoemaker	2.985	1.720	1.25
Drechslera state of *Cochliobolus spicifer* Nelson	2.0.89	2.365	0.416
Fusarium culmorum (Smith) Sacc.	0.00	0.00	0.833
F. equiseti (Corda) Sacc.	0.00	0.00	0.833
Fusarium longipes	0.00	0.215	0.00
F. oxysporum Schlecht emend Snyd and Hans	0.298	0.215	1.250
F. semitectum Berk and Rav.	0.00	0.00	0.416
F. solani (Mart) Appel and Wollenw emend Snyd and Hans	0.597	1.505	9.58
Mucor mucedo Michelo ex Fries	0.895	3.655	2.50
Mucor sp.	1.194	0.430	1.666
Mycelia sterilia	1.194	0.00	0.00
Penicillium notatum Westling	2.89	1.075	11.25
P. brefeldianum Dodge	1.79	1.290	9.583
Penicillium sp.	0.00	0.00	0.416
Phoma sp.	0.895	0.215	0.00
Puccinia recondita	1.194	1.505	0.416
Rhizopus nigricans Ehrenb	0.00	0.215	1.25
R. stolonifer (Ehrenberg ex Fries) Vuillemen	1.49	3.22	1.25
Saccharomyces cerevisae Meyer	1.791	1.935	3.333
Scopulariopsis sp.	0.895	1.075	0.416
Stemphylium sp.	1.194	0.215	0.00
Syncephalastrum racemosum Cohn ex Schroter	0.895	1.075	3.336
Trichoderma viride Pers.	0.597	0.860	0.00
Ulcladium sp.	0.298	0.645	0.00
Ustilago tritici	1.194	0.430	0.416

The species of *Alternaria* was the second most widespread fungus especially at low and middle altitude. However, it was also recorded at high altitude relatively in low numbers. Species of *Penicillium* were 8.4% and species of *Cladosporium* were 8.3% among the total fungal count during the year 1998-99. The possible reason for the variation in occurrence of the fungal spores may be related to the weight of spores, gravitational force and the velocity of wind (Tan *et al.*, 1992).

Interestingly, *Cladosporium* spp., *Fusarium* spp. and *Penicillium* spp. were comparatively more in spore counts at high altitude as compared with low and middle altitudes (Table 1). The most frequently reported fungus *Aspergillus* from different regions of the world was also the most prevalent fungus during our investigation. Tilak (1990) reported *Aspergillus* to be common in atmosphere. Tan *et al.* (1992) stated that *Aspergillus* is a common air-borne fungus at 40m height in Singapore. Ebner *et al.* (1992) found *Aspergillus* as the most occurring fungus from atmosphere on plates. Earlier Ebner (1989) had reported that *Aspergillus* may play a role in indoor and *Penicillium* in outdoor allergy causation. Similarly Pasanen *et al.* (1991), Simeray *et al.* (1995), Farifax *et al.* (1999) and Sanches *et al.* (1999) reported *Aspergillus* as an airborne fungal allergen. *Alternaria* was found as the second largest spp., which has also been reported by Tan *et al.* (1992) as a next most abundant fungal genus (16.71%) from Singapore. Kumar (1982) reported *Alternaria alternata* as most prevalent species in India. In other reports, abundance of *Alternaria* spp., is the second to that of *Cladosporium* spp., (Frey and Durie, 1962; Meyer *et al.*, 1983; Palmas and Cosentino, 1990).

Ebner *et al.* (1992) reported *Cladosporium* as the most dominant genus. Marchisio *et al.* (1992) reported *Penicillium* from Turin Italy as the most frequent genus. Simeray (1995) reported *Cladosporium, Penicillium* and *Aspergillus* as the most frequent fungi in France. Fungal spores are disseminated by air current and in general large sized spores were comparatively found at lower altitude and smaller sized spores generally occurred at high altitude. On an average, *A. alternata* spores are 20-63μm long and 9-18μm wide (Ellis, 1971) whereas *Aspergillus niger* spores are 5.5 -8μm (Thom and Raper, 1945) *and Penicillium notatum* conidia is

3-3.5μm in length (Raper and Thom, 1949). This shows that size and weight of the spores are extraordinarily important in distribution at different altitudes. This view has been supported by Tan *et al.* (1992), who reported that conidia of *Penicillium lapidosum* are smaller (2.0-2.5μm) and capable to reach high altitude. Since spores of *Alternaria* usually are of larger size therefore it may not have been easily blown to a higher level of the atmosphere by air current.

Simeray *et al.* (1995) reported 40 genera of fungi from the atmosphere of bake houses in which the most frequently occurring fungi were species of *Cladosporium, Penicillium* and *Aspergillus*.

During winter season spores of *Puccina recondita, Ustilago tritici* which cause rust and smut disease of wheat were respectively trapped as air-borne spores. The detection of rust and smut spores in the atmosphere at the time of wheat sowing can be used in plants disease forecasting system for the control of rust and smut diseases. Environment plays a key role on the prevalence and distribution at various heights of air spora. Relative humidity, temperature and wind velocity are among the environmental factors affecting the distribution of spores in the atmosphere.

The atmosphere of Karachi city is laden with particulate matters containing soil, sand and dust impregnated with toxic chemicals and toxic gases emitted from vehicles and industries and released from degrading effluents in addition to the air spora together causing health problems (allergies and skin diseases) which are on increase posing more risk to human health with the increase in pollution day by day. The impact of toxic chemicals and gases on human health is required to be estimated which is beyond the scope of this work, however, the air-spora in the atmosphere of Karachi city is being presented for the first time which may be of interest to doctors dealing with dermal and respiratory diseases caused by fungal allergens and to those engaged in the protection of plants from the wind blown spores of fungi.

In short, the fungal spores are important in allergy provoking factors, which always remain present in the atmosphere in more or less concentration at different altitudes. Although, their quantity and quality depend upon different factors and meteorological parameters, but concentration is greater at medium (5 m height) altitude as compared to others with reference to atmosphere of metropolitan city of Karachi.

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