http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (6): 736-739, 2001

A Quantitative Survey of Air-borne Fungal Spores from Schools in Riyadh, Saudi Arabia

Abdullah M. Al-Falih
Department of Science (Biology), Teachers College in Riyadh,
P.O. Box 4341, Riyadh 11491, Saudi Arabia

Abstract: The air-borne fungal flora inhabiting school environments at different places in Riyadh city, Saudi Arabia were screened. A total of 36 fungal species belonging to 6 genera were isolated from the air of schools at different places in Riyadh, while a total number of 68 fungal species belonging to 21 genera were isolated from the schools dust. The highest number of fungal species was found in the secondary stage followed by intermediate stage. The primary stage, which had a less populated classroom, recorded the lowest number of fungal species. The commonest genera of fungi isolated were *Aspergillus* and *Penicillium*. All the localities, the highest number of fungal colonies were obtained from schools in the south location of Riyadh city followed by schools in the central area.

Key words: Fungal spores, air-born, schools, mycoflora, environments

Introduction

Spores and other particles of actinomycetes, bacteria and fungi are always present in atmospheric air-dust and grain-dust particles (Abdel-Hafez, 1984; Ali *et al.*,1977, Holtmeyer and Wallin, 1981; Moustafa and Kamal, 1976; Palmgren *et al.*, 1983; Robert *et al.*, 1984). These spores and particles are associated with human and animal diseases such as allergy, poisoning and infection (Abdel-Hafez *et al.*, 1986; Pepys, 1969; Purchase, 1974). Fungi are common in both outdoor and indoor environments as spores, conidia, mycelial fragments or dissociated intracellular and extracellular components. In closed environments like schools, the situation for occupants is exacerbated when these fungal components coincide with pollen grains and mites which commonly cause allergic diseases like asthma, rhinitis, nasal eosinophilia and also dermatitis (Krillis *et al.*, 1985; Al-Fryah *et al.*, 1989). Children are more susceptible to these diseases than adults (Mori *et al.*, 1985; Bronswijk *et al.*, 1986). A knowledge of the fungal flora causing these diseases in school environments becomes necessary to facilitate, taking appropriate control measures.

In arid regions like Saudi Arabia, where dust storms are common, allergic diseases are increasing in frequency, especially in children (Al-Fryah *et al.*, 1989; Rafii, 1990). In Saudi Arabia, a few investigations were carried out on the mycoflora in the air at different governorates (Krillis *et al.*, 1985; Bronswijk *et al.*, 1986; Bokhary and Parvez, 1995), but none of these studies were focussed on school environments. The aim of present study is to estimate, the composition, density and frequency of the mycoflora in school environments at Riyadh area of Saudi Arabia. This research and other studies may help in finding suitable means to control some human diseases in Saudi Arabia such as chronic bronchitis, emphysema, asthma and allergies.

Materials and Methods

Sample collection: This research project was conducted in Central Laboratory of Teachers College at Riyadh region of Saudi Arabia during 2000. Samples were collected from schools at different localities in Riyadh. These localities were central, east, north, south and west. Fungi were isolated using two methods described by Bokhary and Parvez (1995), these two methods were carried out as follows:

Settle plate method: For the settle plate method, ten schools were chosen for each stage including primary, intermediate and secondary school (a total of 30 schools). Inside the school, twenty plates were put in each classroom. Czapek-Dox agar (Oxoid Ltd., London) with the addition of rose bengal (0.03 g/l) and streptomycin sulphate (0.033g/l) was used for fungal isolation (Bokhary and Parvez, 1995). The Czapek-Dox agar plates were exposed for 30 minutes at different places inside the school. These plates were then closed and incubated for four days at 30°C.

Dilution plate method: Samples of school dust were collected from the same 30 schools which were chosen for settle plate method. Dust samples were taken from the vacuum cleaners used in the schools. Samples of dust collected from different classrooms were mixed together for each school. Ten replicates, each of five grams were taken from the mixed dust samples. The serial dilution plate method (Al-Falih, 1997) used Czapek-Dox agar (Oxoid Ltd., London) for isolation and maintenance of cultures. Fungal genera and species were identified according to Johnson and Curl (1972), Pitt (1979), Ramirez (1982), Nelson *et al.* (1983). Standard statistical procedures were applied and a Minitab-for-Windows program was used in analysis of variance and standard deviation.

Results and Discussion

The total number of fungal colonies per plate collected from the air of schools at different sites of Riyadh area are given in Fig. 1. The number of colonies per plate was in general higher in secondary schools than in other stages, which may be attributed to the densely populated classrooms compared to less populated classrooms in primary and intermediate stages. The number of colonies was almost double in secondary stage than primary stage. Schools in the south of Riyadh exhibited higher numbers of fungal colonies (mean = 71 / plate) than schools in other localities. Basahy (1989) reported that the highest level of suspended dust particles was observed in the south Riyadh city because of cement factory and other factories in this site.

The total number of fungal colonies per gram of school dust collected from schools at different places in Riyadh was also

Table 1: Fungi isolated from the air of schools at different places in Riyadh. (including all localities, n = 20, ± SD)

Fungi species	Stages		
	Primary	Intermediate	Secondary
Alternaria Total count	21	35	62
A. alternata (Fr.) Keissler	7±2	-	10 ± 1
A. chlamydospora Mouchacca	-	9±3	12 ± 5
A. humicola Oudem	6±1	7±2	9 ± 2
A. phragmospora van Emden	-	11±2	17 ± 3
A. tenuissima (Fr.) Wiltshire	8±2	8±1	14 ± 4
Aspergillus Total count	33	80	246
A. apicalis Mehrotra & Basu	-	18±2	22 ± 5
A. candidus Link ex Fries	-	13±4	-
A. clavatus Desm.	5±2	-	30 ± 1
A. flavus Link ex Fries	8±1	10±2	19 ± 2
A. fumigatus Fres.	-	5±1	28 ± 1
A. nidulans (Eidam) Winter	-	-	3 ± 0
A. niger van Teighem	7±0	11±4	41 ± 5
A. ochraceous Withelm	-	-	24 ± 2
A. oryzea (Ahlburg) Cohn	5±2	9±3	32 ± 6
A. raperi Stolk & Meyer	8± 3	6±1	28 ± 4
A. terreus Thom	-	8±2	19 ± 2
Chaetomium spirale Zopf	4± 2	3±1	-
Curvularia Total count	9	24	46
C. intermedia Boedijin	-	11±3	19 ± 2
C. tuberculata Jain	9±2	-	20 ± 1
C. pallescens Boedijin	-	13±0	24 ± 3
Fusarium Total count	4	21	57
F. solani (Mart.) Sacc.	-	12±1	-
F. oxysporum Schlecht.	4±1	-	14 ± 2
F. coeruleum (Lib.) Sacc.	-	-	26 ± 5
F. ciliatum Link	-	9±2	-
Mucor Total count	7	54	117
M. pusillus Lindt	-	16±3	35 ± 4
M. mucedo L. ex Fr.	3±0	20±2	-
M. hiemalis Wehmer	-	-	43 ± 2
M. racemosus Fres.	4±2	18± 5	39 ± 6
Penicillium Total count	45	69	220
P. lanosum Westl.	-	19±3	28 ± 2
P. notatum Westl.	8±3	5±1	41 ± 5
P. citrinum Thom	12±4	-	35 ± 3
P. nigricans (Bain.) Thom	7±2		-
P. expansum Link	-	14±2	52±4
P. frequentans Westl.	6±0	-	34±6
P. chrysogenum Thom	-	31±6	-
P. islandicum Sopp	12±1		30±2

Table 2: Fungi isolated from school dust at different places in Riyadh. (including all localities, n = 20, ± SD)

Fungi species	Stages		
	Primary	Intermediate	Secondary
Alternaria Total count	56	114	150
A. alternata (Fr.) Keissler	-	32±3	19±2
A. chlamydospora Mouchacca	22±1	-	41±5
A. humicola Oudem	-	27±4	55±4
A. phragmospora van Emden	-	55±2	-
A. tenuissima (Fr.) Wiltshire	34±6	-	35±1
Aspergillus Total count	117	290	616
A. aeneus Sappa	-	-	11±2
A. ambiguus Sappa	-	-	10±0
A. apicalis Mehrotra & Basu	34±7	-	89±12
A. candidus Link ex Fries	-	18±1	-
A. clavatus Desm.	-	-	84±5
A. flavus Link ex Fries	6±0	52±8	65±9
A. fumigatus Fres.	11±2	61±5	72±6
A. nidulans (Eidam) Winter	-	-	42±7
A. niger van Teighem	43±5	44±6	53±8
A. ochraceous Withelm	15±3	51±9	-
A. oryzea (Ahlburg) Cohn	-	17±0	70±11
A. raperi Stolk & Meyer	8±1	32±4	54±7
A. terreus Thom	-	15±1	66 ± 5
Blastobotrys Total count	0	15	32
B. elegans de Hoog et al.	-	-	32 ± 1
B. proliferans Marvanova	-	15±4	-
Botrytis cinerea Pers.:Fr.	12±3	5±1	-
Chaetomium Total count	60	103	163
C. aureum Chivers	34±5	16±0	23±2
C. bostrychodes Zopf	-	28±2	-
C. cymbiforme Lodha	16±1	-	56±1
C. globosum Kunze: Fr.	-	-	31±7
C. gracile Udagawa	-	17±1	53±4
C. homopilatum Omvik	10±7	42±5	-
Cladosporium Total count	14	15	36
C. cladosporioides (Fres.)de Vries	8±1	-	12±3
C. herbarum (Pers. ; Fr.) Link	6±0	15±2	24±5
Curvularia Total count	7	14	67
C. intermedia Boedijin	7±1	14±3	26±1
C. tuberculata Jain	-	-	41±6
Dimargaris Total count	14	19	18
D. cristalligena van Tieghem	5±2	15±3	18±4
D. verticillata R.K. Benjamin	9±0	4±1	-
Embellisia indefessa Simmons	7±1	12±3	23±1
Epicoccum purpurascens Ehrenb.	9±2	10±1	7±0
Eurotium echinulatum Delacr.	14±5	26±4	-
Fusarium Total count	39	102	161
F. solani (Mart.) Sacc.	-	52± 2	47± 5
F. oxysporum Schlecht.	14±5	18± 3	54± 8
F. coeruleum (Lib.) Sacc.	25±1	-	60±7
F. ciliatum Link	-	32±4	-
Mortierella Total count	-	45	49
M. macrocystis W. Gams	-	-	12±0
M. oligospora Bjorling	-	45±6	-
M. zonata Linnemann ex W. Gams	-	-	37±5
Mucor Total count	37	48	53
M. pusillus Lindt	-	-	1±0
M. mucedo L. ex Fr.	13±4	32±7	34±2
M. hiemalis Wehmer	-	-	18±5
M. racemosus Fres.	24±1	16±5	-
Penicillium Total count	55	127	187
P. lanosum Westl.	-	29±3	26±5
P. notatum Westl.	8±1	25±2	11±0
P. citrinum Thom	12±4	-	43±8
P. nigricans (Bain.) Thom	7±2	-	-
P. expansum Link	-	14±1	32±5
P.frequentans Westl.	16±5	-	40±6
P. chrysogenum Thom	-	31±5	38±4
P. islandicum Sopp	12±3	28±2	-
Rhizopus Total count	18	20	17
R. microsporus van Tieghem	11±5	15±2	9±3
R. stolonifer (Ehrenb.:Fr.) Vuill	7±0	5±1	8±2
Scytalidium Total count	-	38	45
S. album Beyer & Klingstrom	-	6±1	-
S. aurantiacum Klingstrom & Beyer	-	9±2	45±7
S. hyalinum Campbell & Mulder	-	23±5	-
Stachybotrys Total count	6	-	35
S. kamplensis Hansford	2±1	-	11±3
S. bisbyi (Srin.) Barron	-	-	24±5
S. atra Corda	4±2	-	-
Torula Total count	-	14	
T. herbarum Link:Fr.	-	-	9±3
T. ndjilensis Kiffer	-	14±2	42±7
Trichoderma Total count	38	45	118
T. hamatum (Bon.) Bain.	31±6	-	12±1
T. harzianum Rifai	-	10±4	67±8
T. inhamatum Veerkamp & W. Gams	7±2	23±3	16±2
T. koningii Oudem	-	12±2	23±5
Ulocladium atrum Preuss	7±0	15±4	-

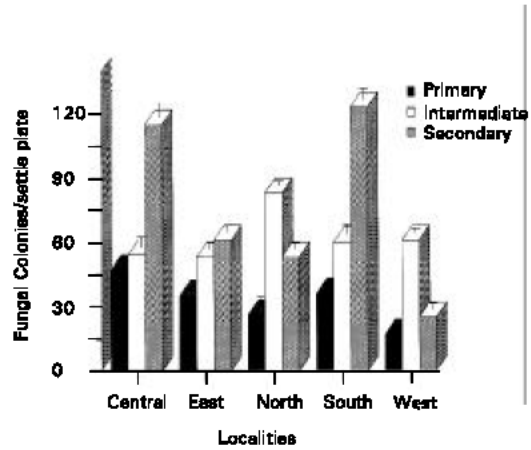

Fig. 1: Total number of fungal colonies per settle plate collected from schools at different localities of Riyadh, all values are means of triplicates ± S.D.

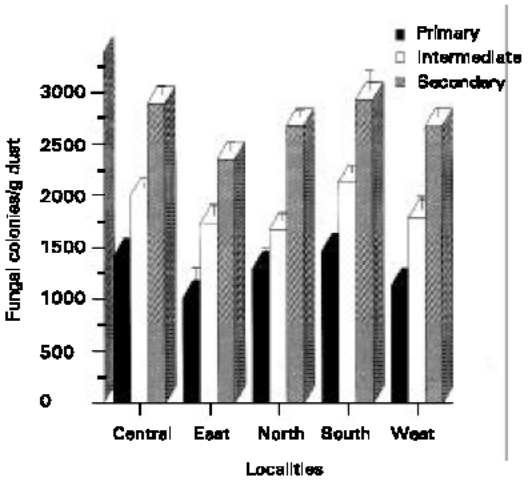

Fig. 2: Total number of fungal colonies per gram of schools dust collected from different localities of Riyadh, all values are means of triplicates ± S.D.

greater in densely populated stage (secondary) than in less populated stages (Fig. 2). Schools in the south of Riyadh yielded the highest number of colonies per gram of school dust (2923 colonies / g dust) followed by central localities with 2890 colonies per gram of school dust.

A total of 36 fungal species belonging to 6 genera were isolated from the air of schools at different places in Riyadh (Table 1). *Aspergillus* was the most common genus and was represented by 11 species. It was followed by *Penicillium* (8 species), *Alternaria* (5 species), *Fusarium* and *Mucor* (4 species each). *Penicillium expansum* exhibited the highest number of colonies per plate among the fungal species (52) followed by *Penicillium notatum* and *Mucor hiemalis*.

Fungi isolated from the school dust samples are given in Table 2. A total number of 68 fungal species belonging to 21 genera were isolated. The highest number of species was found in the secondary stage (50 species) followed by intermediate stage (45 species), while the lowest number of fungal species was observed in the primary stage, that was 36 species. *Aspergillus* was also a common genus here, with 13 species followed by *Penicillium* (8 species), *Chaetomium* (6 species), *Alternaria* (5 species), *Fusarium, Mucor,* and *Trichoderma* (4 species each). *Mortierella, Scytalidium* and *Stachybotrys* (3 species each). Two species were isolated from each of the genera *Blastobotrys, Cladosporium, Curvularia, Dimargaris, Rhizopus* and *Torula*. On the other hand, one specie each of *Botrytis, Embellisia, Epicoccum, Eurotium* and *Ulocladium* were isolated from the school dust of Riyadh city. *Aspergillus apicalis* exhibited the highest number of colonies per gram of school dust among the fungal species (89) followed by *Aspergillus clavatus* with 84 colonies per gram of school dust. *Aspergillus*, which yielded the highest number of dust species, and the second ranking *Penicillium* were also recorded earlier as the most prevalent genera in air of Riyadh city (Ali *et al.*, 1977; Baggy and Gohar, 1988; Bokhary and Parvez, 1995). *Aspergillus* and *Penicillium* species together with other common genera like *Alternaria, Fusarium, Mucor, Trichoderma, Cladosporium, Curvularia,* and *Ulocladium* which are prevalent genera in school dust, are also common in different types of environments and dusts (Palmgren *et al.*, 1983; Robert *et al.*, 1984; Abdel-Hafez and Shoreit, 1985; Abdel-Hafez *et al.*, 1986). These genera were reported as common genera of house dust (Hamada and Yamada, 1991; Bokhary and Parvez, 1995).

Fungi together with school dust and mites have become the allergens most frequently associated with allergic diseases like bronchial asthma (Bokhary and Parvez, 1995). Mites are associated with house-dust allergens and fungi may stimulate the population growth of the house-dust mites (Samson and Lustgraaf, 1978; Bokhary and Parvez, 1995). Most of the fungal genera found here were also reported from floor dust of schools (Mercantini *et al.*, 1986; Al-Shatayel and Arda, 1989), while *Aspergillus* and *Penicillium* were the prevalent genera of Muna atmosphere (Al-Falih, 2000) and air-conditioning dust from houses in Riyadh (Saad and El-Gindy, 1990; Bokhary and Parvez, 1995).

Conclusion: The study provides evidence of the air-borne fungal flora inhabiting school environments at different places in Riyadh city, Saudi Arabia. A total of 36 fungal species belonging to 6 genera were isolated from the air of schools at different places in Riyadh, while a total of 68 fungal species belonging to 21 genera were isolated from the schools dust. The highest number of fungal species was found in the secondary stage followed by intermediate stage. The primary stage, which had a less populated classroom, recorded the lowest number of fungal species. The commonest genera of fungi isolated were *Aspergillus* and *Penicillium*. Overall, the highest number of fungal colonies were obtained from schools in the south of Riyadh city followed by schools in the central area of Riyadh.

References

Abdel-Hafez, S.I.I., 1984. Survey of air-borne fungus spores at Taif, Saudi Arabia. *Mycopathol.*, 88: 39-44.

Abdel-Hafez, S.I.I. and A.A.M. Shoreit, 1985. Mycotoxins producing fungi and mycoflora of air-dust from Taif, Saudi Arabia. *Mycopathol.*, 92: 65-71.

Abdel-Hafez, S.I.I., A.A.M. Shoreit, A.I.I. Abdel-Hafez and O.M.O. Maghraby, 1986. Mycoflora and mycotoxin-producing fungi of air-dust particles from Egypt. *Mycopathol.*, 93: 25-32.

Al-Falih, A.M., 1997. The relationship between heavy metal concentration and soil mycoflora in the Gizan region, Saudi Arabia. Qatar Univ, Sci, J., 17: 111-119.

Al-Falih, A.M., 2000. Microbial Air Pollution of Muna Area, Makkah Region, Saudi Arabia. King Saud Univ. Sci. J., 13.

Al-Fryah, A., S.M. Hasnain and H.A. Harfi, 1989. Respiratory allergy and aero-allergens in Saudi Arabia. J. Allergy, Clin. Immunol., 83: 198-201.

Ali, M.I., A.H. Abu-Zinada and Z. Al-Mashharawi, 1977. Survey of air-borne mould flora at Riyadh, Saudi Arabia. Saudi Biol. Soc., 1: 215-228.

Al-Shatayel, M.S. and H.M. Arda, 1989. Isolation of keratinophilic fungi from floor dust in Arab elementary and preparatory schools in the west bank of Jordan. *Mycopathol.*, 106-111.

Baggy, M.M.K. and Y.M. Gohar, 1988. Mycoflora of air-conditioners dust from Riyadh Saudi Arabia. J. Basic Microbiol., 28: 571-577.

Basahy, AY., 1989. Effect of cement dust on the growth of some plants in Saudi Arabia. Symposium Saudi Bio. Soci., 12: 62-63.

Bokhary, H.A. and S. Parvez, 1995. Fungi inhabiting household environments in Riyadh, Saudi Arabia. *Mycopathol.*, 130: 79-87.

Bronswijk, J.E., D.S. George-Gridelet and B.V. Lustgraaf, 1986. An evolution of biological methods in house dust allergen research. *Allerg Immunol (Leipz).* 24: 18-22.

Hamada, N. and A. Yamada, 1991. Seasonal change in the fungal flora of house dust. Trans Mycol Soc Japan, 32: 45-53.

Holtmeyer, MG., J.R. Wallin, 1981. Incidence and distribution of airborne spores of *Aspergillus flavus* in Missouri. Plant Dis., 65: 58-60.

Johnson, L. F. and E.A. Curl, 1972. Methods of research on the ecology of soil-borne plant pathogens. Burgess Publ Co. Minnesota, USA.

Krillis, S., B.A. Baldo and A. Basten, 1985. Analysis of allargen-specific Immunoglobin E response in 341 allergic patients association between allergens and between allergen groups and clinical diagnosis. Aust. New Zealand, J. Med., 15: 421-426.

Mercantini, R., R. Marsella, L. Lambiase and M. Belardi, 1986. Isolation of keratinophilic fungi from floors in Roman kindergarten and secondary schools. *Mycopathol.*, 94: 109-115.

Mori, M., Y. Orgami and T. Takahashi, 1985. Microbial contamination of carpet dust in private houses. J. Antibact. Antifung. Agents, 13: 109-117.

Moustafa, A.F. and S.M. Kamal, 1976. A study of fungal spore population in the atmosphere of Kuwait. *Mycopathol.*, 59: 29-35.

Nelson, P.E., T.A. Toussoun and W.F.O. Marassas, 1983. *Fusarium* species. An Illustrated Manual for Identification. Penn, State Univ. Press, USA.

Palmgren, M.S., L.S. Lee, A.L. Delucca and A. Ciegler, 1983. Preliminary study of mycoflora and mycotoxin in grain-dust from New Orleans area grain elevators. Am. Ind. Hyd. Assoc. J., 44: 485-488.

Pepys, J., 1969. Hypersensitivity diseases of the lungs due to fungi and organic dusts. *Monogr Allergy*, 4: 72-89.

Pitt, J.I., 1979. The Genus Penicillium and Its Telomorphic States Eupenicillium and Talaromyces. Academic Press, London, UK.

Purchase, I.F.H., 1974. Mycotoxins. Elsevier Sciences Publishing Co, Inc, New York. USA.

Rafii, Z.S., 1990. Sinusitis in Saudi Children. Ann Saudi Med., 10: 504-507.

Ramirez, C., 1982. Manual and Atlas of Penicillia. Elsevier Biomedical Press. Amsterdam.

Robert, A.H., M.W. David, R.B. William and L.S. Odette, 1984. Viable fungi in corn dust. Appl. Environ. Microbiol., 47: 84-87.

Saad, R.R and A.A. El-Gindy, 1990. Fungi of the house dust in Riyadh, Saudi Arabia. *Zentrabl Microbiol.*, 145: 65-68.

Samson, R.A. and B. van der. Lustgraaf, 1978. *Aspergillus penicillioides* and *Eurotium halophilicum* in association with house-dust mites. *Mycopathol.*, 64: 13-16.