Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 8 (5): 842-847, 2008
ISSN 1812-5654

Pollen Concentration in the Atmosphere of Abha City, Saudi Arabia and its Relationship with Meteorological Parameters

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Abstract: A qualitative and quantitative evaluation of pollen concentration in the atmosphere of Abha city, Saudi Arabia with the relation to meteorological parameters is presented. Investigations were undertaken from January to December 2006 using a Burkard 7 day volumetric spore trap. A total of 6,492 pollen grains m^{-3} belonging to 50 pollen taxa was detected. Poaceae represented 55.1% of total pollen, Leguminosae (11.7%), Compositae (6.1%), Solanaceae (4.6%) and Cupressaceae (4.2%). Pollen grains were found throughout the year. July represented the highest peak of pollen number and also the highest pollen taxa. The monthly variation of pollen taxa and their relationship to meteorological parameters were investigated. It was found that the pollen concentration is positively correlated with temperature and negatively correlated with rainfall, relative humidity and wind velocity. May-September represented the months of highest pollen number (95% of total pollen).

Key words: Aerobiology, airborne pollen, meteorological factors, Saudi Arabia

INTRODUCTION

Pollen grains are male reproductive units and are released into the air in huge amounts for the purpose of pollination. The concentration of different pollen types in the atmosphere varies enormously from one country to another, in regions of the same country and even among different cities, because pollen emissions depend on the vegetational structure and meteorological conditions (Kaplan, 2004). A positive correlation of pollen concentration and surrounding vegetation density has been described (Romano *et al.*, 1988) indicating that changes in the floral composition of a given area have a direct influence on its aeropalynological spectrum. Ninety-eight percent of the total pollen grains in the atmosphere are from anemophile plants, whereas 2% are from entemophile plants (Mullins and Emberlin, 1997; Molina *et al.*, 2001).

Generally, meteorological parameters have an important influence on pollen concentration in the air. Aerial transport of pollen may have an important impact on earth life, which increases with economic expansion around the world (Ribeiro *et al.*, 2003).

In other countries, many of aeropalynological studies have been conducted for several years using different types of samplers (Giorato *et al.*, 2000; Villegas and Nolla, 2001; Mishra *et al.*, 2002; Murray *et al.*, 2002; Ballero and Maxia, 2003; Porsbjerg *et al.*, 2003; Rodrfguez-Rajo *et al.*, 2003; Paloma *et al.*, 2004; Hasnain *et al.*, 2005; Tejera and Beri, 2005; Ture and Salkurf, 2005).

In Saudi Arabia, aeropalynological studies are scarce but gaining importance (Hasnain *et al.*, 2005). However, the purpose of this study was to identify pollen grains in the air of Abha city, Saudi Arabia and their relation to meteorological parameters.

MATERIALS AND METHODS

Abha city (18°14` N and longitude 42°39` E, altitude of about 2093 m) lies in the Southwestern part of the Arabian Peninsula about 1100 km from Riyadh, the capital of Saudi Arabia. The city is characterized by moderate climate, heavy rainfall, green pasture and agricultural plateaus. The region abounds in mountains, valleys and fertile plains and surrounded by dense forests.

Pollen sampling was carried out from January to December, 2005 using a Burkard volumetric 7 day spore trap (Burkard Manufacturing Co. Ltd., England). The trap was placed on the roof of the laboratories building at the College of Science, King Khalid University, approximately 15 m above ground level. The Sampler was set for seven day sampling onto Melinex tape which was coated with a thin film of Lubriseal (Levetin, 1991). Tapes were changed weekly, cut into seven daily segments and mounted on microscope slides. Slides were stained with glycerin jelly containing basic fuchsin and examined microscopically at 400X using a single longitudinal traverse. Microscope counts were converted into atmospheric concentrations and expressed as pollen grains m^{-3}. Daily concentrations were summed for cumulative monthly totals. Pollen identification was followed using the books on palynology (Erdman, 1966, 1969; McDonald and O'Driscoll, 1980; Moore *et al*., 1991).

Meteorological data were kindly obtained from Abha Meteorological Station (No. 41112).

With the help of MINITAB computer programme, non-parametric statistical analysis by Spearman's rank test was applied to determine whether monthly pollen concentration and meteorological parameters were positively or negatively correlated (MINITAB, 1985). The statistical significance of correlation was studied by student's-test for paired samples following the methods of Subiza *et al*. (1992) and Vega-Maray *et al*. (2003).

RESULTS

During the year of observation, 6,492 pollen grains cm^{-3} belonging to 50 pollen taxa were found. The highest concentration of pollen was that of Poaceae (55.1%), Leguminosae (11.7%), Compositae (6.1%), Solanaceae (4.6%) and Cupressaceae (4.2%) (Table 1). The total pollen count varied throughout the year with the peak period in July (Fig. 1a). Brassicaceae is the only pollen taxon was found all year round with maximum concentration during October, followed by Compositae (9 months, from January-November) with maximum concentration during July, Poaceae (8 months, from March-December) with maximum concentration during July. Palmae and Crassulaceae were found all year round, except February and March with maximum concentration during June and August, respectively. The highest number of taxa was recorded in June (29 taxa), July (31 taxa) and August (24 taxa), whereas, the lowest number of taxa was recorded in February (5 taxa) (Table 2) which represented also the lowest number of pollen.

In the present investigation, most of pollen number was recorded during five months of the year (May-September) (95% of total pollen). During this period, Poaceae, Leguminosae, Compositae, Solanaceae and Cupressaceae were prevailed.

In the present investigation, the influence of meteorological factors on the pollen concentration was studied (Fig. 1a-c and 2a-c). Here, a positive and statistically significant correlation was found between the air temperature and pollen concentration. Conversely, a negative correlation was observed between rainfall, relative humidity and wind velocity and pollen concentration (Table 3).

Maximum concentration of pollen grains was found mostly between June-September (Fig. 1a), probably due

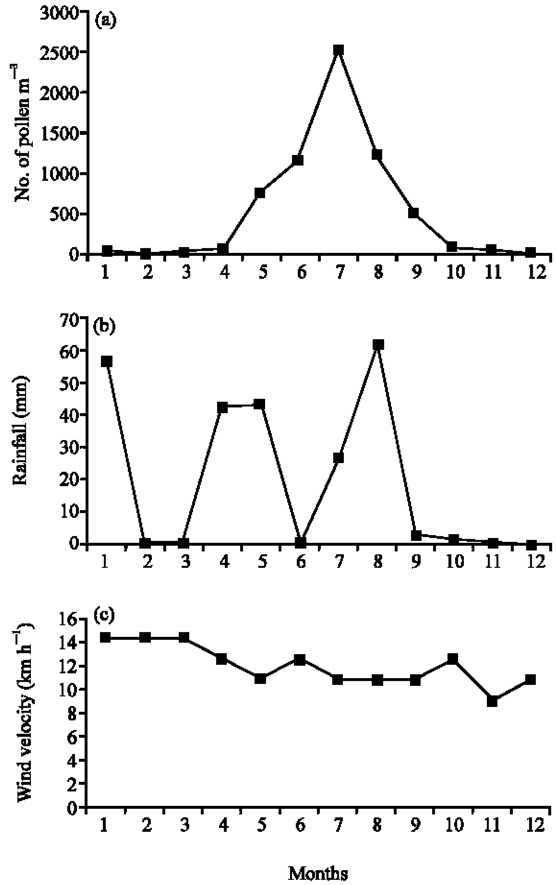

Fig. 1: Relationship between pollen number (a) rainfall (b) and wind velocity (c) during the year of study

to moderately high temperature, low relative humidity, moderately low wind velocity and low rainfall. The count became very low during January-April and October-December may be due to high wind velocity. Thus the pollen concentration depends upon the climatic factors and this has been statistically supplemented. A correlation was made between the monthly total pollen count (Table 3) and meteorological parameters through statistical analysis. From the value of the correlation coefficient (r), it was found that pollen concentration was positively correlated with temperature and negatively correlated with rainfall, relative humidity and wind velocity during the year (Table 3). The level of significance was also determined from the statistical table. In case of temperature, the level of significance was below 0.1, while it was between 0.1-0.05 for rainfall and between 0.01-0.001 for relative humidity and below 0.1 for wind velocity.

Table 1: Monthly pollen taxa found in the air of Abha city from January (1) December (12), 2006

	Months												Total pollen	
Pollen taxa	1	2	3	4	5	6	7	8	9	10	11	12	Total /m^3	%
Plumbaginaceae						1							1	0.02
Pinaceae					2	3							5	0.08
Amaranthaceae							69	10	10				89	1.40
Rosaceae			9	8	12	9							38	0.60
Rubiaceae								1					1	0.02
Salicaceae											7	8	15	0.20
Asclepidiaceae						2							2	0.03
Umbelliferae	2		1	2	2	11					1	1	20	0.30
Solanaceae	9	8	16	50	79	61	76						299	4.60
Scrophulariaceae	3				1	12	1				1		18	0.30
Chenopodiaceae						8	10	87	7				112	1.70
Convolvulaceae						3	12						15	0.20
Geraniaceae					2								2	0.03
Myrtaceae						39	105	24	7	2			177	2.70
Capparaceae							2						2	0.03
Cupressaceae						10	160	102	2				274	4.20
Poaceae			5	4	620	730	990	790	402	20	7	7	3575	55.10
Caryophyllaceae						12	5						17	0.30
Betulaceae						12	7						19	0.30
Boraginaceae						13	1						14	0.20
Leguminosae					1	4	650	99	6				760	11.70
Moraceae					9	14	9		2				34	0.50
Urticaceae					1	5							6	0.10
Labiatae						4	1	1					6	0.10
Papavaraceae								1					1	0.02
Euphorbiaceae			2	5	5	7							19	0.30
Aloaceae							3						3	0.05
Portulacaceae							2						2	0.03
Resedaceae									1				1	0.02
Brassicaceae	6	2	4	2	2	8	8	6	9	48	18	5	118	1.80
Primulaceae								1					1	0.02
Palmae	3			1	1	6	3	1	1	3	1	1	21	0.30
Plantaginaceae		2			1	4	73	5					85	1.30
Casuarinaceae							4	7	1	1			13	0.20
Polygonaceae									1				1	0.02
Rhamnaceae							1						1	0.02
Acanthaceae							9						9	0.10
Compositae	6	3	5	3	6	120	140	34	45	16	18		396	6.10
Ericaceae								6					6	0.10
Dracaenaceae								1					1	0.02
Crassulaceae	2			1	1	4	3	5	1	4	1	1	23	0.40
Malvaceae		1			1	3	120	9					134	2.10
Commelinaceae							4	7	1	1			13	0.20
Santolaceae							1						1	0.02
Cyperaceae					9	38	38						85	1.30
Ranunculaceae						7	5	1					13	0.20
Betulaceae						2	5	12					19	0.30
Typhaceae								2	7				9	0.10
Apocyanaceae	1				1			1		1	1		5	0.10
Asparagaceae										3	5	3	12	0.20
Total	32	16	42	76	756	1152	2517	1213	503	99	60	26	6492	100.00

Table 2: Monthly number of pollen taxa recorded during the period of study

Months	No. of pollen taxa
January	8
February	5
March	7
April	9
May	20
June	29
July	31
August	24
September	16
October	10
November	10
December	7

Table 3: Correlation between meteorological parameters and monthly total pollen count (coefficient of correlation (r) values)

	Temperature	Rainfall	Relative humidity	Wind velocity
Rainfall	0.579			
Relative humidity	0.498	0.826		
Wind velocity	0.427	0.245	0.377	
Total pollen	0.084	-0.532	-0.801	-0.122

Degree of Freedom (DF) (12-2 = 10)

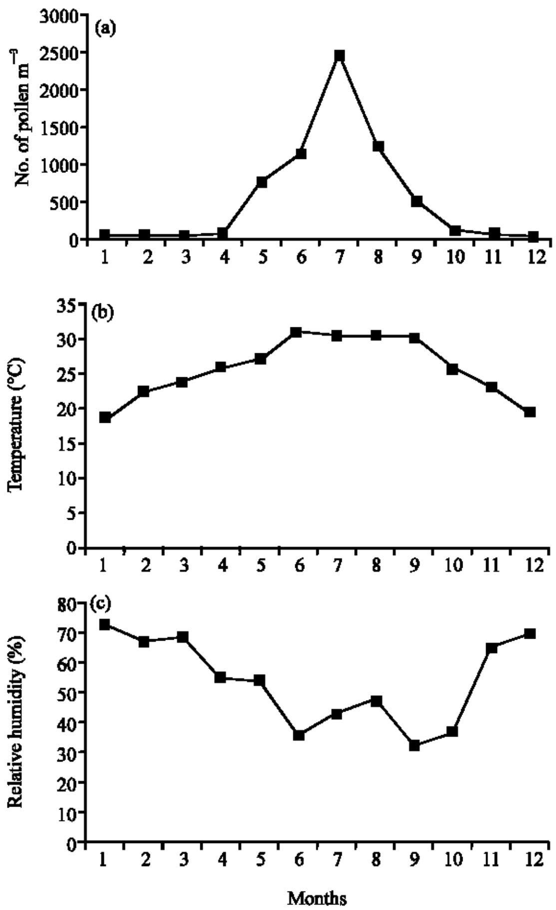

Fig. 2: Relationship between pollen number (a), temperature (b) and relative humidity (c) during the year of study

DISCUSSION

The frequency of pollen differs from place to another due to the difference in geographical position, local vegetation and other environmental conditions (Subiza *et al*., 1992; Frenze, 2000; Vega-Maray *et al*., 2003). Frenze (2000) demonstrated that airborne pollen concentrations exhibit spatial variability, as pollens from nearby vegetation exert a profound local influence. Moreover, the size of source area represented by a pollen sampler depends on the distance between the sampler and the nearest vegetation. The present results support the view of Frenze (2000), because of high incidence of Poaceae, Leguminosae, Compositae, Solanaceae and Cupressaceae pollens was probably due to the presence of a large area of such vegetation and grass loan, in and around the sampling site.

Magnitude and quality of annual pollen load in the atmosphere varies significantly. Meteorological parameters like temperature, rainfall, relative humidity, wind velocity are responsible for fluctuations in pollen concentration (Anderson, 1980; Bricchi *et al*., 1992).

In the present investigation, the influence of meteorological factors on the pollen concentration was studied. Here, a positive and statistically significant correlation was found between the air temperature and the pollen concentration. Conversely, a negative correlation was observed between rainfall, relative humidity and wind velocity and pollen concentration. The present results are consistent with previous observations in different countries (Puc and Wolski, 2002; Vega-Maray *et al*., 2003; Boral *et al*., 2004).

Apart from rhythm of plant pollination, meteorological conditions are considered the most important factors determining the dispersion and content of pollen in the air (Subiza *et al*., 1992; Puc and Wolski, 2002). Subiza *et al*. (1992) have shown that humidity and rainfall appear to be the predominant factors in determining the grass pollen potential for the season. It is evidenced that temperature is the factor that exerts the greatest influence on the release of pollen grains in the atmosphere (Puc, 2003; Vega-Maray *et al*., 2003). Rainfall and relative humidity yielded negative correlations since water droplets wash away pollen particles (Vega-Maray *et al*., 2003). Puc and Wolski (2002) showed a positive and statistically significant correlation between the air temperature and the *Betula* pollen concentration, while a similar but negative correlation was found for *Populus* pollen. A relationship was established between the airborne ragweed pollen concentration and the macrosynoptic weather situation (Feher and Jarai-Komlodi, 1996).

Therefore, the aerobiological survey in relation to meteorological parameters has proved that weather factors have great influence on the occurrence and distribution of pollen grains in the atmosphere.

Fifty airborne pollen taxa have been identified from Abha city. Poaceae, Leguminosae, Compositae, Solanaceae and Cupressaceae recorded the highest pollen number throughout the year of investigation. July represented the highest peak of pollen number and also the highest pollen taxa. A positive correlation was found between pollen concentration and air temperature,

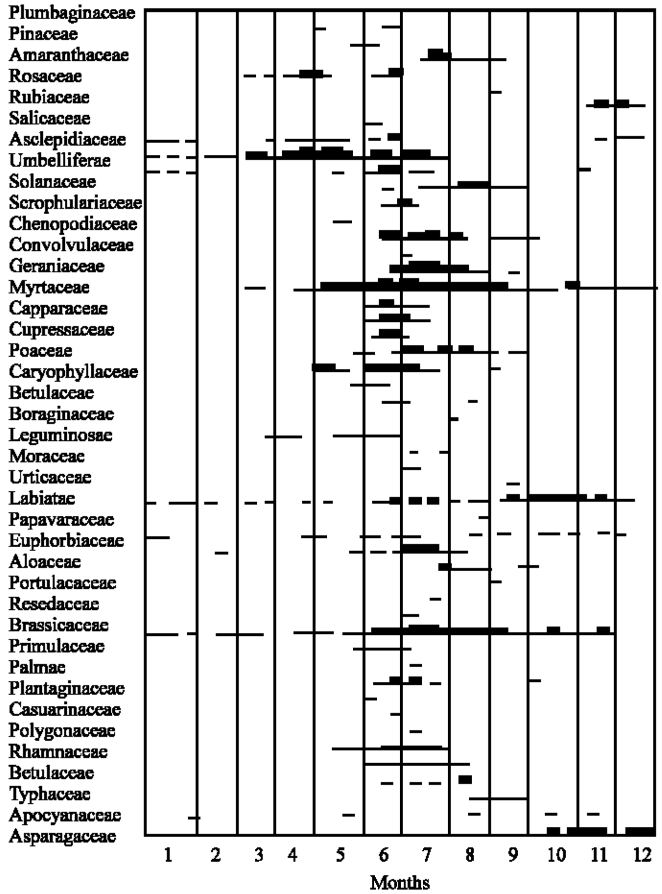

Fig. 3: One-year (2006) pollen calendar of Abha city

while a negative correlation of pollen concentration was observed with rainfall, relative humidity and wind velocity.

This study gives an idea about the airborne pollen types present in the Abha atmosphere and gives also an indication of their main flowering seasons (Fig. 3). It can be concluded that Abha receives a large pollen concentration from grasses, weeds, ornamental trees and shrubs found around the city. However, an aeropalynological study of 1 year is not sufficient to analyze seasonal variations of airborne pollen. It would be necessary to extend these studies to more years and to other strategically placed areas to achieve a global pollen calendar for the city and to improve the knowledge of flowering and pollen dynamics and its relation to the meteorological parameters.

ACKNOWLEDGMENTS

This study was financially supported by SABEC Company, Saudi Arabia. The author is grateful to the Department of Biology, College of Science, King Khalid University for providing the facilities of this study.

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