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Prevalence of airborne allergenic *Amaranthus viridis* pollen in seven different regions of Saudi Arabia

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BACKGROUND: *Amaranthus* pollen grains are known to be highly allergenic and a potential cause of respiratory allergic diseases. Nevertheless, data on the prevalence of *Amaranthus* pollen in the environment is limited and almost non-existent for Saudi Arabia.

METHODS: We conducted an investigation to record the airborne incidence of *A. viridis* and other allergenic pollen in Al-Khobar, Dammam, Hail, Jeddah, Jizan, Qassim and Taif, using Burkard Volumetric Samplers. The samplers were operated continuously for one year at each location.

RESULTS: The data revealed *A. viridis* as one of the major components of outdoor airspora, constituting a maximum of 96% of total pollen counts in Hail, followed by Al-Khobar (89%), Jeddah (87%), Qassim (85%), Taif (84%), Dammam (83%) and Jizan (61%). These higher percentages contributed largely to the total weed pollen catch during August to November in all seven regions. In addition, the data also showed that *A. viridis* pollen were present throughout the year with distinct seasonal variations. The diel periodicities for at least five sites averaged over a year showed mid-day to early evening maxima. The maximum concentration approached 3000/m^3 of air in October and 1827/m^3 of air in September. The data also exhibited a seasonal pattern in their maximum appearance.

CONCLUSION: Further studies related to biochemical and allergological aspects are needed to confirm the allergenic impact of *Amaranthus* pollen and sensitization in allergic individuals in the Kingdom of Saudi Arabia.

Amaranthus viridis, also called slender amaranth or pigweed, is a cosmopolitan naturally growing weed found widespread in temperate and tropical regions of the world. It grows mainly on wastelands, along water coarses and as a weed in cultivated crops. It is known to flower all through the year and produce enormous amounts of pollen in the airspora. Of several species of *Amaranthus*, only eight species are known to exist in Saudi Arabia. Among these, *A. spinosus, A. graecizans, A. viridis* and *A. lividus* are considered the most common weeds.[1]

Allergenicity to a few species of *Amaranthus* pollen has been reported.[2,3] Many genera belonging to Chenopodiaceae and Amaranthaceae are also well known for causing pollinosis.[2,4] However, only a few reports have documented the airborne occurrence of *A. viridis* pollen.[5-9] Apparently, no detailed study on seasonal and diel periodicities of *A. viridis* pollen has been previously undertaken or published. The objective of the current study was to determine the airborne incidence of *A. viridis* pollen in different regions in Saudi Arabia, and to describe their seasonal and diurnal (diel) periodicities.

METHODS

Atmospheric samplings at seven major regions (Al-Khobar, Dammam, Hail, Jeddah, Jizan, Qassim and Taif) in Saudi Arabia were conducted using Burkard Seven-Day Volumetric Spore Traps. The traps were operated continuously for more than 12-month periods and one-year data were included for each site during 1994-2001.

Al-Khobar (sampled during the years 1998-1999) is a comparatively newly developed city, with major oil fields located in the region and it has become the commercial hub of the eastern province. Dammam (1999-

2000) is a newly developed business city on the east coast. Hail (1996-1997), a newly developed city in the Northern province of Saudi Arabia, is a rich agricultural region. Jeddah (2000-2001) is an ancient coastal city by the Red Sea. Jizan (1994-1995) is another ancient coastal city by the Red Sea in the Southern province. Qassim (1997-1998), located in the central province of Saudi Arabia, is mostly an agricultural region. Taif (1995-1996), located in the western province of Saudi Arabia and situated on a plateau, is a hilly summer resort with deciduous plants and highlands.

The Burkard Volumetric (7-day recording) Samplers were installed on the roof of hospital buildings and the intake orifice of the samplers was approximately 10 meters above the ground level. Samplers were set for 7-day sampling onto Melinex tape. Air was drawn through the 2×14-mm orifice at 10 L/min to impact onto adhesive-coated, transparent tape. The tapes were changed weekly and cut into one-day (24 hour) segments, which were mounted with a gelvatol-phenol mixture onto a microscopic slide. Identification and counting were undertaken in 10 random fields for each hourly count (4-mm traverse) for each 24-hour period (=240 fields). Slides were scanned at a magnification of ×400 for counting and, where necessary, ×1000 under oil immersion for identification. The trap operates on the principle of "impaction through suction" with a 2-mm movement of the drum each hour. Spores were converted to cubic meter of air by a factor obtained by applying the formula: concentration of propagules m^3 =NT AE/n×a×V_a, where NT is the total number of spores counted in "n" areas, n is the number of fields counted (=10 field areas), a is a field area, mm^2 (= 0.15205 mm^2); V_a is the air volume sampled (m^3)(0.63) and AE is the total effective area, mm^2 (i.e. long axis of orifice × distance tape moves in hour, 14×2=28 mm^2) (Hasnain et al., 1984, 2004a).[10] Based on the above equation, each hour counts were added to calculate daily mean/m^3 and monthly mean/m^3 of air.

RESULTS

The results were recorded in various individual categories. The weeds pollen group mostly included common airborne pollen grains from weeds, viz., *Amaranthus viridis, Plantago spp., Rumex vesicarius, Atriplex spp., Cyperus rotundus, Chenopodium album* and *Ricinus communis*. However, in this communication only data relating to *A. viridis* are presented. The percent catch (Table 1) of *A. viridis* pollen out of total pollen encountered from seven different regions for 12 months of the year reveals that *A. viridis* pollen constituted a maximum of 89% (October) in Al-Khobar, followed by 83% in Dammam (September), 96% in Hail (September), 87% in Jeddah (October), 61% in Jizan (October), 85% in Qassim (September and October) and 84% in Taif (October). In other months, *A. viridis* pollen were found to be less frequent in all regions. The data exhibited a distinct rise in percent catch of *A. viridis* pollen during August to November.

Data for diel periodicities are based on accumulated monthly mean values per cubic meter for each site for a complete 12 months. The data exhibit a mild trend of diurnal pattern with day time maxima for three sites (Qassim, Taif and Al-Khobar), and a clear dirunal pattern for one site (Hail) (Figure 1). At the other two sites, because of low concentration, no such trend was obtained.

The maximum concentrations of *A. viridis* pollen at the seven different sites are presented in Figure 2. The data also exhibited a seasonal pattern in their maximum appearance starting from August to November showing a peak in September and October. The maximum concentration of *A. viridis* pollen during these months reached 1827-3000/m^3 in the Hail region followed by

Table 1. Percentages of *A. viridis* pollen of total airborne pollen over sampling year for each site.

Sites	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Al-Khobar	48	31	11	17	50	48	60	68	76	89	65	49
Dammam	44	42	10	18	24	18	20	36	83	78	51	43
Hail	18	7	3	1	2	3	5	48	96	52	78	62
Jeddah	15	24	14	10	47	55	50	84	20	87	75	68
Jizan	3	3	0	0.4	0.3	2	0	26	61	56	7	0
Qassim	31	38	28	21	45	41	31	56	85	85	80	67
Taif	1	2	2	0.5	0.1	0.4	3	9	80	84	25	6

Numbers are percentage. 0=no pollen.

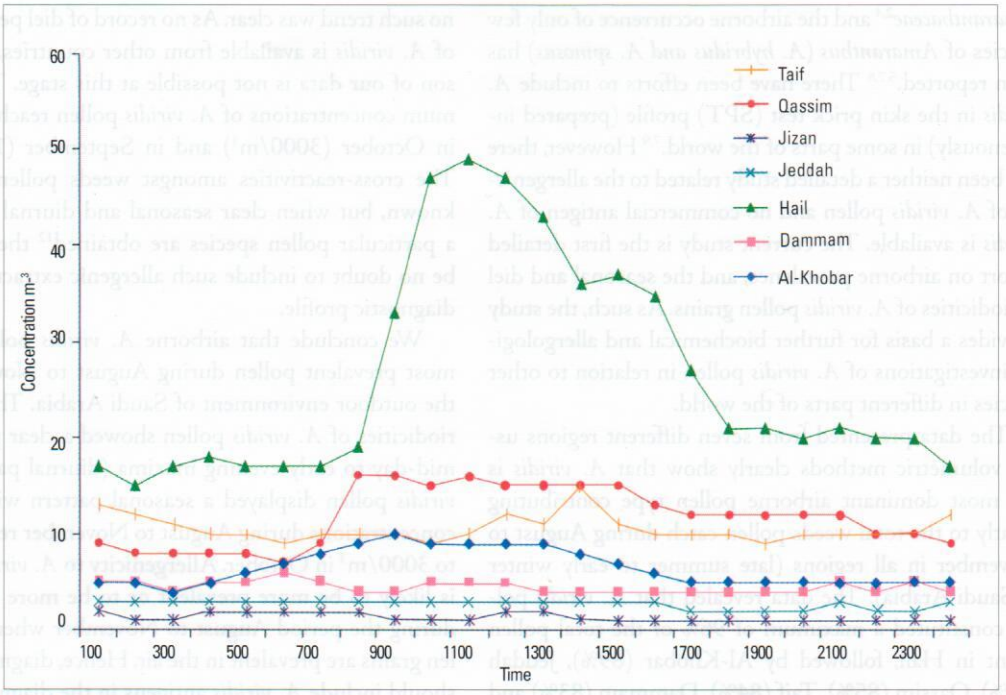

Figure 1. Diel periodicities of airborne *Amaranthus viridis* pollen in seven different regions of Saudi Arabia.

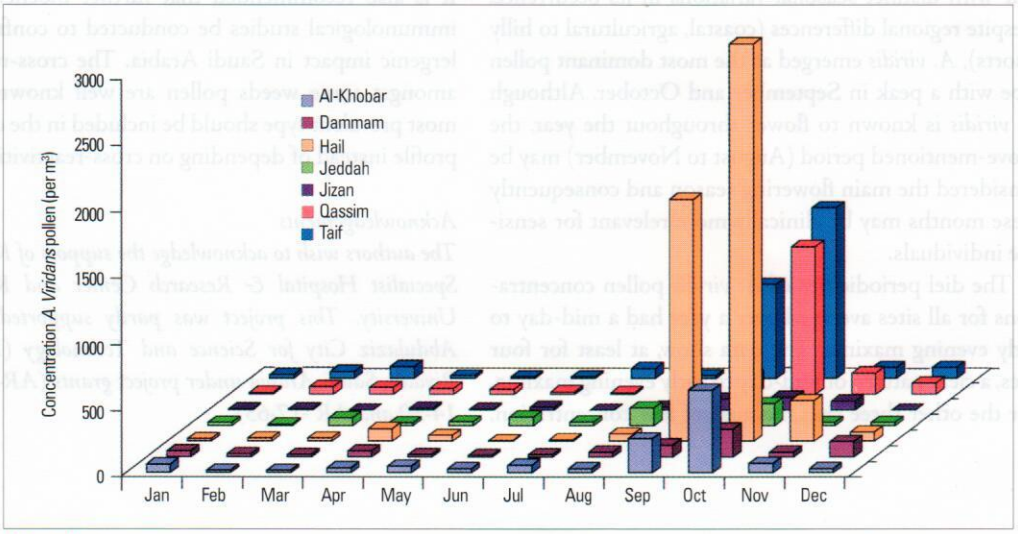

Figure 2. Maximum concentration of airborne *Amaranthus viridis* pollen in seven different regions of Saudi Arabia.

1289/m^3 in Taif, 1115/m^3 in Qassim, 622/m^3 in Al-Khobar, 212/m^3 in Dammam, 167/m^3 in Jeddah and 96/m^3 in Jizan. The rest of the months had low concentrations of pollen.

DISCUSSION

Pollen from some species of *Amaranthus* weed are known to be highly allergenic[2,3] and consequently commercial diagnostic allergens are available only for three species (*A. spinosus, A. retroflexus, and A. palmeri*) out of approximately 87 species known to exist.[12] Two species of *Amaranthus*, namely *A. retroflexus and A. spinosus* are known to be included in the skin test profile.[2,4] The cross-reactivity of some members of *Chenopodiaceae* and

Amaranthaceae[2,4] and the airborne occurrence of only few species of *Amaranthus* (*A. hybridus and A. spinosus*) has been reported.[5,7,8] There have been efforts to include *A. viridis* in the skin prick test (SPT) profile (prepared indigenously) in some parts of the world.[7,9] However, there has been neither a detailed study related to the allergenicity of *A. viridis* pollen and no commercial antigen of *A. viridis* is available. The current study is the first detailed report on airborne prevalence, and the seasonal and diel periodicities of *A. viridis* pollen grains. As such, the study provides a basis for further biochemical and allergological investigations of *A. viridis* pollen in relation to other species in different parts of the world.

The data presented from seven different regions using volumetric methods clearly show that *A. viridis* is the most dominant airborne pollen type contributing greatly to the total weeds pollen catch during August to November in all regions (late summer to early winter in Saudi Arabia). The data revealed that *A. viridis* pollen constituted a maximum of 96% of the total pollen count in Hail, followed by Al-Khobar (89%), Jeddah (87%), Qassim (85%), Taif (84%), Dammam (83%) and Jizan (61%). In addition, the data also showed that *A. viridis* pollen are present in the airspora throughout the year with distinct seasonal variations in its occurrence. Despite regional differences (coastal, agricultural to hilly resorts), *A. viridis* emerged as the most dominant pollen type with a peak in September and October. Although *A. viridis* is known to flower throughout the year, the above-mentioned period (August to November) may be considered the main flowering season and consequently these months may be clinically more relevant for sensitive individuals.

The diel periodicities of *A. viridis* pollen concentrations for all sites averaged over a year had a mid-day to early evening maxima. The data show, at least for four sites, a clear pattern of mid-day to early evening maxima. For the other three sites, because of low concentration, no such trend was clear. As no record of diel periodicities of *A. viridis* is available from other countries, comparison of our data is not possible at this stage. The maximum concentrations of *A. viridis* pollen reached a peak in October (3000/m^3) and in September (1867/m^3). The cross-reactivities amongst weeds pollen are well known, but when clear seasonal and diurnal trends of a particular pollen species are obtained[12] there should be no doubt to include such allergenic extract(s) in the diagnostic profile.

We conclude that airborne *A. viridis* pollen is the most prevalent pollen during August to November in the outdoor environment of Saudi Arabia. The diel periodicities of *A. viridis* pollen showed a clear pattern of mid-day to early evening maxima (diurnal pattern). *A. viridis* pollen displayed a seasonal pattern with higher concentrations during August to November reaching up to 3000/m^3 in October. Allergenicity to *A. viridis* pollen is likely to be more prevalent or to be more suspected during the period August to November when the pollen grains are prevalent in the air. Hence, diagnostic tests should include *A. viridis* antigens in the diagnostic profile of allergens for diagnosis of patients suffering from allergic symptoms during this above-mentioned period. It is also recommended that further biochemical and immunological studies be conducted to confirm its allergenic impact in Saudi Arabia. The cross-reactivities amongst some weeds pollen are well known, but the most prevalent type should be included in the diagnostic profile instead of depending on cross-reactivities.

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