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

Syed M. Hasnain,* Khatija Fatima,† Abdulrahman Al-Frayh†

From the *Department of Biological and Medical Research MBC-O3 King Faisal Specialist Hospital and Research Center, Riyadh and the †College of Medicine, King Saud University, Riyadh, Saudi Arabia

Correspondence and reprint requests: Syed M. Hasnain PhD · MBC-03 · King Faisal Specialist Hospital & Research Center · PO Box 3354 · Riyadh 11211 · Saudi Arabia · hasnain@kfshrc.edu.sa · Accepted for publication February 2007

Ann Saudi Med 2007; 27(4): 259-263

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 allergic impact of *Amaranthus* pollen and sensitization in allergic individuals in the Kingdom of Saudi Arabia.
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. Taif (1995-1996), located in the western province of Saudi Arabia, is mostly an agricultural region. 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.

The 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/m³ in the Hail region followed by

**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.*, *Ramex 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 diurnal 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/m³ 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   | 0.4 | 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.
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 and the airborne occurrence of only few species of Amaranthus (A. hybridus and A. spinosus) has been reported. 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 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.

Acknowledgements
The authors wish to acknowledge the support of King Faisal Specialist Hospital & Research Center and King Saud University. This project was partly supported by King Abdulaziz City for Science and Technology (KACST); Riyadh, Saudi Arabia under project grants (AR-7-45, AR 14-30 and AR-17-65).
REFERENCES

1. Chaudary SA, Akram M. Weeds of Saudi Arabia and Arabian Peninsula. National Herbarium Regional Agriculture and Water Research Centre, Ministry of Agriculture and Water, Riyadh, K.S.A. (Book) 1987.
2. Wurtzen PA, Nelson HS, Lowenstein H, Ipson H. Characterization of Chenopodiales (Amaranthus retroflexus, Chenopodium album, Kochia scoparia, Salvia pestifer) pollen allergens. Allergy 1995: 50 (6): 489-97.
3. Singh AB, Dahiya P. Antigenic and allergenic properties of Amaranthus spinosus pollen. A commonly growing weed in India. Ann Agri Environ Med 2002: 9: 147-151.
4. Lombardero M, Duffert D, Selles JG, Hernandez J, Carriera J. Cross-reactivity among Chenopodiaceae and Amaranthaceae. Ann Allergy 1985: 54 (5): 430-436.
5. Bolick MR. Airborne pollen survey for Lincoln Nebraska III. Weeds. Nebr. Med 1991: 76 (6): 178-81.
6. Bucholtz GA, Lockey RF, Wunderlin RP, Binford LR, Stabilein JJ, Serbousek D, Caldas EF. A three-year aerobiologic pollen survey of the Tampa Bay Area, Florida. Ann. Allergy Asthma Immunol 1991: 67: 534-540.
7. Chakraborty P, Bhattacharya SG, Choudary J, Majumdar MR, Chandra S. Differences in concentrations of allergenic pollens and spores at different heights on an agricultural farm in West Bengal, India. Ann. Agri. Environ Med 2001: 8: 123-130.
8. Singh AB, Kumar P. Aeroallergens in clinical practice of allergy in India. An Overview. Ann-Agri Environ Med 2003: 10: 131-136.
9. Boral D, Chatterjee S, Bhattacharya K. The occurrence and allergising potential of airborne pollen in West Bengal, India. Ann Agri Environ Med 2004:11: 45-52.
10. Hasnain S.M., Newhook F.J., Wilson, J.D., Corbin, J.B (1984): First report of Ganoderma allergenicity in Auckland, New Zealand. N.Z.J. Sciences 27(3): 261-267.
11. Mujica A and Jacobsen SE. The genetic resources of Andean grain Amaranthus (A.caudatus L., A. cruentus L. and A.hipochondriacus L) in America. Plant Genetics Resources Newsletter 2003: 133: 41-44.
12. Al-Frayh AR, Hasnain SM, Gad-el-Rah M0, Al-Turki T, Al-Mobeireek K and Al-Sedairy ST. Human sensitization to Prosopis juliflora antigen in Saudi Arabia. Annals of Saudi Medicine 1999: 19 (4): 331-336.