Allergy EUROPEAN JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY

EAACI

Allergy

BRIEF COMMUNICATION

Airborne olive pollen counts are not representative of exposure to the major olive allergen Ole e 1

C. Galan[1], C. Antunes[2,3], R. Brandao[2], C. Torres[1], H. Garcia-Mozo[1], E. Caeiro[2], R. Ferro[2], M. Prank[4], M. Sofiev[4], R. Albertini[5], U. Berger[6], L. Cecchi[7], S. Celenk[8], Ł. Grewling[9], B. Jackowiak[9], S. Jäger[6], R. Kennedy[10], A. Rantio-Lehtimäki[11], G. Reese[12], I. Sauliene[13], M. Smith[6], M. Thibaudon[14], B. Weber[12], I. Weichenmeier[15,16], G. Pusch[15,16] & J. T. M. Buters[15,16] on behalf of the HIALINE working group

[1]Department of Botany, Ecology and Plant Physiology, University of Córdoba, CeiA3, Córdoba, Spain; [2]ICAAM – Institute of Mediterranean Crop and Environmental Sciences, University of Évora, Évora, Portugal; [3]Center for Neuroscience and Cell Biology (CNC), University of Coimbra, Coimbra, Portugal; [4]Finnish Meteorological Institute, Helsinki, Finland; [5]Laboratory of Allergology, Department of Clinical and Experimental Medicine, University of Parma, U.O. Medical Immunology, University Hospital of Parma, Parma, Italy; [6]Department of Oto-Rhino-Laryngology, Research Unit Aerobiology and Pollen Information, Medical University of Vienna, Vienna, Austria; [7]Interdepartmental Centre of Bioclimatology, University of Florence, Florence, Italy; [8]Aerobiology Laboratory, Biology Department, Science and Arts Faculty, Uludag University, Gorukle-Bursa, Turkey; [9]Laboratory of Aeropalynology, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland; [10]National Pollen and Aerobiology Research Unit, University of Worcester, Worcester, UK; [11]Aerobiology Unit, University of Turku, CERUT, Turku, Finland; [12]Allergopharma Joachim Ganzer KG, Reinbek, Germany; [13]Department of Environmental Research, Siauliai University, Siauliai, Lithuania; [14]RNSA (Réseau National de Surveillance Aérobiologique), Brussieu, France; [15]ZAUM – Center of Allergy and Environment, Helmholtz Center Munich/Technische Universität München, Munich, Germany; [16]Christine Kühne Center for Allergy Research and Education (CK-CARE), Kühne Foundation, Munich, Germany

To cite this article: Galan C, Antunes C, Brandao R, Torres C, Garcia-Mozo H, Caeiro E, Ferro R, Prank M, Sofiev M, Albertini R, Berger U, Cecchi L, Celenk S, Grewling Ł, Jackowiak B, Jäger S, Kennedy R, Rantio-Lehtimäki A, Reese G, Sauliene I, Smith M, Thibaudon M, Weber B, Weichenmeier I, Pusch G, Buters JTM, on behalf of the HIALINE working group. Airborne olive pollen counts are not representative of exposure to the major olive allergen Ole e 1. *Allergy* 2013; **68**: 809–812.

Keywords
allergy; enzyme-linked immunosorbent assay; HIALINE; model.

Correspondence
Jeroen T. M. Buters, ZAUM – Center of Allergy & Environment, Helmholtz Center Munich/Technische Universität München, Biedersteinerstrasse 29, 80802 Munich, Germany.
Tel.: +49 89 41403487
Fax: +49 89 41403453
E-Mail: buters@lrz.tum.de

Accepted for publication 9 February 2013

DOI:10.1111/all.12144

Edited by: Reto Crameri

Abstract

Pollen is routinely monitored, but it is unknown whether pollen counts represent allergen exposure. We therefore simultaneously determined olive pollen and Ole e 1 in ambient air in Córdoba, Spain, and Évora, Portugal, using Hirst-type traps for pollen and high-volume cascade impactors for allergen.

Pollen from different days released 12-fold different amounts of Ole e 1 per pollen (both locations $P < 0.001$). Average allergen release from pollen (pollen potency) was much higher in Córdoba (3.9 pg Ole e 1/pollen) than in Évora (0.8 pg Ole e 1/pollen, $P = 0.004$). Indeed, yearly olive pollen counts in Córdoba were 2.4 times higher than in Évora, but Ole e 1 concentrations were 7.6 times higher. When modeling the origin of the pollen, >40% of Ole e 1 exposure in Évora was explained by high-potency pollen originating from the south of Spain. Thus, olive pollen can vary substantially in allergen release, even though they are morphologically identical.

In the southwest Iberian Peninsula, olive pollen (*Olea europaea* L.) is the second largest cause of pollinosis with sensitization rates up to 80% of the population (1, 2). Ole e 1 is the major olive pollen allergen (3, 4). It is unknown whether pollen exposure represents allergen exposure, as only few studies addressed airborne Ole e 1 (5–7).

We therefore assessed airborne Ole e 1 and olive pollen simultaneously in Córdoba (south of Spain) and Évora (south of Portugal). The sites are only 400 km apart, but differ in olive tree cultivars, olive pollen exposure, and climate.

Results

Pollen count

The 2009 olive pollen seasons in Córdoba and Évora followed similar trends (Table 1 and Fig. 1), except that

Table 1 Characteristics of pollen and allergen at the two stations

		Córdoba	Évora
Pollen			
Peak	pollen/m^3	2388	1399
Peak day	date	09/05	09/05
Pollen index‡	Σ pollen/m^3	29,956	12,659
Season length§	days	36	28
Ole e 1 allergen			
Peak value	pg Ole e 1/m^3	10 013	2 302
Peak day	date	28/05	28/05
Allergen index‡	Σ Ole e 1/m^3	108 720	14 375
Pollen potency¶	pg Ole e 1/pollen	3.87 ± 0.22	0.81 ± 0.19***
Till 18/05	pg Ole e 1/pollen	3.53 ± 0.55	0.68 ± 0.159***
From 25/05	pg Ole e 1/pollen	4.32 ± 0.15	3.36 ± 0.479*†

*$P < 0.05$ and ***$P < 0.001$ (Évora compared with Córdoba, Student's *t*-test).
†$P < 0.001$ (peak 'from 25th' compared with the whole season).
‡Sum of all pollen or allergen per season.
§Season was defined as 1% till 95% of all olive pollen for that season, according to the recommendations of the European Aeroallergen Network (ean.polleninfo.eu).
¶From linear regression.

the seasonal pollen index (Σ daily average pollen/m^3) in Córdoba was 2.4 times higher than Évora. Compared with the mean of the preceding 10 years, the pollen index in 2009 was 50% and 30% higher in Córdoba and Évora, respectively.

Allergen count

Quality control was obtained by running control samples with each enzyme-linked immunosorbent assay (ELISA). Córdoba systematically yielded 11.5% higher values for the controls ($P < 0.05$). This was below the 15% variability generally encountered for other ELISAs (8).

In Évora, Ole e 1 was detected for 83.6% ± 10.7% in the PM>10 μm fraction and for only 16.8% ± 10.4% in the 10 μm > PM > 2.5-μm-size fraction ($P < 0.001$, see Fig. 1D). In Córdoba, there were 29 days with olive pollen counts >200 pollen/m^3 when Ole e 1 in the 10 μm > PM > 2.5 μm fraction was not determined reliably and was extrapolated (see supportive material Methods).

The average pollen potency was 3.9 pg Ole e 1 in Córdoba *vs* 0.8 pg Ole e 1/pollen in Évora ($P = 0.004$, Table 1 and Fig. 1). Consequently, the annual allergen load (Σ allergen/m^3) in Córdoba was 7.6 times higher than in Évora.

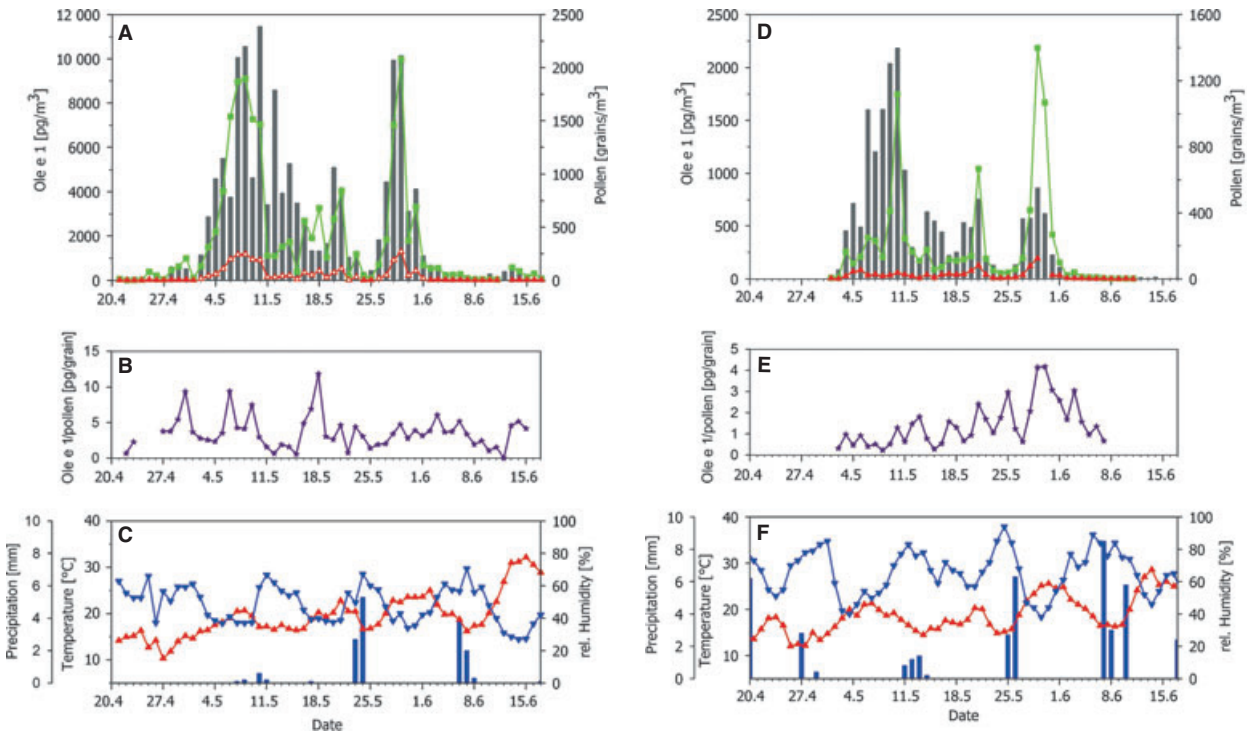

Figure 1 Daily values for olive pollen (gray bars) and allergen Ole e 1 in 2009 in PM>10 μm (green curve) and 10 μm > PM > 2.5 μm (red curve) in (A) Córdoba, Spain, and (D) Évora, Portugal. Pollen potency (pg Ole e 1/pollen) and weather parameters are represented for Córdoba, Spain (B, C), and Évora, Portugal (E, F). Note: The scales differ between stations for clarity. Open triangles for Córdoba indicate extrapolated values (see text).

The difference between the highest 10% of daily pollen potency values and the lowest 10% of values was 12.2-fold in Córdoba ($P < 0.001$) and 11.6-fold in Évora ($P < 0.001$, Fig. 1).

Both locations had two main pollen peaks: (i) approximately 2–18 in May; (ii) approximately 25–30 in May (Fig. 1). Pollen potency in Córdoba during the first peak (3.5 pg Ole e 1/pollen) was not different from the potency in the second peak (4.3 pg Ole e 1/pollen, $P = 0.381$, n.s., Table 1). However, Évora had 5 times higher pollen potency at the end of the season.

Modeling

Pollen potency in Évora increased from 0.9 pg Ole e 1/pollen on 25th May when the air came from the direction of the Atlantic Ocean, and the only source of olive pollen could be located in Portugal, to 4.0 and 4.2 pg Ole e 1/pollen on 28th and 29th May when the winds had turned and came from the southwest of Spain (Fig. S2). On the 30th May, transport from the southwest of Spain collapsed and pollen potency decreased dramatically. These results strongly suggest that the last peak in Évora (Fig. 1D) most likely corresponded to pollen from the southwest of Spain, for example, Córdoba, where much higher-allergenic-potency pollen was detected (Fig. S1).

Average temperature was 17.6°C in Córdoba and 15.8°C in Évora, and rain was 536 mm in Córdoba and 686 mm in Évora. The highest correlations were observed between temperature and allergen in ambient air (Table S1).

Discussion

Pollen season

The 2009 olive pollen seasons recorded in Cordoba and Evora had similar curves, and olive pollen counts in the two cities frequently exceeded levels known to cause allergic symptoms, $\geq$160–400 pollen/m^3 (6, 9) (Table 1 and Fig. 1A,D).

Airborne allergen

The value of 3.9 pg Ole e 1/pollen from Córdoba is similar to the value of 5.5 pg Ole e 1/pollen found in Ciudad Real, a city about 200 km northeast of Córdoba (6). In Évora, 41% of allergen exposure occurred during the 2nd peak in airborne olive pollen concentrations that occurred in late May, but only 17% of the seasonal pollen index was recorded at this time. Peaks in airborne pollen are thought to result often from local sources (10). However, in Évora, the second peak with more potent pollen probably originated from a distant source because:

1 The potency of the pollen after 25th May was 5 times higher than before this date, indicating a very different pollen source.
2 Pollen potency after 25th May is very similar to that of Córdoba (southwest of Spain).
3 The probability (footprint) of an air mass coming from the southwest of Spain increased when pollen potency increased.
4 Olive trees flowering in Badajoz, a city in between Évora and Córdoba, had ceased after 20th of May 2009, making the contribution of local pollen less likely (10).

The potency of pollen recorded after 25th May was 4.3 pg Ole e 1/pollen in Córdoba but 3.4 in Évora (Table 1). Although it is possible that long-range transport could change the potency of pollen, admixture of local, low-potency Portuguese pollen from resuspended grains (no rain in that period) offers another explanation.

Meteorological parameters

Temperature had the strongest correlation with allergen/m^3 (Data S1) as also found by others (6) and indicates that allergen from pollen might be a more sensitive marker of weather parameters than pollen counts. This agrees with allergen ripening in pollen, as demonstrated for birch, where no allergen was detected in otherwise well-developed pollen up to 1 week before pollination (11).

Conclusions

Olive pollen showed a >10-fold daily variation in allergen release. High-potency pollen was transported over 400 km to an area with normally low-potency pollen, resulting in >40% of the yearly exposure. This would go unnoticed if only pollen was counted. Indeed, the yearly pollen exposure was 2.4 times higher in Córdoba than in Évora, but the yearly allergen exposure was 7.6 times higher in Córdoba.

The consequences for allergic individuals were not studied, but deserve attention.

Acknowledgments

The project HIALINE has received funding from the European Union in the framework of the Health Programme. The technical assistance of Manuela Ugolotti, Małgorzata Nowak, Agata Szymańska, and Łukasz Kostecki is greatly appreciated. The excellent management assistance of Annina Sorgner was also greatly appreciated.

Author contributions

All authors contributed to the design of the study. Experiments were performed by Carmen Galan, Celia Antunes, Rui Brandao, Carmen Torres, Herminia Garcia-Mozo, Elsa Caeiro, and Raquel Ferro. Atmospheric modeling was performed by Marje Prank and Mikhail Sofiev. Gudrun Push prepared the data, and Jeroen Buters, Celia Antunes, and Carmen Galan wrote the manuscript.

Conflict of interest

The authors have declared that no conflict of interest exists.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data S1. Methods.

Figure S1. Linear regression analysis of pollen potency from the two stations.

Figure S2. Atmospheric modeling (footprints) of the second, high-potency pollen peak in Évora.

Table S1. Correlation between weather parameters and pollen potency.

References

1. Sanchez Mesa JA, Brandao R, Lopes L, Galan C. Correlation between pollen counts and symptoms in two different areas of the Iberian Peninsula: Cordoba (Spain) and Evora (Portugal). *J Investig Allergol Clin Immunol* 2005;**15**:112–116.
2. Barber D, de la Torre F, Feo F, Florido F, Guardia P, Moreno C et al. Understanding patient sensitization profiles in complex pollen areas: a molecular epidemiological study. *Allergy* 2008;**63**:1550–1558.
3. Barber D, Moreno C, Ledesma A, Serrano P, Galan A, Villalba M et al. Degree of olive pollen exposure and sensitization patterns. Clinical implications. *J Investig Allergol Clin Immunol* 2007;**17**(Suppl 1):11–16.
4. Alche J, Castro AJ, Olmedilla A, Fernandez MC, Rodriguez R, Villalba M et al. The major olive pollen allergen (Ole e I) shows both gametophytic and sporophytic expression during anther development, and its synthesis and storage takes place in the RER. *J Cell Sci* 1999;**112**(Pt 15):2501–2509.
5. De Linares C, Nieto-Lugilde D, Alba F, Diaz de la Guardia C, Trigo MM. Detection of airborne allergen (Ole e 1) in relation to Olea europaea pollen in S Spain. *Clin Exp Allergy* 2007;**37**:125–132.
6. Feo Brito F, Gimeno PM, Carnés J, Martín R, Fernández-Caldas E, Lara P et al. Olea europaea pollen counts and aeroallergen levels predict clinical symptoms in patients allergic to olive pollen. *Ann Allergy Asthma Immunol* 2011;**106**:146–152.
7. Moreno-Grau S, Elvira-Rendueles B, Moreno J, Garcia-Sanchez A, Vergara N, Asturias JA et al. Correlation between Olea europaea and Parietaria judaica pollen counts and quantification of their major allergens Ole e 1 and Par j 1-Par j 2. *Ann Allergy Asthma Immunol* 2006;**96**:858–864.
8. Buters JTM, Kasche A, Weichenmeier I, Schober W, Klaus S, Traidl-Hoffmann C et al. Year-to-year variation in release of Bet v 1 allergen from birch pollen: evidence for geographical differences between West and South Germany. *Int Arch Allergy Immunol* 2008;**145**:122–130.
9. Florido JF, Gonzalez Delgado P, Saenz de San Pedro B, Quiralte J, Arias de Saavedra JM, Peralta V et al. High levels of Olea europaea pollen and relation with clinical findings. *Int Arch Allergy Immunol* 1999;**119**:133–137.
10. Tormo R, Silva I, Gonzalo A, Moreno A, Perez R, Fernandez S. Phenological records as a complement to aerobiological data. *Int J Biometeorol* 2011;**55**:51–65.
11. Buters JTM, Weichenmeier I, Ochs S, Pusch G, Kreyling W, Boere AJ et al. The allergen Bet v 1 in fractions of ambient air deviates from birch pollen counts. *Allergy* 2010;**65**:850–858.