

ROSTRUM**Allergy to *Rosaceae*: the peach**M. Lázaro, J. Cuesta^a and J. M. Igea*"Allergoasma" Clinic, Salamanca*
^a"Jiménez Díaz" Foundation, Madrid, Spain

The peach is the fruit of the peach tree (*Prunus persica* or *Prunus vulgaris*), a member of the botanical *Rosaceae* family (Table I). It is known under several different names in Spain, according to the various regions and varieties (*abridero*, *durazno*, *peseguero*, *presquero*, *prisco* or *presquillero*). An important proportion of the peach production is consumed as fresh fruit, but it is also used in multiple transformation and conservation processes and consumed as juice, syrup or nectar, preserves, dried strips, etc. the nutrient composition of the peach is presented in Table II. The flowers and seeds of the peach tree are also used in the manufacture of medicinal syrups and aromatic seasonings.

HISTORY

The peach tree originates in China, where it was known as "tree of life", and particularly in the northern mountainous regions of that country. From this area of origin it later spread throughout the areas adequate for its cultivation, at first in the Asiatic continent where it was particularly well-known in Afghanistan and northern India. It was imported into Europe by the Romans, who introduced its cultivation in their colonies, among them in Spain. The Spaniards then transferred it to the American continent immediately after its discovery.

PRODUCTION

Spain is a country with a considerable produc-

tion of this fruit. Although is better known for its large citric production, this and other members of the *Rosaceae* family (such as apples and pears) are also harvested. Apples occupy the first place in production among all tree fruits.

The production of peaches is important (924,800 tons/year)¹, although less so than that of apples, and Spain occupies a first-rank place among the European producing countries together with Italy, France and Greece. It is also an important exporter of this fruit to other countries such as France or Germany. The national consumption of this fruit (3.70 kg per person and year)² is surpassed by that of another *Rosaceae* member, the apple, with a consumption that is three times higher.

Cultivation of the peach tree in the American continent has achieved a great importance, particularly in the USA, which has become the first producer worldwide. Other countries in this continent, such as Chile, Argentine and Mexico, are also important producers of this fruit.

SIGNIFICANCE OF THE PEACH AS A CAUSE OF ALLERGY

The data obtained in Spain in the course of the "Allergologica 92" study on the frequency of food allergy³ show that fruits are the foremost cause of this type of allergy with a 27% frequency. Our own group studied a population of 95 pollinosis patients in order to ascertain which fruits were most frequently involved in this problem. This study encompassed a questionnaire survey, skin tests using the prick-by-prick

Table I. The family *Rosaceae*

Subfamily	Genus	Species
<i>Spiraeoideae</i>	<i>Spiraea</i> <i>Aruncus</i> <i>Holodiscus</i> <i>Physocarpus</i> <i>Sorbaria</i> <i>Quillaja</i> <i>Filipendula</i> <i>Exochorda</i>	
<i>Prunoideae</i>	<i>Prunus</i> <i>Nuttalia</i>	<i>Amygdalus communis</i> (almond), <i>Prunus armeniaca</i> (apricot), <i>Prunus avium</i> (cherry), <i>Prunus persica</i> (peach), <i>Prunus domestica</i> (prune)
<i>Rosoideae</i>	<i>Rubus</i> <i>Potentilla</i> <i>Fragaria</i> <i>Sibbaldia</i> <i>Alchemilla</i> <i>Aphanes</i> <i>Rosa</i> <i>Agrimonia</i> <i>Sanguisorba</i> <i>Acaena</i> <i>Cliffortia</i>	<i>Fragaria vesca</i> (strawberry)
<i>Dryadoideae</i>	<i>Dryas</i> <i>Geum</i>	
<i>Pomoideae</i>	<i>Cotoneaster</i> <i>Mespilus</i> <i>Crataegus</i> <i>Crataemespilus</i> <i>Sorbus</i> <i>Cydonia</i> <i>Eriobotrya</i> <i>Pyrus</i> <i>Malus</i> <i>Amelanchier</i>	<i>Mespilus germanica</i> (medlar) <i>Pyrus communis</i> (pear) <i>Pyrus malus</i> (apple)

method, and oral challenge tests⁴. In this study, the fruit most frequently causing allergic reactions was the peach (12%), followed by the melon (7%). Thus, alimentary fruit allergy in our environment is caused mainly by two botanical families, the *Rosaceae* and the *Cucurbitaceae*. The apple, a fruit that is frequently implicated in allergic reactions in pollenosis patients in other countries, caused only 3% of the reactions in our study; all these reactions were associated with the presence of peach allergy.

Among the paediatric population, according to the "Allergologica 92" study, allergy to foodstuffs such as milk, egg and fish predominates in children under 5 years of age, while in patients older than this fresh fruits achieve a particular importance³. Crespo *et al.*⁵ have reported the peach to be a frequent cause of food allergy in a population under 15 years in age, and particularly so in patients with sensitization to several foodstuffs.

Classically, the alimentary habits of a given popu-

Table II. Nutrient composition of the peach

Calories (per 100 mg)	48
Proteins (%)	0,7
Lipids (%)	0,2
Sugars (%)	12,1
Water (%)	86,7

lation and the predominant pollen species in that area have been related to the types of foodstuffs causing allergic reactions in that population. Thus, the apple, a *Rosacea* of the subfamily *Pomoideae*, is a frequent cause of sensitization in studies carried out in Central and Northern Europe⁶⁻¹¹. This correlates with the significance of birch pollen sensitization in those regions and with the immunologic relationship between the major allergen in apples and the major allergen in birch pollen¹². In our own study, however, allergic reactions to fruits were fourfold more frequent with peaches than with apples, despite the greater consumption of apples⁴. Interest for the peach as a cause of food allergy is particularly widespread in the Mediterranean countries, such as Italy^{13,14} or Spain¹⁵⁻¹⁸, possibly because of the large production and consumption of this fruit, to the predominance of grass pollen allergy, and to the negligible presence of birch pollen allergy.

CLINICAL MANIFESTATIONS

The clinical manifestations in patients with vegetable foodstuff allergy, and particularly in the case of fresh fruits, are mainly localised to the oropharyngeal region (oral allergy syndrome). The presence of systemic symptoms is less frequent in most studies, and is often associated to the oropharyngeal manifestations^{13,19-21}.

The peach behaves similarly to other fruits as regards the clinical manifestations, although the high frequency of contact urticaria caused by this fruit bears stressing²². The skin of the peach causes symptoms in a greater number of cases than the flesh^{17,23}, but systemic symptoms in patients with peach allergy are more frequent in those sensitized to the flesh of the fruit²⁴. Many of the patients with allergy to peaches are intolerant to products manufactured from the fresh fruit, such as preserves, juices or liquors. The rate of systemic reactions is higher among patients who develop symptoms upon

ingestion of such products than among those who tolerate them²⁴. A greater number of systemic reactions has also been reported among peach allergy patients who do not have a concomitant allergy to pollen^{22,25}. Thus, three risk factors for systemic reactions in patients with peach allergy have been described: sensitization to the flesh of the fruit, development of symptoms with products manufactured from peaches, and absence of pollinosis²².

Most patients with fruit allergy, and particularly those with peach allergy, also evidence sensitization to pollen^{20-22,26-30}. In a study carried out by our own group, over 80% of the patients with peach allergy were sensitized to pollen²⁴. These patients significantly more often develop asthma as an expression of their pollen sensitization as compared to a control group of pollinosis patients from the same geographic area. Thus, the presence of peach allergy in association to pollinosis might be considered to be a factor worsening the prognosis of the pollinosis due to a higher frequency of bronchial involvement. However, the symptoms elicited by peaches were usually milder among the pollinosis patients (with predominance of the oropharyngeal over the systemic symptoms) than in those with peach allergy yet without pollen sensitization.

NATURAL HISTORY

In a study of a large group of patients with peach allergy from Central Spain carried out by our own group²⁴, clinical manifestations of allergy to this fruit first occurred in most patients before they were 20 years of age, although most of the subjects consulting because of this particular problem were between 10 and 30 years of age. Although the natural history of peach allergy is unknown, at least 50% of the patients in this study had evidenced symptoms of peach allergy since at least five years previously, suggesting that this particular sensitization is not transient, as is the case with the milk or egg intolerance usually diagnosed among babies and children.

ASSOCIATION BETWEEN PEACH ALLERGY AND POLLEN SENSITIZATION

Because of the relationship between allergy to fresh fruits and pollinosis, most investigators have

Table III. Frequency of sensitization to grass, shrub and tree pollen in a group of pollinosis patients with peach allergy (n=57) and in a control group of pollinosis patients without peach allergy (n=95)

	Pollinosis patients with peach allergy		Control pollinosis patients without peach allergy		
<i>Cynodon</i>	47	(82,5)	83	(87,4)	NS
<i>Lolium</i>	54	(94,7)	93	(97,9)	NS
<i>Phleum</i>	54	(94,7)	93	(97,9)	NS
<i>Phragmites</i>	53	(93,0)	83	(87,4)	NS
<i>Secale</i>	52	(91,2)	87	(91,6)	NS
<i>Betula</i>	35	(61,4)	43	(45,3)	<0,05
<i>Corylus</i>	47	(82,5)	76	(80,0)	NS
<i>Fraxinus</i>	49	(86,05)	62	(65,3)	<0,05
<i>Olea</i>	43	(75,4)	78	(82,1)	NS
<i>Populus</i>	53	(93,0)	33	(34,7)	<0,001
<i>Prunus persica</i>	49	(86,0)	17	(17,9)	<0,001
<i>Prunus amygdalus</i>	49	(86,0)	17	(17,9)	<0,001
<i>Ulmus</i>	46	(80,7)	18	(18,9)	<0,001
<i>Ambrosia</i>	35	(61,4)	23	(24,2)	<0,001
<i>Artemisia</i>	45	(78,9)	28	(29,5)	<0,001
<i>Chenopodium</i>	45	(78,9)	47	(49,5)	<0,001
<i>Parietaria</i>	23	(40,3)	37	(38,9)	NS
<i>Plantago</i>	41	(71,9)	61	(64,2)	<0,05
<i>Salsola</i>	40	(70,2)	50	(52,6)	<0,05
<i>Taraxacum</i>	36	(63,2)	35	(36,8)	<0,01

Results expressed in numbers of patients (percentages in parentheses).

NS: Non-significant differences.

focused their studies upon the analysis of this association and the prevalence of allergy to these foodstuffs among pollinosis patients. However, research on this particular form of food allergy in patients without pollen sensitization is rather scarce^{17,25}.

Fruit allergy in general has usually been considered in the light of pollen allergy, and the studies initially focused on the association of birch pollen hypersensitivity and allergy to vegetables such as apple, celery, carrot or hazelnut^{7,10,26-28,31} in Europe, or on ragweed pollinosis and *Cucurbitaceae* allergy in the USA²⁹. The relationship between these two sensitizations is based on the presence of shared allergens in the fruits and in the pollen, such as the allergens homologous to *Bet v1*^{10,32,33}, the prophyllins³³⁻³⁵ and the lipid transport proteins^{36,37}. A further group of proteins with molecular weights in the 46-60 kDa range have been considered to be allergenic in this case, have been recently identified as pectate-lyases, and appear in the birch and grass pollen and in vegetables such as apple and celery³⁸. In order to assess the association between peach allergy and sensitization to pollen in our environment, a study was designed and implemented investigating the differences between the pollen hypersensitivities among pollino-

sis patients with and without peach allergy and the existence of cross reactivities. The results showed that pollinosis patients with associated peach allergy evidenced a peculiar pattern of pollen sensitivity, involving sensitization to multiple taxonomically unrelated types of pollen. Both the association and the Odds Ratios were statistically significant for various tree and shrub pollen (Table III). These results led us to the suspicion that some component in the peach might be responsible for a cross reactivity explaining this situation, hitherto not reported in relation to other fruits. Various taxonomically unrelated pollen (*Lolium*, *Phleum*, *Artemisia*, *Betula*, *Corylus*, *Populus*, *Prunus*) were able to cause specific peach IgE inhibition in the RAST inhibition technique²², and peach, on the other hand, caused inhibition of the specific IgE to these pollen types. The Western Blot studies revealed bands in the 13 - 15 kDa range which were shared by taxonomically unrelated types of pollen, and the peach was able to inhibit several bands visualised in the pollen extracts when Western Blot inhibition was performed. The preabsorption of the sera of peach-allergic pollinosis patients with prophyllin revealed the importance of this substance in the cross reactivity between pollen and peach.

Other studies have also demonstrated the high prevalence of prophyllin sensitization in patients allergic to fruits and legumes^{39,40}.

ALLERGENS IN THE PEACH

Interest in the allergens in foodstuffs, and particularly in fruits, has been less than in the case of airborne allergens, and only a small number of such allergens have been characterised. Studies of the allergens present in peaches and in other fruits of the subfamily *Prunoideae* have been performed mainly in the Mediterranean countries^{14,16,18,23,41}, and various allergenic bands have been described in the peach and other *Prunoideae* in immunodetection studies. Leonart *et al.*¹⁶ first described an 8-10 kDa major allergen in the skin of the peach. Ortolani *et al.*¹⁶, using SDS-PAGE, studied this fruit and further ones from the *Prunoideae* subfamily (cherry, prune, apricot). The major allergens in the peach had molecular weights of 12.8 and 20 kDa, as did the major allergens in the cherry, and there was also a 30-kDa allergenic protein in the former. In the immunodetection inhibition studies there was coincidence of the 12.8 and 20 kDa bands between the fruits, and the 12.8 kDa component was not inhibited by birch and grass pollen. Pastorello *et al.*¹⁴, in 1994, studied the cross reactivity between these same fruits in pollinosis patients, and found a 13 kDa band shared by all the fruits, a 14 kDa band in the peach, and a 30 kDa band in the cherry. The 14-kDa component in peach was inhibited by the birch and grass pollen, while the 13-kDa one, which was recognised by 90% of the patients with peach allergy and seems to have greater clinical importance, was not inhibited by those same pollen types. They also identified a low molecular weight protein which was recognised by the sera of all the patients with peach allergy, which they later purified³⁶. This particular band, with a molecular weight of 9 kDa, was designated *Pru* p1 and was identified as a lipid transport protein. This allergen is shared by other fruits of the subfamily *Prunoideae*, but does not evidence cross reactivity to grass or birch pollen, so that it represents a fruit-specific allergen. Spanish investigators have purified 9-kDa proteins in apple and peach, which show homology to lipid transport proteins³⁷.

At present, fruit allergy is the focus of the studies of several research groups. The findings achieved in this field have led to a deeper and better knowledge of this particular type of allergy, which had remained forgotten until a few years ago. The development of methods for the quantitative assessment of the biologic activity of the extracts of these foodstuffs and the description of the main allergens involved in allergic reactions to them will render possible the preparation of standardized allergenic extracts, representing a very significant step forward in this field.

It is quite probable that, in our environment, prophyllins may be the allergens responsible for the frequent sensitization to peach and other fruits in pollinosis patients, although the presence or absence of symptoms in these patients appears to be related to a sensitization to other allergens, such as the lipid transport proteins.

REFERENCES

1. Ministerio de Agricultura, Pesca y Alimentación. Anuario de Estadística Agraria 1997. Madrid: Secretaria General Técnica. Centro de Publicaciones, 1997.
2. Ministerio de Agricultura, Pesca y Alimentación. La alimentación en España 1994. Madrid: Secretaria General Técnica. Centro de Publicaciones, 1995.
3. Alergia a alimentos. Alergológica. Factores Epidemiológicos, Clínicos y Socioeconómicos de las Enfermedades Alérgicas en España. Madrid: SEA IC y A I Abelló SA, 1995:163-183.
4. Lázaro Sastre M, Cuesta Herranz J, Igea Aznar JM, Compaired Villa JA, Losada Cosmes E. Estudios de sensibilización a alimentos de origen vegetal en pacientes polínicos en el área de Madrid. *Rev Esp Alergol Inmunol Clin* 1994; 9: 66.
5. Crespo JF, Blanco C, Contreras J, Pascual C, Martín Esteban M. Food allergy. A clinical and epidemiological study. *J Allergy Clin Immunol* 1992; 89:192.
6. Eriksson NE, Formgren H, Svenonius E. Food hypersensitivity in patients with pollen allergy. *Allergy* 1982; 37:437-443.
7. Andersen KE, Lowenstein H. An investigation of possible immunological relationship between allergen extracts from birch pollen, hazelnut, potato and apple. *Contact Dermatol* 1978;4:73-79.
8. Hamelpuro L, Vountela K, Kalimo K, Björkstén F. Cross-Reactivity of IgE antibodies with allergens in birch pollen, fruits and vegetables. *Int Arch Allergy Appl Immunol* 1984; 74: 235-240.

9. Hamelpuro L, Lowenstein H. Immunological investigation of possible structural similarities between pollen antigens and apple, carrot and celery tuber. *Allergy* 1985; 40: 264-272.
10. Ebner C, Birkner T, Valenta R, Rumpold H, Breitenbach M, Scheiner O, et al. Common epitopes of birch pollen and apples. Studies by Western and Northern blot. *J Allergy Clin Immunol* 1991; 88: 588-594.
11. Björkstén F, Hamelpuro L, Hannuksela M, Lahti A. Extraction and properties of apple allergens. *Allergy* 1980; 35: 671-677.
12. Vanek-Krebitz M, Hoffmann-Sommergruber K, Laimer da Camara Machado M, Susani M, Ebner C, Kraft D, et al. Cloning and sequencing of Mal d 1 the major allergen from apple (*Malus domestica*), and its immunological relationship to Bet v 1, the major birch pollen allergen. *Biochem Biophys Res Commun* 1995; 214: 538-551.
13. Ortolani C, Ispano M, Pastorello EA, Bigi A, Ansaloni R. The oral allergy syndrome. *Ann Allergy* 1988; 61: 47-52.
14. Pastorello EA, Ortolani C, Farioli L, Pravettoni V, Ispano M, Borga A, et al. Allergenic cross-reactivity among peach, apricot, plum, and cherry in patients with oral allergy syndrome: An in vivo and in vitro study. *J Allergy Clin Immunol* 1994; 94: 699-707.
15. Mazón A, Caballero L, Plazaola MV, Nieto A. Urticaria/angioedema en relación con melocotón y alergia a pólenes. *Rev Esp Alergol Inmunol Clin* 1988; 3: 107-112.
16. Leonart R, Cisteró A, Carreira J, Batista A, Moscoso del Prado J. Food allergy: identification of the major IgE-binding component of peach (*Prunus persica*). *Ann Allergy* 1992; 69: 128-130.
17. Cuesta J, Lázaro M, de las Heras M, Compaired JA, Fernández M, Lluch M, et al. Alergia a frutas: datos epidemiológicos de la alergia al melocotón en el área de Madrid. *Rev Esp Alergol Inmunol Clin* 1994; 9: 37.
18. Cuesta-Herranz J, Lázaro M, Martínez A, Álvarez-Cuesta E, Figueredo E, Martínez J, et al. A method for quantitation of food biologic activity: Result with peach allergen extracts. *J Allergy Clin Immunol* 1998; 102: 275-280.
19. Eriksson NE. Food sensitivity reported by patients with asthma and hay fever. *Allergy* 1978; 33: 189-196.
20. Anderson BL, Dreyfuss E, Logan S, Johnstone DE, Glaser J. Melon and banana sensitivity coincident with ragweed pollinosis. *J Allergy* 1970; 45: 310-319.
21. Pauli G, Bessot JC, Dietemann-Molard A, Braun PA, Thierry R. Celery sensitivity: clinical and immunological correlations with pollen allergy. *Clin Allergy* 1995; 15: 273-279.
22. Lázaro M. Alergia al melocotón: estudio epidemiológico, clínico e inmunológico [tesis doctoral]. Universidad de Salamanca, 1997.
23. Fernández Rivas M. Alergia a frutas de la familia Rosaceae y polinosis. Estudio de alergenidad y comunidad alérgica [tesis doctoral]. Universidad de Alcalá de Henares, 1995.
24. Cuesta-Herranz J, Lázaro M, de las Heras M, Lluch M, Figueredo E, Umpierrez A, et al. Peach allergy pattern: experience in 70 patients. *Allergy* 1998; 53: 78-82.
25. Fernández Rivas M, van Ree R, Cuevas M. Allergy to Rosaceae fruits without related pollinosis. *J Allergy Clin Immunol* 1997; 100: 728-733.
26. Hirschwehr R, Valenta R, Ebner C, Ferreira F, Sperr WR, Valent P, et al. Identification of common allergenic structures in hazel pollen and hazelnuts: a possible explanation for sensitivity to hazelnuts in patients allergic to tree pollen. *J Allergy Clin Immunol* 1992; 90: 927-936.
27. Wüthrich B, Stager J, Johannsson SGO. Celery allergy associated with birch and mugwort pollinosis. *Allergy* 1990; 45: 566-571.
28. Vallier P, Dechamp C, Vial O, Deviller P. A study of allergens in celery with cross-sensitivity to mugwort and birch pollens. *Clin Allergy* 1988; 18: 491-500.
29. Enberg RN, Leickly FE, McCullough J, Bailey J, Ownby DR. Watermelon and ragweed share allergens. *J Allergy Clin Immunol* 1987; 79: 867-875.
30. Ortolani C, Ispano M, Pastorello EA, Ansaloni R, Magri GC. Comparasion of result of skin prick test (with fresh food and commercial extracts) and RAST in 100 patients with oral allergy syndrome. *J Allergy Clin Immunol* 1989; 83: 683-690.
31. Belin L. Immunological analyses of birch pollen antigens, with special reference to the allergenic components. *Int Arch Allergy* 1972; 42: 300-322.
32. Vieths S, Schöning B, Petersen A. Characterization of the 18-KDa apple allergen by two-dimensional immunoblotting and microsequencing. *Int Arch Allergy Immunol* 1994; 104: 399-404.
33. Ebner C, Hirschwehr R, Baver L, Breiteneder H, Valenta R, Ebner H, et al. Identification of allergens in fruits and vegetables: IgE crossreactivities with the important birch pollen allergens Bet v 1 and Bet v 2 (birch profilin). *J Allergy Clin Immunol* 1995; 95: 962-969.
34. van Ree R, Aalberse RC. Pollen-vegetable food cross-reactivity: serological and clinical relevance of crossreactive IgE. *J Clin Immunoassay* 1993; 16: 124-130.
35. van Ree R, Voitenko V, van Leeuwen WA, Aalber-

- se RC. Profilin is a cross-reactive allergen in pollen and vegetable foods. *Int Arch Allergy Immunol* 1992; 98: 97-104.
36. Pastorello EA, Incorvaia C, Pravettoni V, Farioli L, Conti A, Vigano G. New allergens in fruits and vegetables. *Allergy* 1998; 53 (suppl 46): 48-51.
37. Lombardero M, Sánchez-Mongue R, García-Sellés FJ, Barber D, Salcedo G. Purificación y caracterización de dos alergenios homólogos de manzana y melocotón. Homología con LTPs. *Rev Esp Alergol Inmunol Clin* 1998; 13 (Extr 2): 252-253.
38. Turcich MP, Hamilton DA, Mascarenhas JP. Isolation and characterization of pollen-specific maize genes with sequence homology to ragweed allergens and pectate lyases. *Plant Mol Biol* 1993; 23: 1061-1065.
39. Daschner A, Crespo JF, Pascual CY. Specific IgE to recombinant pollen panallergens (rBet v 2) and fruit allergy in pollinic patients. *Allergy* 1998; 53: 614-618.
40. Díez-Gómez ML, Quirce S, Cuevas M, Sánchez Fernández C, Baz G, Moradiellos FJ, et al. Síndrome de alergia a frutas, polen y látex. Implicación de la profilina Bet v 2. *Rev Esp Alergol Inmunol Clin* 1998; 13 (Extr 2): 173.
41. Ortolani C, Pastorello EA, Farioli L, Ispano M, Pravettoni V, Berti C, et al. IgE mediated allergy from vegetable allergens. *Ann Allergy* 1993; 71: 470-476.

Milagros Lázaro
Clínica Alergoasma
C/ Pinto, 2-18, bajo
37001 Salamanca