



ORIGINAL ARTICLE

Prevalence of oral allergy syndrome in children with allergic diseases



M. Bedolla-Barajas^{a,*}, A. Kestler-Gramajo^b, G. Alcalá-Padilla^{b,d}, J. Morales-Romero^c

^a Servicio de Alergia e Inmunología Clínica, Nuevo Hospital Civil de Guadalajara "Dr. Juan I. Menchaca", Salvador de Quevedo y Zubieta No. 750, Colonia La Perla, Guadalajara, Jalisco, C. P. 44340, Mexico

^b Servicio de Alergología e Inmunología Clínica, Hospital Civil de Guadalajara "Fray Antonio Alcalde", Coronel Calderón No. 777, Colonia El Retiro, Guadalajara, Jalisco, C. P. 44280, Mexico

^c Instituto de Salud Pública, Universidad Veracruzana, Av. Luis Castelazo Ayala s/n., Colonia Industrial Ánimas, Xalapa, Veracruz, C. P. 91190, Mexico

^d Centro Universitario en Ciencias de la Salud, Universidad de Guadalajara, Sierra Mojada No. 950, Colonia Independencia Oriente, Guadalajara, Jalisco, C.P. 44340, Mexico

Received 2 March 2016; accepted 27 April 2016

Available online 24 August 2016

KEYWORDS

Food hypersensitivity;
Child;
Cross-reactions;
Pollen;
Risk factors

Abstract

Introduction: The oral allergy syndrome (OAS) is a particular type of food allergy rarely explored in the paediatric population that is already considered an adult problem.

Objective: Identify the prevalence of OAS, symptoms and pollen species associated with its presence in children affected by allergic diseases.

Methods: A cross-sectional study was conducted. Consecutive sampling included children from 6 to 14 years who needed allergy treatment for the first time. A structured questionnaire was carried out to collect demographic and clinical data and history of OAS. Besides sensitisation to various allergens, the skin prick-by-prick test was performed to corroborate sensitisation to food related to OAS. Prevalence of OAS and its association with pollens was established following the covariate adjusted logistic regression.

Results: 267 subjects were included. Overall prevalence of OAS was 8.9% (95%CI 6.1–13.1%). Prevalence of OAS for allergic rhinitis and asthma were 8.8% and 9.1%, respectively. In patients sensitised to pollen, the prevalence ranged from 9.6% to 12.2% depending on the type of pollen. 62.5% of children with OAS were sensitive to pineapple. After adjusting for gender and family history of atopic disease, trees from the *Quercus* species showed an association with OAS (OR = 2.7, 95%CI 1.2–6.2).

Conclusions: OAS is not uncommon in our environment. Pineapple, a typical fruit from the region, was the main food related. *Quercus* sp., but not birch nor olive, was the pollen associated with this syndrome.

© 2016 SEICAP. Published by Elsevier España, S.L.U. All rights reserved.

* Corresponding author.

E-mail address: drmbedbar@gmail.com (M. Bedolla-Barajas).

Introduction

Food allergy is the result of an immune response directed against certain antigens found in food.¹ Its prevalence in children has been estimated to range from 4.8% to 6.0%.^{2,3}

Recently, a group of patients who exhibit symptoms after consumption of food and whose skin prick tests are positive has gained notoriety.⁴ The oral allergy syndrome (OAS) or pollen-food syndrome (PFS) refers to a hypersensitivity reaction mediated by immunoglobulin IgE that is directed against food. Such reaction is triggered by prior sensitisation to inhaled allergens coming from plants.⁵ This syndrome is characterised by symptoms that are usually limited to the mouth (palate or lips itching, throbbing pain and swelling of lips, tongue, palate and throat, as well as a sensation of tightness in the throat),⁶ and sometimes is accompanied by extra-oral manifestations (rash, nasal or otic itching, runny nose and itchy eyes).⁷

OAS has rarely been explored in the paediatric population, since it is considered primarily an adult problem.⁸ In the USA, the prevalence in children has been estimated to be 5.0%.⁹ More recently, in Australia it was almost 17%,¹⁰ while in some European countries it was higher than 20%.^{11,12} In Latin America there are no data related to OAS in children.

Our study aimed to determine the prevalence of oral allergy syndrome within a sample of children with allergic diseases and, identify foods that are frequently associated with its symptoms and pollen species related to its occurrence.

Methods and patients

Ethics

The parents signed a written informed consent for their children to participate in the study; another one for the skin prick test; and, if necessary, one more for the skin prick-by-prick tests. The Research and Ethics Committee of the hospital approved this study.

Design and population

A cross-sectional study was conducted to analyse a sample that included 267 children older than six years old and under 15 years old who needed allergy treatment for the first time. Children with asthma, allergic rhinitis or atopic dermatitis were considered, as well as those with allergies to foods or drugs or hives. Children were recruited consecutively from July to December 2014.

Skin testing

Parents of the children were instructed to stop providing their children with drugs that could interfere with the interpretation of results, especially antihistamines, at least one week before performing the allergy skin tests to their children.

Allergen sensitisation was established by testing a battery of multiple glycerinated allergens common in our geographical area (house dust mites, cockroach mix, dog and cat

epithelia, feathers, grass pollen, weeds and trees and fungal spores). Histamine and glycerinated solution were used as positive and negative controls respectively. The allergens were applied on the back of each child using a multiple applicator (Multitest®) and after 15 min the test results were interpreted following international recommendations.¹³

The skin prick-by-prick test¹⁴ was performed to corroborate sensitisation to food related to OAS. The interpretation of the results also followed international recommendations.

Definitions

For purposes of this study, OAS was the occurrence of clinical manifestations in the oral cavity (oral pruritus, hoarseness, swelling of lips, tongue, pharynx or larynx) associated with the consumption of certain fruits, vegetables or spices¹⁵ within 30 min after eating the offending food, as well as the positive skin prick test to that food. PFS was the association between OAS and sensitisation to pollens.

Statistical analysis

To determine the OAS prevalence, its frequency and respective 95% confidence intervals (95%CI) were calculated. The qualitative variables were represented as percentages, while both the mean and standard deviation were calculated for the quantitative variables. The Chi square test was used to compare qualitative variables, whereas the Fisher's exact test was used when necessary. To identify the associated pollens (independent variables) with OAS (dependent variable), *odds ratios (OR) and their respective 95%CI were calculated* using the multivariate logistic regression model adjusted for gender and family history of atopy. Any value of $p < 0.05$ was considered statistically significant. The IBM SPSS software version 20.0 for Windows (Armonk, NY, USA) was used to process data.

Results

Regarding the population analysed, 55.8% were men (149/267), while the mean age was 9.2 ± 2.5 years (see Table 1). Over 90% of children had allergic rhinitis with or without asthma. Atopic dermatitis and food or drug allergy were less than 5%. According to the family history of atopic disease, allergic rhinitis and asthma, in that order, were the most frequent alterations in the father, mother and siblings of the children.

The clinical manifestations most frequently associated with OAS were as follows, oral tingling, oral pruritus and swelling of lips fewer than 15%, dysphonia was the main extra-oral symptom followed by nasal itching. One child exhibited systemic symptoms (rash) (see Table 2).

In children with OAS, two years was the median age for the onset of oral symptoms and, the median evolution time for asthma and allergic rhinitis were three years and four years, respectively.

The prevalence of OAS was 24/267 children (8.9%; 95%CI 6.1–13.1%), while for children with allergic rhinitis was 8.8% and 9.1% for asthma. In children sensitised to any type of pollen the frequency of OAS was 9.6%, while 3.7% ($p=0.485$) for those sensitised to other allergens. When

Table 1 Description of the patients, $n = 267$.

Characteristic	Indicator
Age (in years), mean $\pm$ SD (minimum–maximum)	9.2 $\pm$ 2.5 (6–14)
Gender, n (%)	
Male	149 (55.8)
Female	118 (44.2)
Atopic disease,^a n (%)	
Allergic rhinitis	249 (93.3)
Asthma	186 (69.7)
Atopic dermatitis	7 (2.6)
Food allergy	5 (1.9)
Drug allergy	4 (1.5)
Hives	1 (0.4)
Family history of atopic disease, n (%)	
<i>Mother</i>	
Allergic rhinitis	75 (28.1)
Asthma	51 (19.1)
Drug allergy	9 (3.4)
Atopic dermatitis	7 (2.6)
Food allergy	4 (1.5)
Hives	2 (0.7)
<i>Father</i>	
Allergic rhinitis	37 (13.9)
Asthma	25 (9.4)
Drug allergy	4 (1.5)
Atopic dermatitis	3 (1.1)
Food allergy	2 (0.7)
Hives	1 (0.4)
<i>A sibling</i>	
Allergic rhinitis	101 (37.8)
Asthma	81 (30.3)
Drug allergy	2 (0.7)
Atopic dermatitis	9 (3.4)
Food allergy	4 (1.5)
Hives	0 (0)

SD: standard deviation.

^a Some children had more than one disease.

comparing patients sensitised to tree, weed or grass pollens with patients not sensitised to each of these pollens, the frequency of OAS was 11.3% vs. 2.8% ($p = 0.031$), 10.3% vs. 7.4% ($p = 0.420$) and 12.2% vs 7.7% ($p = 0.331$), respectively. Individually, *Quercus* sp. (15.9% vs 5.9%, $p = 0.009$) and *Fraxinus* sp. (14.9% vs 6.7%, $p = 0.038$) were the pollens that showed a significant association with OAS. The frequency of OAS in those sensitised to pollens coming from *Betulaceae*, *Betula* sp. or *Alnus* sp., did not show any statistically significant association, $p = 0.999$ and $p = 0.172$ respectively. In sensitised patients versus non-sensitised patients to *Fraxinus* sp. the frequency was 14.9% vs. 6.7% ($p = 0.038$).

The frequency of the pollen-food syndrome was 23/24 (95.8%). No latex-fruit syndrome cases were observed. Patients sensitised to *Artemisia*, 1/54 (1.9%), exhibited the mugwort-peach association.

House dust mites (*Dermatophagoides farinae*) were significantly associated with OAS ($p = 0.006$), (see Table 3). Regarding trees, oak ($p = 0.009$) and ash ($p = 0.038$), the

Table 2 Clinical manifestations of the oral allergy syndrome in children, $n = 24$.

Oral symptoms, n (%)	
Oral tingling/irritation	10 (41.7)
Oral pruritus	10 (41.7)
Pharyngeal pruritus	8 (33.3)
Swelling of lips	3 (12.5)
Extra-oral symptoms, n (%)	
Dysphonia	3 (12.5)
Nasal itching	2 (8.3)
Systemic symptoms, n (%)	
Rash	1 (4.2)

magnitude of the association was OR 3.41 (95%CI 1.37–8.54, $p = 0.009$), 2.98 (95%CI 1.27–6.97, $p = 0.012$) and OR 2.42 (95%CI 1.03–5.67, $p = 0.042$) respectively. Neither weed nor grass showed a significant association.

The skin prick-by-prick test showed that pineapple (62.5%) followed by peach, avocado and banana (16.7% each) were the foods mainly involved in OAS (see Table 4).

The multivariate analysis identified the *Quercus* species as the main factor associated with OAS (see Table 5). Factors such as family history of atopic disease or gender were excluded from the final model because they did not show any significant association.

Discussion

To the best of our knowledge this is the first study in Mexico to document that 10% of children with allergic diseases develop OAS. Therefore, it is shown that OAS is not uncommon in Mexican schoolchildren and fruits, in this case pineapple, were the foods most often associated with its symptoms. Finally, we were able to identify the *Quercus* species as a factor strongly associated with OAS.

The occurrence of OAS in the paediatric population has rarely been explored. In our study the frequency in children with allergic diseases was about 9%. To date few studies have analysed in detail the prevalence of OAS in children. In the USA a survey among allergists reported a frequency of 5% (range, 0–75%) in children with some type of allergic disease.⁹ In Australia, the prevalence was 14.7%.¹⁰ Recently, in a sample of 1360 Italian children with pollen-induced allergic rhinitis the prevalence of OAS was 24%.¹¹ Similarly, Croatian children with seasonal allergic rhinitis developed OAS in 26.7% of cases.¹² At present no studies on children have been carried out in our country before, hence, we are temporarily unable to know the true extent of the problem. Therefore, our results have become the starting point for further studies involving different geographic areas from our country.

According to our results, the prevalence of OAS in children differed from that observed in the adult population from our country, where it ranged from 13% to 50%^{7,16} or that reported in other regions of the world.^{8,17–19} This may be explained because some children have difficulty expressing their symptoms. Thus, in our study we decided to analyse children aged over or equal to six years to overcome

Table 3 Frequency of sensitisation to allergens in children.

Allergen category	Oral allergy syndrome		p value
	Yes n = 24	No n = 243	
Indoor, n (%)			
Dermatophagoides farinae	17 (70.8)	101 (41.6)	0.006
Dermatophagoides pteronyssinus	9 (37.5)	142 (58.4)	0.048
Dog epithelia	8 (33.3)	81 (33.3)	0.999
Cat epithelia	6 (25.0)	76 (31.3)	0.646
Feathers (mix)	6 (25.0)	38 (15.6)	0.238
Pigeon droppings	2 (8.3)	16 (6.6)	0.669
Cockroach mix ^a	1 (4.2)	21 (8.6)	0.704
Trees, n (%)			
Quercus sp.	13 (54.2)	69 (28.4)	0.009
Fraxinus sp.	11 (45.8)	63 (25.9)	0.038
Prosopis sp.	9 (37.5)	52 (21.4)	0.073
Populus sp.	6 (25.0)	47 (19.3)	0.507
Ligustrum sp.	6 (25.0)	29 (11.9)	0.070
Eucalyptus sp.	5 (20.8)	32 (13.2)	0.300
Alnus sp.	1 (4.2)	1 (0.4)	0.132
Betula sp.	0 (0)	1 (0.4)	0.999
Schinus molle	0 (0)	6 (2.5)	0.999
Weed, n (%)			
Chenopodium album	5 (20.8)	30 (12.3)	0.240
Ambrosia trifida	4 (16.7)	27 (11.1)	0.499
Salsola pestifer	3 (12.5)	35 (14.4)	0.999
Amaranthus palmeri	3 (12.5)	36 (14.8)	0.999
Helianthus annuus	2 (8.3)	24 (9.9)	0.999
Artemisia vulgaris	1 (4.2)	53 (21.8)	0.058
Grass, n (%)			
Zea mays	7 (29.2)	43 (17.7)	0.169
Phleum pratense	5 (20.8)	29 (11.9)	0.212
Cynodon dactylon	2 (8.3)	26 (10.7)	0.999
Fungi, n (%)			
Cladosporium spp.	1 (4.2)	13 (5.3)	0.999
Alternaria alternata	1 (4.2)	6 (2.5)	0.487
Cephalosporium sp.	0 (0)	6 (2.5)	0.999

^a *Blattella germanica* and *Periplaneta americana*.

p value obtained following the Chi square test or Fisher's exact test.

Table 4 Frequency of sensitisation to foods established following the skin prick-by-prick test in children with oral allergy syndrome.

Food	n	%
Pineapple	15	62.5
Peach	4	16.7
Avocado	4	16.7
Banana	4	16.7
Almond	1	4.2
Pear	1	4.2

n = 24.

this communication barrier. Another reason could be the evolution time of the allergic disease, particularly allergic rhinitis. On the other hand, it has been proposed that mothers of children tend to say their children do not like or do not want to eat some foods, when in fact they are allergic to those foods.¹² Thus, in these cases it is not possible to corroborate sensitisation to food related to OAS. Finally, the geographical location is an important factor to consider. Recently, it was shown that children living in northern Italy have a higher prevalence of OAS than those who live in the south and this difference is dependent on the type and concentration of vegetation, especially birch.¹¹

In general, patients with allergic rhinitis, particularly those sensitised to pollens, show a greater tendency

Table 5 Association between pollen and oral allergy syndrome adjusted for gender and family atopy.

	Unadjusted model			Adjusted model		
	OR	95%CI	p value	OR	95%CI	p value
Gender						
Female	1					
Male	1.2	0.5–3.0	0.66	–	–	0.61
Skin testing						
<i>Quercus</i> sp.						
Negative	1			1		
Positive	2.5	1.04–5.9	0.04	2.7	1.2–6.2	0.02
<i>Fraxinus</i> sp.						
Negative	1					
Positive	2.0	0.8–4.7	0.13	–	–	0.13
Family atopy						
Mother and father with no atopy	1					
Mother or father with atopy	0.7	0.3–1.9	0.52	–	–	0.61
Mother and father with atopy	1.5	0.4–4.9	0.54	–	–	0.44

Model adjusted following the *Forward conditional method*.

OR obtained following logistic regression.

to develop OAS. In our patients the frequency of OAS associated with allergic rhinitis or asthma was not higher than 10%. Also, a similar percentage was observed in children sensitised to pollens. In our country the frequency of OAS in adults sensitised to *Oleaceae* sp. pollens, including *Fraxinus*, was higher than 50%.¹⁶ This result differs notably with that observed in our study, where the frequency of OAS associated with ash trees was 15%.

Several studies in Europe have shown that birch pollen is a key player strongly linked to OAS.^{20,21} However, our city is not aware of the existence of this type of tree in the forest areas that surround it. Instead, *Alnus* species, which fall into the same category as birch (*Betulaceae*), have been discovered in the mountain ranges of our state, more than 100 km away and over 2000 m above sea level. Consequently, both factors could help explain why the low frequency of sensitisation to birch and alder pollen observed in our children (less than 1% and 5% respectively). Thus, the prevalence of OAS is expected to be lower compared to other regions of the world.

Quercus sp. and *Fraxinus* sp. showed an association with OAS in our study, both species are very common in our region. The first are located in an ecological reserve called *Bosque de la Primavera* (Spring Forest) and the latter in the city itself. However, in the multivariate analysis the *Quercus* species remained the only factor associated with OAS. Although oak and ash showed high rates of sensitisation in children, the frequency of OAS was nearly 15%. A possible explanation may be the low consumption of foods associated with these trees, such as the fruits from the *Rosaceae* species.

Interestingly, we observed an association between OAS and sensitisation to house dust mites. In our view, we have no information to explain this association, so we believe that it could be a chance finding.

Compared with other studies, in our study the fruit most often related to OAS was the pineapple (*Ananas comosus*). In

Australian children, watermelon was the fruit most related (6/24), while pineapple only appeared in three cases.¹⁰ The kiwi, followed by peach, was the fruit most often related to OAS in a group of children with pollen-induced allergic rhinitis in Italy; no case involving pineapple¹¹ was documented. The pineapple is a tropical fruit usually eaten raw or as juice, circumstances that favour allergens related to OAS to remain unaltered by processing or cooking. Different allergens from pineapple have been characterised, where Ana C1 and Ana C2 are the main ones. The first is a profilin and the latter a protease. An explanation of why our children showed a greater sensitisation to pineapple can be found in the sensitisation to ashes and oak, since profilins (Fra e 2 and Que a 2) have been identified in these trees. These profilins can cross-react with pineapple profilin (Ana C1).²² Another explanation may be the availability of pineapple, as the semi-tropical climate of our region favours the cultivation of this fruit so that its consumption is facilitated.

Several studies on adults have shown that the sensitisation process to pollens occurs prior to the onset of symptoms of OAS.^{7,23,24} However, this behaviour in children has rarely been explored. In our study we observed that allergic rhinitis or asthma occurred prior to the beginning of OAS. As expected, all children with OAS displayed some sort of symptoms in the mouth. However, it should be noted that the occurrence of systemic symptoms (4.2%) differed from that observed in adults, where it ranges from 15% to 20%.^{7,9} It is very likely that the evolution time of the allergic disease is related to the progression of OAS symptoms. The lack of evidence of oral challenges with offending food in our children did not allow us to specify the real frequency of systemic symptoms.

Nowadays, there is an ongoing dispute about the best term to describe the group of people with oral symptoms associated with food consumption. It seems that the pollen-food syndrome concept is gaining greater acceptance.^{4–6,9} In

our study most of the children with oral symptoms from food (23/24) were sensitised to some kind of pollen. Additionally, most of the foods involved were of plant origin. Thus, this would be the most appropriate term to describe, at least in children, this population.

This study has some limitations. The prevalence of OAS was calculated in children with allergic diseases, so this could represent an overestimation of the real prevalence in the paediatric population. On the other hand, the lack of an oral challenge with offending food did not allow us to obtain objective data about the frequency and severity of oral symptoms. Finally, the cross-reaction between sensitisation to pollens and foods of plant origin could not be specified.

In conclusion, the prevalence of OAS in children with allergic diseases is common. Tropical fruits, including pineapple, are the main food-related oral symptoms. Tree species other than birch or olive were strongly associated with OAS.

Ethical disclosures

Confidentiality of data. The authors declare that they have followed the protocols of their work centre on the publication of patient data and that all the patients included in the study have received sufficient information and have given their informed consent in writing to participate in that study.

Right to privacy and informed consent. The authors have obtained the informed consent of the patients and/or subjects mentioned in the article. The author for correspondence is in possession of this document.

Protection of human subjects and animals in research. The authors declare that the procedures followed were in accordance with the regulations of the responsible Clinical Research Ethics Committee and in accordance with those of the World Medical Association and the Helsinki Declaration.

Funding

None.

Conflicts of interest

The authors have no funding or conflicts of interest to disclose.

References

- Boye JI. Food allergies in developing and emerging economies: need for comprehensive data on prevalence rates. *Clin Transl Allergy*. 2012;2:25.
- Ho MH, Lee SL, Wong WH, Ip P, Lau YL. Prevalence of self-reported food allergy in Hong Kong children and teens – a population survey. *Asian Pac J Allergy Immunol*. 2012;30:275–84.
- Nwaru BI, Hickstein L, Panesar SS, Roberts G, Muraro A, Sheikh A, EAACI Food Allergy and Anaphylaxis Guidelines Group. Prevalence of common food allergies in Europe: a systematic review and meta-analysis. *Allergy*. 2014;69:992–1007.
- Katellaris CH. Food allergy and oral allergy or pollen-food syndrome. *Curr Opin Allergy Clin Immunol*. 2010;10:246–51.
- Price A, Ramachandran S, Smith GP, Stevenson ML, Pomeranz MK, Cohen DE. Oral allergy syndrome (pollen-food allergy syndrome). *Dermatitis*. 2015;26:78–88.
- Kondo Y, Urisu A. Oral allergy syndrome. *Allergol Int*. 2009;58:485–91.
- Bedolla-Barajas M, Morales-Romero J, Ortiz-Miramontes LR, Jáuregui-Franco RO. Frequency and clinical features of the oral allergy syndrome in Mexican adults with nasal pollinosis. *Rev Alerg Mex*. 2013;60:17–25.
- Webber CM, England RW. Oral allergy syndrome: a clinical, diagnostic, and therapeutic challenge. *Ann Allergy Asthma Immunol*. 2010;104:101–8.
- Ma S, Sicherer SH, Nowak-Wegrzyn A. A survey on the management of pollen-food allergy syndrome in allergy practices. *J Allergy Clin Immunol*. 2003;112:784–8.
- Brown CE, Katellaris CH. The prevalence of the oral allergy syndrome and pollen-food syndrome in an atopic paediatric population in south-west Sydney. *J Paediatr Child Health*. 2014;50:795–800.
- Dondi A, Tripodi S, Panetta V, Asero R, Businco AD, Bianchi A, et al. Pollen-induced allergic rhinitis in 1360 Italian children: comorbidities and determinants of severity. *Pediatr Allergy Immunol*. 2013;24:742–51.
- Ivković-Jureković I. Oral allergy syndrome in children. *Int Dent J*. 2015;65:164–8.
- van Kampen V, de Blay F, Folletti I, Kobierski P, Moscato G, Olivieri M, et al. EAACI position paper: skin prick testing in the diagnosis of occupational type I allergies. *Allergy*. 2013;68:580–4.
- Ortolani C, Ispano M, Pastorello EA. Comparison of results of skin prick tests (with fresh foods and commercial food extracts) and RAST in 100 patients with oral allergy syndrome. *J Allergy Clin Immunol*. 1989;83:683–90.
- Amlot PL, Kemeny DM, Zachary C, Parkes P, Lessof MH. Oral allergy syndrome (OAS): symptoms of IgE-mediated hypersensitivity to foods. *Clin Allergy*. 1987;17:33–42.
- Morfín-Maciel BM, Flores I, Rosas-Alvarado A, Bautista M, López-López JR. Sensitization to pollens of Oleaceae family in a group of patients from Mexico City. *Rev Alerg Mex*. 2009;56:198–203 (in Spanish).
- Osterballe M, Hansen TK, Mortz CG, Bindslev-Jensen C. The clinical relevance of sensitization to pollen-related fruits and vegetables in unselected pollen-sensitized adults. *Allergy*. 2005;60:218–25.
- Czarnecka-Operacz M, Jenerowicz D, Silny W. Oral allergy syndrome in patients with airborne pollen allergy treated with specific immunotherapy. *Acta Dermatovenerol Croat*. 2008;16:19–24.
- Caliskaner Z, Naiboglu B, Kutlu A, Kartal O, Ozturk S, Onem Y, et al. Risk factors for oral allergy syndrome in patients with seasonal allergic rhinitis. *Med Oral Patol Oral Cir Bucal*. 2011;16:e312–6.
- Bartra J, Sastre J, del Cuvillo A, Montoro J, Jáuregui I, Dávila I, et al. From pollinosis to digestive allergy. *J Investig Allergol Clin Immunol*. 2009;19 Suppl 1:3–10.
- Geroldinger-Simic M, Zelniker T, Aberer W, Ebner C, Egger C, Greiderer A, et al. Birch pollen-related food allergy: clinical aspects and the role of allergen-specific IgE and IgG4 antibodies. *J Allergy Clin Immunol*. 2011;127:616–22.

22. Allergome. The platform for allergens knowledge. http://www.allergome.org/script/search_step2.php?action=search&type_archive=&no_unknown=&only_iuis=&no_isoform=&first_archivie=3&first_field=Profilin (accessed 15.11.15).
23. Martín E, Quiralte J, Florido F, Hinojosa B, López E, Navarrete MA, et al. Alergia a alimentos de origen vegetal en una población adulta de la provincia de Jaén. *Alergol Inmunol Clin.* 2003;18:187–94.
24. Gotoda H, Maguchi S, Kawahara H, Terayama Y, Fukuda S. Springtime pollinosis and oral allergy syndrome in Sapporo. *Auris Nasus Larynx.* 2001;28 Suppl:S49–52.