

LITERATURE REVIEW**The presence of aeroallergens in food products:
a potential risk for the patient with allergic rhinitis****Florin-Dan Popescu, Mariana Vieru**

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ABSTRACT

Clinical entities of food allergy in allergic rhinitis patients due to IgE-sensitization to cross-reactive aeroallergen and food allergen components are well described, but less data are available regarding allergic reactions to foods containing aeroallergens, either due to food contamination, such as oral mite anaphylaxis, or due to their natural presence in the edible products, such as pollen grains in honey and bee products. There are some potential risks for allergic rhinitis subjects due to ingestion of food products containing domestic mite, insect, fungal and pollen allergens. The knowledge of these risks is useful for the allergists and ENT specialists, especially in the context of climate changes with warmer periods facilitating mite growth in flours, and of increase use of phytotherapy and apitherapy products containing pollen grains.

KEYWORDS: aeroallergens, allergic rhinitis, food allergy.

INTRODUCTION

Food allergy may be associated with allergic rhinitis. Clinical entities due to IgE sensitization to cross-reactive aeroallergen and food allergen components are well described¹, but less data are available in the scientific literature regarding allergic reactions to foods containing aeroallergens, either due to food contamination, such as oral mite anaphylaxis, or due to their natural presence in the edible products, such as allergic reactions to pollen grains present in honey and other bee products. The discussion on this topic will include the potential risks for allergic rhinitis patients due to ingestion of food products containing domestic mite, insect, fungal and pollen allergens.

DOMESTIC MITE ALLERGENS IN FOODS

Mite allergens are the most relevant indoor induc-

ers of allergic diseases worldwide, asthma and allergic rhinitis being major global health problems contributing significantly to socio-economic burden. Oral mite anaphylaxis (OMA) is a relatively new hypersensitivity syndrome characterized by severe allergic symptoms, typically anaphylaxis (with clinical variants of mite ingestion-associated exercise-induced anaphylaxis or anaphylaxis mimicking acute asthma, but not as isolated oral allergy syndrome). OMA occurs immediately (10-60 minutes, sometimes up to 120 minutes) after eating foods contaminated with mites, in patients with allergic rhinitis with/without asthma, with IgE-sensitization to house dust mites. OMA is more prevalent in subtropical and tropical regions where mites grow easily in warm and humid environments, but isolated cases were also reported in United States of America (in several locations: Birmingham, Charlottesville, Detroit, Massachusetts, Minnesota, New Orleans, Philadelphia), Japan, and Europe (most cases in Canary Islands, Spain, and a couple of cases in

Belgium). In the literature, there are two fatalities reported as being associated with the ingestion of foods contaminated with mites²⁻⁵.

The species of domestic mites (*Astigmata* order, *Acar*i subclass) associated with OMA belong to the *Pyroglyphidae* family (house dust mites): *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae* (more common); *Echimyopodidae* family: *Blomia tropicalis*, *Blomia freemani*; and storage mites from the *Acaridae* family: *Tyrophagus putrescentiae*, *Tyrophagus entomophagus*, *Aleuroglyphus ovatus*, *Acarus siro*, and *Suidasiidae* family: *Suidasia medanensis*, *Suidasia nesbitti*. Responsible allergen components are probably allergen molecules from Group 2 (thermostable, resistant to digestion) cross-reactive among species, while those from Group 1 are masked by binding to prolamins from flour and those from Group 10 are not involved. An OMA risk factor is the ingestion of more than 500 mites *per* gram of flour, having in mind that a usual microscopic analysis of flour contaminated with mites may even reveal 5000-50000 mites *per* gram. Aspirin and other non-steroidal anti-inflammatory drugs (NSAIDs) can be cofactors for OMA^{1-3,5}.

Foods contaminated with mites are usually food preparations with wheat and/or corn flour, including: pancakes (most commonly named pancake syndrome or pancake anaphylaxis), including takoyaki and okonomiyaki, but also donuts or beignets, sponge cakes, pizza, pasta, homemade bread, white sauce with wheat flour, pané foods, croquettes, cornmeal cakes and polenta. Mites preferably grow in cooking flours containing high amounts of wheat, at room temperature, especially after eight weeks of storage. Since exposure to low temperatures inhibits the growth of mites, it is recommended to store the flour in refrigerated containers, and storage should not exceed 20 weeks. Other foods that may be contaminated with mites when stored for long periods of time at ambient temperature are cheese, ham, chorizo and salami. Patients with oral mite anaphylaxis present also an increased prevalence of NSAIDs hypersensitivity, manifested as urticaria and angioedema. Even if no salicylates were detected in mite-contaminated wheat flour, the opisthonotal gland secretion from house dust mites contains a salicylaldehyde analog 2-formyl-3-hydroxybenzyl formate, and allergenic extracts of mites may inhibit COX-1 *in vitro*^{1-3,5-7}.

OTHER ANIMAL ALLERGENS IN FOODS

Insects represented by domestic cockroaches, especially *Blattella germanica*, are important urban indoor airborne allergen sources. Cross-reactivity between inedible (*Blattella germanica*) and edible (mealworm, cricket, grasshopper) insect allergens is possible, and it

was revealed that shrimp allergic patients are more likely at risk of food allergy to mealworm and other insects⁸⁻¹⁰. There is a report of anaphylaxis to ingested mopane tree worm (edible caterpillar of the *Gonimbrasia belina* African moth) in an adolescent with IgE sensitization to house dust mites and cockroaches, which suggests cross-reactivity due to glutathione transferases (Der p 8, Der f 8, Bla g 5) or tropomyosins (Der p 10, Der f 10, Bla g 7)¹¹. Based on cross-reactivity studies, there is a realistic possibility that house dust mite and crustacean allergic patients may react to food containing insects, such as the yellow mealworm (*Tenebrio molitor*)¹². Moreover, several termite proteins, including hemocyanin and tropomyosin homologs of Bla g 3 and Bla g 7, were shown to cross-react with cockroach allergens¹³. According to US Food and Drug Administration (FDA), the limits of insect contamination at which a food product is considered "adulterated" are for chocolate: 60 or more insect fragments per 100 grams when six 100-gram subsamples are examined or any subsample containing 90 or more insect fragments; for wheat flour: 75 or more insect fragments *per* 50 grams; for peanut butter: 30 or more insect fragments *per* 100 grams; for canned citrus fruit juices: 5 or more fly eggs *per* 250 ml; for tomato paste: 30 fly eggs *per* 100 grams¹⁴. Cocoa beans are susceptible to attack by several species of storage beetles and moths¹⁵. Lentils can also be attacked by a wide range of insect species. Lentil pest *Bruchus lentis* proteins may be a cause of IgE-mediated rhinoconjunctivitis and asthma in patients eating or inhaling infested legume particles¹⁶. Estimations of entomologists suggest an unintentional annual consumption of 500 g insect fragments¹⁷.

Contamination of foods with aeroallergens from *mammals* is also possible, but there are no reports of food allergic reactions due to this. Dispersion of aeroallergens from furred animals, such as cats and dogs, and also horses, able to generate large amounts of airborne allergens¹⁸, may contaminate food products improperly stored. Regarding rodent hairs, according to US FDA, the limits are, for example, for curry powder: 4 or more *per* 25 grams, and for ground paprika: average of more than 11 *per* 25 grams¹⁴.

FUNGAL ALLERGENS IN FOODS

Respiratory allergy to moulds is relatively common. *Alternaria alternata* contamination of tomatoes (black spots), raw mushrooms, dried fruits, old flour may be a risk for food allergic reactions in patients with respiratory allergy to the fungi. *Mucor racemosus* is another mold found on soft fruit, fruit juice and marmalade. *Penicillium chrysogenum/notatum* is cross-reactive with *Penicillium camemberti*, *Penicillium roqueforti*, *Penicillium nalgiovense* used for the production of special types of

cheese, dry and fermented sausages or salami varieties¹⁹⁻²¹. *Fusarium venenatum*, used to produce an edible mycoprotein, is cross-reactive with *Alternaria alternata* and *Cladosporium herbarum*, due to ribosomal proteins P2 Fus c 1, Alt 5, and Cla h 5. Anaphylaxis was reported immediately after eating a mycoprotein burger produced from *Fusarium* in an adult patient with allergic rhinitis to *Alternaria* sp²²⁻²⁴.

A fatal case of anaphylaxis was reported in a teenage boy allergic to fungi due to ingestion of pancakes made with a 2-year-old opened packaged flour mix heavily contaminated with *Fusarium*, *Penicillium*, *Mucor* and *Aspergillus* spp²⁵.

Honey bee products, including bee pollen supplements, may be contaminated with fungi (up to 6% of composition), such as *Aspergillus* and *Cladosporium* spp, and may cause anaphylaxis in patients with IgE sensitization to such molds^{26,27}.

POLLEN ALLERGENS IN FOODS

Pollen allergy represents a significant cause of allergic morbidity worldwide. The most common outdoor allergens responsible for respiratory allergies are the pollen grains of anemophilous plants, such as of grasses, trees and weeds.

Edible honey bee products, such as honey and royal jelly, contain pollen grains of many types, especially from entomophilous plants, including important ones from the *Asteraceae* family, such as sunflower *Helianthus annuus*, cornflower *Centaurea cyanus*, dandelion *Taraxacum officinale*. Such *Compositae* pollen-containing bee products were reported to induce food allergic reactions, from oral allergy syndrome to anaphylaxis, in patients with *Asteraceae* weed pollen allergic rhinitis/rhinoconjunctivitis, especially with IgE sensitization to mugwort (*Artemisia vulgaris*) and ragweed (*Ambrosia elatior*) pollen, due to cross-reactivity between pollen of wind-pollinated weeds and other *Asteraceae* insect-pollinated plants, involving common allergenic components such as profilins, polcalcins, lipid transfer proteins²⁷⁻³². In patients with birch pollen allergic rhinitis, honey containing *Betula* pollen grains, taken so it could dissolve slowly in the mouth, present mild itching in the mouth, but no severe systemic allergic events³³. It is noteworthy that bee products may contain not only pollen from entomophilous plants, but also from anemophilous trees or herbaceous plants that grow in the same area^{1,27}.

The mugwort-chamomile association consists in primary respiratory IgE sensitization to mugwort (*Artemisia vulgaris*) pollen and secondary allergic symptoms, from allergic contact conjunctivitis to anaphylaxis, in patients exposed to infusion or tea of chamomile (*Matricaria chamomilla* var. *recutita*), both of which belong to

the *Asteraceae* family. The incidence of mugwort-chamomile association is frequently underestimated. Patients with allergic rhinitis to *Artemisia* pollen sometimes present allergic reactions to chamomile, but most patients with chamomile allergy are IgE sensitized to mugwort pollen. The possible cross-reactive component in this association is Art v 1 defensin, while Bet v 1 homologue (Mat c 1) and high molecular weight allergens may also have a role, but probably not the vegetable panallergens profilins^{1,34-38}. Moreover, also due to fears of cross-reactivity, patients with allergic rhinitis to ragweed (*Ambrosia artemisiifolia*) pollen should avoid taking *Echinacea* supplements³⁹. Severe anaphylaxis was reported after gargling with an infusion of *Calendula*, another *Asteraceae* plant with ethnopharmacological uses^{40,41}. Other reports not related to the mugwort-chamomile association and pollen sensitization are of airborne allergic contact dermatitis caused by exposure to volatile oils in the vapours rising from hot chamomile tea, and systemic allergic dermatitis caused by sesquiterpene lactones, such as matricin and desacetylmaticarin^{42,43}.

The mugwort-sunflower association consists of food allergy to consumption of *Helianthus annuus* seeds in patients with allergic rhinitis to *Artemisia vulgaris* pollen. There was a report of anaphylaxis to *Helianthus* pollen contaminated commercial peeled sunflower seeds in a patient sensitized to mugwort pollen, and another of oral allergy syndrome to sunflower seeds in a case of airborne allergy to pet food seed particles. *Helianthus annuus* belongs to the *Asteraceae* family and its pollen allergen component Hel a 4 is an Art v 1-like allergen^{44,46}. In a recent case of anaphylaxis after consumption of sunflower seeds, in an adult patient with IgE sensitization to mugwort pollen, hypersensitivity to Hel a 3 LTP and defensin-like proteins, both cross-reactive with *Artemisia vulgaris* pollen allergen components, were suspected as a cause of anaphylaxis⁴⁷.

Hypersensitivity reactions to ceremonial use of oral corn pollen in Navajo Native Americans were previously reported, with clinical manifestations of oral allergy syndrome, rhinoconjunctivitis and bronchospasm⁴⁸. An adult patient with seasonal allergic rhinitis and intermittent asthma, sensitized to grass pollen, was more recently reported with urticaria to corn silk (*Stigma maydis*) infusion, used as traditional herbal medicinal product. He presented high levels of serum specific IgE to rPhl p 1, revealing true sensitization to *Pooideae* pollen, without IgE sensitization to ribonuclease rPhl p 5 and profilin rPhl p12, but with high levels of specific IgE against polcalcin rPhl p 7, a calcium-binding protein likely to cross-react with Zea m 7 from maize pollen^{49,50}.

Dietary supplements with pollen grains of bee-pollinated plants may induce allergic IgE-mediated reactions and rarely non-allergic adverse reactions as well.

Since almost forty years, honey bee pollen containing *Asteraceae* pollen grains, including dandelion, have been reported to induce immediate systemic allergic reactions in patients allergic to short ragweed, a member of the same plant family⁵¹. Severe anaphylaxis after ingesting bee pollen was also reported in a patient with no history of allergies⁵². Other more recent cases of anaphylaxis occurred in adult and preschool patients with mugwort (*Artemisia vulgaris*) and other pollen allergic rhinitis, including a case previously treated with allergen immunotherapy^{26,53}. Almost two thirds of the patients with atopy and IgE sensitization to olive tree, grass and mugwort pollen have positive skin tests to one or more of the bee pollen extracts⁵⁴. Because allergic rhinitis is generally caused by anemophilous plants, rather than entomophilous plants, the presence of airborne pollen in honey bee pollen products may contribute to the risk of allergic reactions, particularly if the pollen supplements contain a substantial amount of airborne pollen to which the patient is sensitized. Other suggested mechanisms include cross-reactivity between the common epitopes on entomophilous and anemophilous pollen grains from the same botanical family, especially *Asteraceae* (*Compositae*) family⁵⁵.

The association between bee pollen supplements and allergic eosinophilic gastroenteritis has been reported in the literature, though very rarely. An adult woman with personal history of seasonal rhinoconjunctivitis and honey intolerance, with heartburn and abdominal pain, developed eosinophilic gastroenteritis three weeks after starting ingestion of bee pollen⁵⁶. Honey bee pollen supplement was also considered as a cause of eosinophilic gastroenteropathy in a young child without allergic rhinitis⁵⁷. Other non-IgE adverse reactions to dietary bee pollen supplements included a phototoxic skin reaction to a product also containing ginseng and goldenseal⁵⁸, and renal failure after prolonged administration (five months)⁵⁹. Moreover, pyrrolizidine alkaloid content of bee pollen may have hepatotoxic potential⁶⁰.

CONCLUSIONS

In **conclusion**, the knowledge and awareness of all these potential risks for the allergic rhinitis patient due to ingestion of food products containing animal, fungal and pollen aeroallergens, even if they are less important compared to food allergies due to cross-reactivities, is useful for the allergists and ENT specialists, especially in the context of climate changes with warmer periods facilitating mite growth in flours, and of increased use of phytotherapy and apitherapy products containing pollen grains.

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REFERENCES

- Popescu FD. Cross-reactivity between aeroallergens and food allergens. *World J Methodol.* 2015;5(2):31-50. DOI: 10.5662/wjm.v5.i2.31. eCollection 2015 Jun 26.
- Sánchez-Borges M, Suárez Chacón R, Capriles-Hulett A, Caballero-Fonseca F, Fernández-Caldas E. Anaphylaxis from ingestion of mites: pancake anaphylaxis. *J Allergy Clin Immunol.* 2013;131(1):31-5. DOI: 10.1016/j.jaci.2012.09.026. Epub 2012 Nov 13.
- Mangodt EA, Van Gasse AL, Bridts CH, Sabato V, Ebo DG. Simultaneous oral mite anaphylaxis (pancake syndrome) in a father and daughter and a review of the literature. *J Investig Allergol Clin Immunol.* 2015;25(1):75-6.
- García ME, Sánchez-Borges M, Capriles-Hulett A, Fernández-Caldas E. Oral mite anaphylaxis mimicking acute asthma. *Allergol Immunopathol (Madr).* 2016;44(5):484-5. DOI: 10.1016/j.aller.2016.02.005. Epub 2016 May 27.
- Sánchez-Borges M, Fernández-Caldas E, Thomas WR, Chapman MD, Lee BW, Caraballo L, et al. [International consensus \(ICON\) on: clinical consequences of mite hypersensitivity, a global problem.](#) *World Allergy Organ J.* 2017;10(1):14. DOI: 10.1186/s40413-017-0145-4. eCollection 2017.
- Sánchez-Borges M, Fernández-Caldas E, Capriles-Hulett A, Caballero-Fonseca F. [Mite-induced inflammation: More than allergy.](#) *Allergy Rhinol (Providence).* 2012;3(1):e25-9. DOI: 10.2500/ar.2012.3.0025.
- Suesirisawad S, Malainual N, Tungtrongchitr A, Chatchatee P, Suratannon N, Ngamphaiboon J. [Dust mite infestation in cooking flour: experimental observations and practical recommendations.](#) *Asian Pac J Allergy Immunol.* 2015;33(2):123-8. DOI: 10.12932/AP0484.33.2.2015.
- Broekman HCHP, Knulst AC, de Jong G, Gaspari M, den Hartog Jager CF, Houben GF, et al. Is mealworm or shrimp allergy indicative for food allergy to insects? *Mol Nutr Food Res.* 2017;61(9). DOI: 10.1002/mnfr.201601061. Epub 2017 Jul 18.
- Broekman HCHP, Knulst AC, den Hartog Jager CF, van Bilsen JHM, Raymakers FML, Kruizinga AG, et al. Primary respiratory and food allergy to mealworm. *J Allergy Clin Immunol.* 2017;140(2):600-3.e7. DOI: 10.1016/j.jaci.2017.01.035. Epub 2017 Mar 6.
- Payne CLR, Van Itterbeeck J. Ecosystem services from edible insects in agricultural systems: a review. *Insects.* 2017;8(1). pii: E24. DOI: 10.3390/insects8010024.
- Kung SJ, Fenimore B, Potter PC. Anaphylaxis to Mopane worms (*Imbrasia belina*). *Ann Allergy Asthma Immunol.* 2011;106(6):538-40. DOI: 10.1016/j.anai.2011.02.003. Epub 2011 Mar 4.
- Verhoeckx KC, van Broekhoven S, den Hartog-Jager CF, Gaspari M, de Jong GA, Wichers HJ, et al. House dust mite (Der p 10) and crustacean allergic patients may react to food containing Yellow mealworm proteins. *Food Chem Toxicol.* 2014;65:364-73. DOI: 10.1016/j.fct.2013.12.049. Epub 2014 Jan 9.
- Mattison CP, Khurana T, Tarver MR, Florane CB, Grimm CC, Pakala SB, et al. Cross-reaction between Formosan termite (*Coptotermes formosanus*) proteins and cockroach allergens. *PLoS One.* 2017;12(8):e0182260. DOI: 10.1371/journal.pone.0182260. eCollection 2017.
- US Food and Drug Administration (FDA). Defect Levels Handbook. The Food Defect Action Levels: Levels of natural or unavoidable defects in foods that present no health hazards for humans. [Internet]. Available from: www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/SanitationTransportation/ucm056174.htm. Revised February 2005.
- Tetty E, Jonfia-Essien WA, Obeng-Ofori D. The impact of insect infestation on stored purpled cocoa beans. *JENRM.* 2014;1(3):176-81.
- Armentia A, Lombardero M, Blanco C, Fernández S, Fernández A, Sánchez-Monge R. Allergic hypersensitivity to the lentil pest *Bruchus lentis*.

- tis. *Allergy*. 2006;61(9):1112-6.
17. Van Huis A, Van Gurp H, Dicke M. The insect cookbook - food for a sustainable planet. New York: Columbia University Press; 2014, p.19.
 18. Gawlik R, Pitsch T, Dubuske L. Anaphylaxis as a manifestation of horse allergy. *World Allergy Organ J*. 2009;2(8):185-9. DOI: 10.1097/WOX.0b013e3181b2fe51.
 19. Brito FF, Mur P, Leal JA, Galindo PA, Gómez E, Borja J, et al. [Penicillium nalgioense as an occupational and contact allergen](#). *J Allergy Clin Immunol*. 2003;112(1):213-5.
 20. Merget R, Sander I, Rozynek P, Heinze E, Imoehl M, Raulf-Heimsoth M, et al. Occupational immunoglobulin E-mediated asthma due to *Penicillium camemberti* in a dry-sausage packer. *Respiration*. 2008;76(1):109-11. Epub 2006 Nov 4.
 21. Steinman H, Ruden S. Native & recombinant allergen components: Allergy - Which allergens? *Allergy Resources International: Phadia AB*; 2008, p.5-201.
 22. Katona SJ, Kaminski ER. [Sensitivity to Quorn mycoprotein \(Fusarium venenatum\) in a mould allergic patient](#). *J Clin Pathol*. 2002;55(11):876-7.
 23. Hoff M, Ballmer-Weber BK, Niggemann B, Cistero-Bahima A, San Miguel-Moncin M, Conti A, et al. Molecular cloning and immunological characterisation of potential allergens from the mould *Fusarium culmorum*. *Mol Immunol*. 2003;39(15):965-975.
 24. Hoff M, Trüeb RM, Ballmer-Weber BK, Vieths S, Wuethrich B. Immediate-type hypersensitivity reaction to ingestion of mycoprotein (Quorn) in a patient allergic to molds caused by acidic ribosomal protein P2. *J Allergy Clin Immunol*. 2003;111(5):1106-10.
 25. Bennett AT, Collins KA. An unusual case of anaphylaxis. Mold in pancake mix. *Am J Forensic Med Pathol*. 2001;22(3):292-5.
 26. Greenberger PA, Flais MJ. [Bee pollen-induced anaphylactic reaction in an unknowingly sensitized subject](#). *Ann Allergy Asthma Immunol*. 2001;86(2):239-42.
 27. [Choi JH, Jang YS, Oh JW, Kim CH, Hyun IG. Bee pollen-induced anaphylaxis: a case report and literature review](#). *Allergy Asthma Immunol Res*. 2015;7(5):513-7. DOI: 10.4168/aa.2015.7.5.513.
 28. Lombardi C, Senna GE, Gatti B, Feligioni M, Riva G, Bonadonna P, et al. Allergic reactions to honey and royal jelly and their relationship with sensitization to compositae. *Allergol Immunopathol (Madr)*. 1998;26(6):288-90.
 29. Fuiano N, Incorvaia C, Riario-Sforza GG, Casino G. Anaphylaxis to honey in pollinosis to mugwort: a case report. *Eur Ann Allergy Clin Immunol*. 2006;38(10):364-5.
 30. Paola F, Pantalea DD, Gianfranco C, Antonio F, Angelo V, Eustachio N, et al. Oral allergy syndrome in a child provoked by royal jelly. *Case Rep Med*. 2014;2014:941248. DOI: 10.1155/2014/941248.
 31. Atanassova J, Bozilova E, Todorova S. Pollen analysis of honey from the region of three villages in West Bulgaria. *Phytologia Balcanica (Sofia)*. 2004;10(2-3):247-52.
 32. Atanassova J, Yurukova L, Lazarova M. Pollen and inorganic characteristics of Bulgarian unifloral honeys. *Czech J Food Sci*. 2012;30(6):520-6.
 33. Saarinen K, Jantunen J, Haahela T. [Birch pollen honey for birch pollen allergy - a randomized controlled pilot study](#). *Int Arch Allergy Immunol*. 2011;155(2):160-6. DOI: 10.1159/000319821. Epub 2010 Dec 23.
 34. Reider N, Sepp N, Fritsch P, Weinlich G, Jensen-Jarolim E. [Anaphylaxis to chamomile: clinical features and allergen cross-reactivity](#). *Clin Exp Allergy*. 2000;30(10):1436-43.
 35. de la Torre Morín F, Sánchez Machín I, García Robaina JC, Fernández-Caldas E, Sánchez Triviño M. Clinical cross-reactivity between *Artemisia vulgaris* and *Matricaria chamomilla* (chamomile). *J Investig Allergol Clin Immunol*. 2001;11(2):118-22.
 36. Egger M, Mutschlechner S, Wopfner N, Gadermaier G, Briza P, Ferreira F. [Pollen-food syndromes associated with weed pollinosis: an update from the molecular point of view](#). *Allergy*. 2006;61(4):461-76.
 37. Andres C, Chen WC, Ollert M, Mempel M, Darsow U, Ring J. Anaphylactic reaction to chamomile tea. *Allergol Int*. 2009;58(1):135-6. DOI: 10.2332/allergolint.C-08-63. Epub 2008 Dec 1.
 38. Melioli G, Spenser C, Reggiardo G, Passalacqua G, Compalati E, Rogkakou A, et al. Allergenius, an expert system for the interpretation of allergen microarray results. *World Allergy Organ J*. 2014;7(1):15. DOI: 10.1186/1939-4551-7-15.
 39. Don't take echinacea if you're allergic to ragweed. *Consum Rep*. 2012;77(2):12.
 40. Gol'dman II. Anaphylactic shock after gargling with an infusion of *Calendula*. *Klin Med (Mosk)*. 1974;52(4):142-3.
 41. Arora D, Rani A, Sharma A. A review on phytochemistry and ethnopharmacological aspects of genus *Calendula*. *Pharmacogn Rev*. 2013;7(14):179-87. DOI: 10.4103/0973-7847.120520.
 42. Anzai A, Vázquez Herrera NE, Tosti A. Airborne allergic contact dermatitis caused by chamomile tea. *Contact Dermatitis*. 2015;72(4):254-5. DOI: 10.1111/cod.12353. Epub 2015 Jan 27.
 43. Paulsen E. Systemic allergic dermatitis caused by sesquiterpene lactones. *Contact Dermatitis*. 2017;76(1):1-10. DOI: 10.1111/cod.12671. Epub 2016 Aug 29.
 44. Palma-Carlos AG, Palma-Carlos ML, Tengarrinha F. Allergy to sunflower seeds. *Eur Ann Allergy Clin Immunol*. 2005;37(5):183-6.
 45. Gruber P, Gadermaier G, Bauer R, Weiss R, Wagner S, Leonard R, et al. Role of the polypeptide backbone and post-translational modifications in cross-reactivity of Art v 1, the major mugwort pollen allergen. *Biol Chem*. 2009;390(5-6):445-51. DOI: 10.1515/BC.2009.063.
 46. Berecz B, Clare Mills EN, Parádi I, Láng F, Tamás L, Shewry PR, et al. Stability of sunflower 2S albumins and LTP to physiologically relevant in vitro gastrointestinal digestion. *Food Chem*. 2013;138(4): 2374-81. DOI: 10.1016/j.foodchem.2012.12.034. Epub 2012 Dec 31.
 47. Ukleja-Sokolowska N, Gawrońska-Ukleja E, Żbikowska-Gotz M, Bartuzi Z, Sokolowski Ł. [Sunflower seed allergy](#). *Int J Immunopathol Pharmacol*. 2016;29(3):498-503. DOI: 10.1177/0394632016651648. Epub 2016 May 24.
 48. Freeman GL. Oral corn pollen hypersensitivity in Arizona Native Americans: some sociologic aspects of allergy practice. *Ann Allergy*. 1994;72:415-7.
 49. Popescu FD, Vieru M. Molecular allergology approach in a patient with corn silk (*Stigma maydis*) infusion and pollen allergy. *Allergy*. 2014;69(Suppl 99):462.
 50. Popescu FD, Vieru M. Pooideae molecular sensitization profile in selected rhinitis patients with allergy to grass pollen and maize-derived edible products. *Clin Transl Allergy*. 2015;5(Suppl 4):P21.
 51. Cohen SH, Yunginger JW, Rosenberg N, Fink JN. [Acute allergic reaction after composite pollen ingestion](#). *J Allergy Clin Immunol*. 1979;64(4):270-4.
 52. Geyman JP. Anaphylactic reaction after ingestion of bee pollen. *J Am Board Fam Pract*. 1994;7(3):250-2.
 53. Martín-Muñoz MF, Bartolome B, Caminoa M, Bobolea I, Ara MC, Quirce S. Bee pollen: a dangerous food for allergic children. Identification of responsible allergens. *Allergol Immunopathol (Madr)*. 2010;38(5):263-5. DOI: 10.1016/j.aller.2009.12.003. Epub 2010 May 5.
 54. Pitsios C, Chliva C, Mikos N, Kompoti E, Nowak-Węgrzyn A, Kontou-Fili K. [Bee pollen sensitivity in airborne pollen allergic individuals](#). *Ann Allergy Asthma Immunol*. 2006;97(5):703-6.
 55. Jagdis A, Sussman G. Anaphylaxis from bee pollen supplement. *CMAJ*. 2012;184(10):1167-9. DOI: 10.1503/cmaj.112181.
 56. Puente S, Iñiguez A, Subirats M, Alonso MJ, Polo F, Moneo I. Eosinophilic gastroenteritis caused by bee pollen sensitization. *Med Clin (Barc)*. 1997;108(18):698-700.
 57. Güç BU, Asilsoy S, Canan O, Kayaselçuk F. Does bee pollen cause to eosinophilic gastroenteropathy? *Turk Pediatri Ars*. 2015;50(3):189-192. DOI: 10.5152/TurkPediatriArs.2015.1105.
 58. Palanisamy A, Haller C, Olson KR. Photosensitivity reaction in a woman using an herbal supplement containing ginseng, goldenseal, and bee pollen. *J Toxicol Clin Toxicol*. 2003;41(6):865-7.
 59. Akiyasu T, Paudyal B, Paudyal P, Kumiko M, Kazue U, Takuji N, et al. A case report of acute renal failure associated with bee pollen contained in nutritional supplements. *Ther Apher Dial*. 2010;14(1):93-7. DOI: 10.1111/j.1744-9987.2009.00707.x.
 60. Boppré M, Colegate SM, Edgar JA, Fischer OW. Hepatotoxic pyrrolizidine alkaloids in pollen and drying-related implications for commercial processing of bee pollen. *J Agric Food Chem*. 2008;56(14):5662-72. DOI: 10.1021/jf800568u. Epub 2008 Jun 14.