

Causes, symptoms and prevention of food allergy

Wioletta Agnieszka Żukiewicz-Sobczak¹, Paula Wróblewska¹, Piotr Adamczuk¹, Przemysław Kopczyński²

¹Department of Allergology and Environmental Hazards, Institute of Rural Health, Lublin, Poland

Head: Dr Wioletta A. Żukiewicz-Sobczak

²Centre for Orthodontic Mini-implants at the Department and Clinic of Maxillofacial Orthopaedics and Orthodontics,

Poznan University of Medical Sciences, Poland

Head: Przemysław Kopczyński MD

Postep Derm Alergol 2013; XXX, 2: 113–116

DOI: 10.5114/pdia.2013.34162

Abstract

Currently, food allergy is considered to be one of the diseases of civilization, which occurs as a result of the changing conditions of life and environmental changes (e.g. increased popularity of cesarean delivery, excessive hygienic regime during the neonatal-infantile period). Based on medical statistics, it can be concluded that this problem will be intensified. Consumption of food is one of the main activities in human life. What and how one eats affects our health. Meals eaten regularly provide the components necessary for the energy metabolism. Multicultural society, travel, and new trends affect the diversity of food consumed. The mechanism of food allergy reaction covers all 4 types of the immune response of the classical division of Gell and Coombs. The percentage of the immune response was assessed by Chandra as follows: type I – 48%, type II – 6%, type III – 10%, and type IV – 18%. The article presents the risk factors for food allergy, most common symptoms, preventive measures and characteristics of food products that are potential allergens.

Key words: food allergy, allergens, food intolerance.

Introduction

Consumption of food is one of the main activities in human life. What and how one eats affects our health. Meals eaten regularly provide the components necessary for the energy metabolism. Multicultural society, travel, and new trends affect the diversity of food consumed. Ingredients widely tolerated by the general population may not be well tolerated by some people. This specific situation brings about very serious consequences, sometimes endangering human life [1, 2].

Reactions that may be associated with allergic hypersensitivity to food have been reported by doctors of the oldest known civilization. Babylonian Talmud mentions egg white intolerance and suggests treatment options for this condition. Hippocrates observed stomach upset and hives caused by cow's milk. In the late 19th and early 20th century, the development of resistance and anaphylaxis was understood, which helped create a proper understanding of the basis of clinical and immunological phenomena associated with hypersensitivity-type reactions to foods.

In 2001, a new proposal for terminology and the overall classification of allergic diseases (including adverse reactions to foods), taking into account the etiopathogenetic mechanisms, was proposed by the Task Force at the European Academy of Allergy and Clinical Immunology (EAACI). The term “hypersensitivity” is used to describe all the clinical response of the body initiated by exposure to allergens of different biological nature (airborne, food and contact) [3]. According to the proposal, the term “food allergy” describes the ingested food-stimulated response in which the immune mechanism is documented or highly likely. All other reactions are determined as “non-allergic food hypersensitivity” [4-7].

Characteristics of food allergens

Food allergens are proteins whose molecular weight varies from 15 kDa to 40 kDa or glycoproteins having a molecular weight from 10 kDa to 70 kDa, which cause allergies in immunologically conditioned, abnormal response of the body. The structure, and biochemical and physico-

Address for correspondence: Dr. Wioletta A. Żukiewicz-Sobczak, Department of Allergology and Environmental Hazards, Institute of Rural Health, 2 Jaczewskiego St, 20-090 Lublin, Poland, phone: +48 698 143 743, e-mail: wiola.zukiewicsobczak@gmail.com

Received: 7.01.2013, **accepted:** 11.02.2013.

chemical properties of the allergen determine its allergenic strength. Many food allergens are capable of binding ligands, such as metal ions, lipids and steroids [8, 9]. An important role in the molecular structure of the allergen is played by epitopes, which are fragments of the antigen, connecting directly to the antibody. They directly interact with the antibody (namely, the paratope). The epitopes may more or less stimulate the human immune system. The antigen epitopes that generate the strongest immune response in a given species or individual, are called immunodominant determinants [10-12].

Currently, the allergen nomenclature subcommittee under the auspices of the International Union of Immunological Societies and the World Health Organization has developed a list of more than 400 allergens and 200 isoallergens [13]. Allergens derived from a given species can be made up of molecules of a similar structure. These particles, if they have similar biochemical properties, i.e. molecular weight, biological function, and more than 67% amino acid sequence similarity, are called isoallergens [14].

The mechanism of allergic reactions

The mechanism of food allergy reaction covers all 4 types of the immune response of the classical division of Gell and Coombs. The percentage of the immune response was assessed by Chandra as follows: type I – 48%, type II – 6%, type III – 10%, and type IV – 18%. If the harmful food triggers the abnormal immune response by type I reaction, the IgE antibodies are involved, and the clinical symptoms occur soon after ingestion of food or within a short period of time (usually about 2 h). This reaction is called immediate (early), and because of the pathogenetic mechanisms – IgE-mediated [15-19]. The IgE antibodies play the main role in allergy, and in the healthy human they can be found in small quantities. Only in some people, especially with a hereditary risk of atopy, there is an excessive production of IgE antibodies which trigger allergic reactions [20]. The presence of IgE antibodies in the pathogenesis of the disease is the main criterion for the definition of food allergy [2]. IgE-dependent allergy in the primary form is especially frequent in children, in which foods are the main or the only cause of the disease or disorder in contrast to the secondary form, which is more typical of older children and adults, in which foods are one of the many factors causing the disorder. Adverse food-induced immune response can be a sign of other pathogenic mechanisms of allergic reaction – II, III or IV type when T cells, IgG, IgM, IgA, and other immunologically competent cells are involved. Due to the pathogenetic mechanism of these reactions, they are described as IgE-independent [16, 17, 21]. Few studies have been conducted to evaluate the function of cytokines in immunopathology of food allergy. There was a statistically significant increase in IL-10 levels in patients undergoing an oral challenge, and lower levels of IL-10 in the serum of patients having a delayed reaction.

Circulating immune complexes (IC) containing IgE in allergic reactions often create difficulty in interpretation of serum IgE levels [22, 23].

Environmental factors

Occurrence of food allergy depends on many factors, including genetic predisposition of an individual, the degree of exposure to food, and molecular characteristics of the allergen [9]. The greatest risk of developing an allergy depends on genetic factors. It has been found that the risk of allergy development in children of healthy parents ranges from 5% to 15%, when one of the parents is allergic, it increases to 40% and if both parents are sick, reaches 60-80%. Environmental factors are also important in the development of allergies, such as improved hygiene, lifestyle, diet and nutrition, which are seen as factors responsible for the increase in allergic pathology in Western populations. Breastfeeding, which is the most natural and appropriate form of nutrition for infants, has been replaced with manufactured formulas full of proteins which can impose immunological reaction. Consumption of canned foods rich in additives and dissemination of new eating habits have contributed to the increase in the number of potential allergens [24].

Food products that cause allergies

In theory, all foods can cause allergic reactions, but in reality a small part is responsible for food allergies. Milk, eggs, wheat, fish, soy and peanuts are most often associated with allergic reactions in childhood. In adult humans, allergies to fish, shellfish (lobster, crab, crayfish) and some fruits, especially cherries, peaches, plums, apricots, as well as oleaginous fruits (nuts, seeds) and peanuts are reported [20].

Food traditions of different countries encourage the consumption of certain specific products, which if consumed frequently and in large amounts can cause allergic symptoms. For example, in Italy there are quite frequent cases of allergy to certain fruits, raw vegetables, tomatoes and corn. In the countries of northern Europe, the allergy to cod, often consumed in the daily diet, dominates. In the United States, high consumption of peanuts is responsible for an increasing number of extremely rapid allergic reactions, including anaphylactic shock [24].

Allergens may be divided into two groups: resistant and non-resistant to heat. The former group of allergens is linked to the order of amino acids in the protein segment. This group includes peanut allergens, cod, milk lactoglobulin, egg white ovalbumin, all of which are resistant to heat and act even after cooking the product. The latter group is associated with the spatial structure of the protein. The impact of high temperature causes changes in the three-dimensional structure of the protein, these allergens, predominantly fruits, vegetables or meat, often lose their sen-

sitization by boiling, while they are still active in raw fruits and vegetables [24].

In 1995, experts of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) compiled a list consisting of eight groups of foods that cause most food allergies. A number of clinical experience from Europe and North America suggest that these eight groups of foodstuffs are responsible for about 90% of all food allergies. The main causes of protein allergies are milk, eggs, peanuts, other nuts, fish, shellfish, soy, cereals, sensitizing at different frequencies [24]. According to the law, in the European Union, ready meals may contain a mixture of different known allergens without having to show data on the individual components of the package. "25 percent rule" states that the components of the product must be listed separately only if their share exceeds 25%. According to the Act, the ingredients of a food product and not the individual substances in the ingredients must be shown [25].

According to the literature, food allergies may increase as a result of the use of genetically modified products [24, 26]. In the research of Brazil nut gene insertion to soybean genetic material, allergies in patients who are allergic to these nuts were reported. Manipulating the composition of plant proteins without the knowledge of their allergenic potential can be very dangerous. However, not every genetic modification may have negative effects. In the U.S.A., for example, major work was carried out on removing allergens from peanuts to get the nut free of allergens [27].

Symptoms of food allergy

Food allergy can manifest a wide range of symptoms. No other disease known in the medical world has a greater variety of symptoms that may persist even after the resolution of the major allergy attack [28]. The appearance of itching of the lips or tongue, repeated vomiting, frequent diarrhea or urticaria may be defined as the most common symptoms, which reveal an allergic reaction to food. Refusal of certain foods by some children may indicate an allergy or intolerance and not a whim, especially when combined with a particular problem [24]. Fatigue caused by allergies can be felt the most in the morning and right after getting out of bed, or late in the afternoon, when any kind of rest or its length does not bring relief. Pain, stiffness and muscle tearing of the shoulder, neck and back, which may occur with headache, may drag through the days and weeks. Psychiatric disorders (tension, nervousness, irritability, stubbornness, anxiety, confusion, nervousness combined with trembling, stammering, disorderly speech, lethargy, stupor, aphasia – loss of the ability to speak, and feeling dazed, depression, discouragement, melancholy) are common in allergic individuals [28].

Generally, there are two types of food allergy. The first type is characterized by immediate reaction, which is

accompanied by symptoms occurring within a few minutes, or even seconds after consumption of the food, which is anaphylaxis (shock), urticaria, angioneurotic edema (skin swelling). Eggs, nuts, peanuts, fish and shellfish are often foods that often cause this type of allergy. The second type of food allergy is a late reaction, in which the symptoms (fatigue, irritability, depression, hyperactivity, insomnia, headache, poor concentration, paleness, itching limbs, involuntary bedwetting, asthma, colds, indigestion, colic, diarrhea, bloating and skin lesions) appear a few hours, and even a few days after food intake. Foods that cause this type of reaction are milk, chocolate, legumes, citrus and food additives. Because of this delay, it is difficult to determine what is the cause of food allergies [27].

Non-allergic food hypersensitivity

In the case of food intolerance, many of the same symptoms as allergic reactions persist but have other causes. Enzyme deficiency is responsible for the lack of tolerance causing certain food ingredients not to be degraded. The enzymatic defect can be either congenital or acquired in the course of life. For example, due to the lack of enzymes, some people do not digest milk sugar (lactose). In other cases, an ingredient of a food product acts like an allergen. The symptoms are the same as in the allergic response, including excessive histamine production leading to a runny nose, watery eyes and swollen lips, but the immune system is not involved, and the reaction is evoked directly by a component of a food product. The factors that cause the reaction are colorants (E 102, E 107, E 110, E 122, E 123, E 124, E 128, E 151), preservatives (E 210, E 219, E 200, E 203), substances enhancing taste and flavor (E 620, E 625, E 626, E 629, E 630, E 633), flavors (salt of cinnamic acid, vanillin, eugenol, menthol) and synthetic antioxidants (E 311, E 320, E 321) added to many food products [25]. An important role among the causes of hypersensitivity reaction is played by sulfur dioxide, which can be found in various species of wine, dried fruits and pickles. Tyramine and histamine (biogenic amines) contained in some foods (histamine in strawberries, tomatoes, some kinds of cheese, and tyramine in cheese, wine, nuts) may also be responsible for the symptoms [29].

Food allergy prevention

The basic principle of food allergy treatment is to avoid these food ingredients that cause allergic reactions. This requires a careful selection of products for the meal, which involves the obligation to read the composition of the products given on the labels. The most recent legislation on food labeling is aware of the needs of allergic people. An important step is the list of the most important allergens and ingredients derived from them, given in the directive of the European Union. Sometimes, however, typical symptoms of allergy occurs to hidden allergens – components nat-

urally present in the food or added to it in the form of a multi-product, whose name appears on the label as opposed to its specific composition [30].

One allergen may be present in many foods and many allergens can be found in one food product. Allergenic properties may have both components naturally occurring in foods and added ones. Monosodium glutamate (additive E 621) has the same allergenic properties as monosodium glutamate found in many foods naturally, such as tomatoes, mushrooms, corn, peas, parmesan, in hydrolysates of vegetable proteins, yeast extracts, caseinates. Symptoms of allergies to monosodium glutamate depend on the size of the dose. Therefore, in order not to restrict the consumption of the products, in which sodium glutamate is naturally present, products that contain it as additive E 621 must be eliminated from the diet [30].

The increase in the incidence of the disease, which underlies the phenomena associated with allergic hypersensitivity to food, and the progress of knowledge in new fields such as immunology, molecular biology and genetics over the last several years led to an unprecedented increase in interest in the difficult field of allergy. It is to be hoped, therefore, that this knowledge in subsequent years will be further expanded [31, 32].

References

1. Thom D. How to deal with food allergies and environmental, nutritional advice and recommendations. KDC, Warsaw 2009; 263-7.
2. Bartuzi Z. Allergy to foods [Polish]. Vol. VI. Publisher Mediton, Lodz 2006.
3. Czarnobilska E, Dyga W, Krzystyniak D, et al. Influence of environment exposures on the frequency of contact allergies in children and adolescents. *Ann Agric Environ Med* 2012; 19: 11-6.
4. Bartuzi Z. Food allergy in adults – a little-known and still undervalued problem. *Prz Gastroenterol* 2007; 2: 192-8.
5. Żukiewicz-Sobczak W, Krasowska E, Zwoliński J, et al. Allergic diseases – current state of knowledge. *Postep Derm Alergol* 2012; 29: 451-5.
6. Kaczmarski M, Krasnow A, Daniluk U, Gocał M. What we knew and what we know today about food allergy [Polish]. *Alerg Astma Immun* 2002; 7: 41-6.
7. Kamer B, Wąsowicz W, Pyziak K, et al. Role of selenium and zinc in the pathogenesis of food allergy in infants and young children. *Arch Med Sci* 2012; 8: 1083-8.
8. Aalberse RC. Structural biology of allergens. *J Allergy Clin Immunol* 2000; 106: 228-38.
9. Bartuzi Z. The molecular traits of food allergens. *Postep Derm Alergol* 2009; 26: 310-2.
10. Chapman MD, Pomés A, Breiteneder H, Ferreira F. Nomenclature and structural biology of allergens. *J Allergy Clin Immunol* 2007; 119: 414-20.
11. Ferreira F, Hawranek T, Gruber P, et al. Allergic cross-reactivity: from gene to the clinic. *Allergy* 2004; 59: 243-67.
12. Levinskaite L. Susceptibility of food-contaminating Penicillium genus fungi to some preservatives and disinfectants. *Ann Agric Environ Med* 2012; 19: 85-9.
13. Thomas WR, Hales BJ, Smith WA. Structural biology of allergens. *Curr Allergy Asthma Rep* 2005; 5: 388-93.
14. Dobek R, Obojski A. Alergeny inhalacyjne. http://www.gornicki.pl/uploads/TiShop/67/Alergeny_inhalacyjne.pdf (access: 2012.10.15).
15. Chapman JA, Bernstein L, Lee RE, et al. Food allergy: a practice parameter. *Ann Allergy Asthma Immunol* 2006; 96: 51-68.
16. Kaczmarski M (ed.). The position of the Polish Group of Experts – allergy and food intolerance [Polish]. Symposium 97/1, UNIMED 1997.
17. Johansson SG, Hourihane JO, Bosquet J, et al. A revised nomenclature for allergy. An EAACI position statement from the EAACI nomenclature task force. *Allergy* 2001; 56: 813-24.
18. Bahna SL. Diagnosis of food allergy. *Ann Allergy Asthma Immunol* 2003; 90: 77-80.
19. Bindslev-Jensen C, Ballmer-Weber BK, Bengtsson U, et al.; European Academy of Allergology and Clinical Immunology. Standardization of food challenges in patients with immediate reactions to foods – position paper from the European Academy of Allergology and Clinical Immunology. *Allergy* 2004; 59: 690-7.
20. Ciborowska H, Rudnicka A. Dietetics: nutrition healthy and sick man [Polish]. Medical Publisher PZWL, Warsaw 2010.
21. Niggemann B, Rolinck-Werninghaus C, et al. Controlled oral food challenges in children: when indicated, when superfluous? *Allergy* 2005; 60: 865-70.
22. Stadler BM, Vogel M, Aebischer S, et al. IgE and anti-IgE antibodies: key elements in the allergic response. In: Highlights in allergy and clinical immunology. Wütrich B (ed.). Hogrefe and Huber Publishers, Seattle 1992.
23. Ritter C, Batting M, Kraemer R, Stadler BM. IgE hidden in immune complexes with anti-IgE autoantibodies in children with asthma. *J Allergy Clin Immunol* 1991; 88: 793-801.
24. Conti L. Allergies and food intolerances [Polish]. Bellona, Warsaw 2007; 10-13, 45.
25. Kurek M. Allergy and pseudo-allergy in adolescents and adults [Polish]. *Alerg Astma Immun* 1998; 3: 66-75.
26. Piątek J, Gibas-Dorna M, Olejnik A, et al. The viability and intestinal epithelial cell adhesion of probiotic strain combination – in vitro study. *Ann Agric Environ Med* 2012; 19: 99-102.
27. Austin P, Thrash A, Thrash C. Food allergy [Polish]. Foundation "Source of Life" 1998.
28. Schwarz G, Carlsson S. Food allergies [Polish]. Medical Publisher PZWL, Warsaw 2003.
29. Rymarczyk B, Rogala B. Food allergies [Polish]. *Gastroenterol Pol* 2001; 8: 277-82.
30. Jarosz M, Dzieniszewski J. Food allergies [Polish]. Medical Publisher PZWL, Warsaw 2004; 27-30.
31. Bartuzi Z. Food allergy. In: Allergy, allergic diseases, asthma [Polish]. Vol. II. Fal AM (ed.). Practical Medicine, Krakow 2011; 395-6.
32. European Allergy White Paper, The UCB Institute of Allergy. Allergic diseases as a public health problem in Europe. UCB Institute of Allergy 1997.