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Review paper

Major allergens — the big nine

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ABSTRACT

Legal standards specifically describe the need for allergy labelling on foods, beverages and other non-pre-packaged items because food allergies have developed as a concealed problem that seriously jeopardizes public health. The growing number of people who have food allergies has made it difficult for the foodservice business to control them appropriately. Current efforts in order to protect vulnerable customers include recognized standards for producers aiming to eliminate an allergen from their products and the inclusion of food allergy education in the training for people in food service and those in charge of enforcing food standards.

1. Introduction

A life-threatening chronic illness, food allergy significantly reduces a person's quality of life. The management of these allergies is an important aspect of public health policy. Children and adults are affected, and it has a significant negative impact on health, the medical system and growing economies (*Greenhawt*, 2016). According to *Muraro et al*. (2014), food-specific IgE antibodies, cellular processes, or both may play a role in the development of food allergy, which is defined as a health problem brought on by a specific immune-mediated reaction that occurs consistently after eating a particular food (*Wang and Sampson*, 2011). The European Academy of Allergology and Clinical Immunology (EAACI) describes food allergy as a subclass of allergic reactions where the immune system is involved. Based on the action mechanism, food allergies can be classified as IgE-mediated, non-IgE-mediated, or other types of reactions (*Wang and Sampson*, 2011). Food allergy is acknowledged as a significant public health concern that must be adequately addressed by a variety of stakeholders, including the food sector. To ensure the safety of customers who have allergies, the food industry has attempted to manage allergens, but this has proven to be extremely difficult due to the distinctive characteristics of food allergies and food allergens. The cornerstones of efficient allergen management include accurate allergen labelling, minimizing random allergen presence and safe use of relevant precautionary labelling where necessary. There are currently no effective treatments for food allergies. The best way to manage allergies is to strictly avoid allergens because they can cause serious and occasionally life-threatening allergic reactions (*Muraro et al*., 2014).

2. Big nine

Non-ingredient allergenic components that can be generated through cross-contact, such as during manufacturing or packing, are not covered by the EU food information control. In cas-

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es where unexpected allergens are present, food manufacturers might adopt voluntary precautionary allergen labelling (PAL) to notify and protect allergy sufferers (*Muraro et al*., 2014). Unfortunately, incorrect labelling and sporadic use of PAL that is not based on a quantitative assessment of allergy risk could cause a mismatch between labelling and allergen presence (*Crotty and Taylor*, 2010; *Remington et al.,* 2015), putting allergic consumers at risk and limiting their choices of products (*Holzhauser et al*., 2020). In Serbia, the Ordinance on declaring, labelling, and advertising of food (*Republic of Serbia,* 2017–2020) and the Ordinance on the health safety of dietary foods (*Republic of Serbia*, 2010–2018) provide legislation regarding allergens that takes into account 14 food ingredients that can cause allergic reactions. The information on the nine top allergenic foods (often known as the "big nine") will be presented in this study. More than 170 foods have been reported to cause allergic reactions, but the vast majority are caused by the "big nine": milk, eggs, nuts, fish, crustaceans, shellfish, wheat, soy and sesame (*FDA*, 2022).

2.1 Eggs and egg products

A wide range of culinary products, including bread and confectionery, gourmet (soups, sauces, dressings), and meat products, regularly contain eggs and egg components or additives. The edible portion of an egg is made up of 63% egg white, 27.5% yolk, and 9.5% egg shell, including the membrane that lines the shell. According to *Lee, Loh and Tang* (2018), 1.8 to 2% of children under the age of five have allergies to eggs, making it one of the most prevalent allergenic foods. The majority of the proteins connected to egg hypersensitivity are found in egg white (*Réhault-Godbert et al.*, 2019). Both egg white and egg yolk contain clinically significant allergenic egg proteins. Egg allergies can result in symptoms ranging from a mild rash to anaphylaxis. The anticipated prevalence is between 0.2% to 7% (*Rona et al*., 2007; *Lee*, 2017). The precise amount of a food allergen needed to cause an allergic reaction is rarely determined due to variations in patient sensitivity and the specificity of the allergen. According to *Taylor et al.* (2002), the cumulative doses of whole raw eggs that can cause allergies range from 0.13 mg to 200 mg of dry protein.

2.2 Milk and milk products

Since milk provides the needed proteins, minerals, fats, and carbohydrates for human health, it is regarded as a complete food (*Pereira et al*., 2012). Although milk has many nutritional advantages and is widely recommended (*Lucarini*, 2017; *Chalupa-Krebzdak et al*., 2018; *Silva et al.*, 2020), milk consumption in Western countries is rapidly declining. Milk contains high-quality proteins, fats, vitamins, and minerals (such as potassium, phosphorus, and calcium). Babies and young children frequently have cow's milk allergies, which typically go away by the age of six. The immune system's reaction to a particular milk protein causes it to show up as an allergic reaction (*Edwards and Younus*, 2021). Numerous cow's milk proteins are immunologically active and antigenic, and it has been discovered that many people are sensitive to a variety of cow's milk proteins. According to studies done on large populations of allergic patients, the most prevalent proteins in cow's milk, particularly lactoglobulins, caseins, and α-lactalbumin (ALA), are the main allergens; however, proteins present in low quantities, like bovine serum albumin, lactoferrin and immunoglobulins, have also proven to be important in causing milk allergies (*Silva et al*., 2020).

2.3 Cereals containing gluten and cereal products

For baked goods (bread, pastries, pizza), pasta (noodles, pasta, spaghetti), some confections (cakes, biscuits, gingerbread), and prepared foods (cream soups, sauces, etc.), wheat flour is used as a raw material (*Popov-Raljić*, 2016); *Psodorov*, 2014). Infants are most likely to develop allergic reactions to wheat and other cereals, and these reactions often subside within the first few years of life. Cereal allergy symptoms that are IgE-mediated range from mild local skin or gastrointestinal reactions to more severe, frequently fatal anaphylactic crises. Examples of wheat allergies include bakers' asthma (occupational exposure to grain flour dust) and, less frequently, IgE-mediated allergy related to exercise, also known as wheat-dependent exercise-induced anaphylaxis. People who are sensitive to wheat-related crops (barley, oats, and rye) can usually tolerate rice. In Europe and America, allergies to rice are rare, but they might be more prevalent in Asia. With an estimated 5% global incidence, gluten-related diseases have grown in epidemiological relevance. Wheat allergy, non-celiac gluten sensitivity, and celiac disease are all conditions linked to gluten (*Rubio-Tapia and Murray*, 2010).

2.4 Fish, crustaceans, molluscs and their products

Although seafood is essential for human nutrition, health and economics, it can have serious IgE antibody-mediated adverse reactions in individuals who are vulnerable. Seafood includes fish (cod, salmon and tuna), shellfish (shrimp, crab and lobster), and molluscs (squid, shellfish and snails). According to *Sharp and Lopata* (2014), eating seafood can result in severe acute hypersensitivity reactions, including fatal anaphylaxis. There are over 20,000 edible fish species, although just a few groups (*Actinopterygii*) produce the fish that are frequently eaten. People who are allergic to fish should avoid eating any fish because they are typically allergic to a wide range of species. According to *Freidl et al.* (2017), adverse reactions to seafood can be immunological, such as IgE allergy, which is mediated by the antibody for which the trigger is taken. They can also be non-immunologic, such as toxins or pathogenic components. Worldwide, 0.3% of people have a fish allergy, while 0.6% have a shellfish allergy.

2.5 Soybeans and soybean products

Due to their high concentration of physiologically active compounds that can have positive effects, legumes like soybeans grown under specific conditions are also included in the functional food list (*Popov-Raljić*, 2016). Soybean allergy is less common than each of the other seven major allergens, which has been used to argue that soybean could be eliminated from the eight major allergens without endangering the general population (*Messina and Venter*, 2020). In four adult surveys, allergies to milk/dairy products and shellfish were more prevalent than allergies to soy protein. Worldwide, 0.1% to 0.6% of the population were found to be allergic to soybeans.

2.6 Sesame

Since sesame allergy causes severe/systemic adverse immunological reactions in sesame-allergic people, it is typically a life-persisting allergy. Native to the Middle East and Africa, where it has been grown as an oilseed crop for more than 3,000 years, sesame (*Sesamum indicum*) is a seed. Traditionally, it is eaten as a paste known as tahini or as a sweet known as halva. Western nations sometimes utilize it as a topping for breads and crackers. In the USA and Canada, estimates of the population prevalence of self-reported sesame allergy range from 0.1% to 0.2%. According to studies, prevalence rates range from 0.1% in Canadian children to up to 0.8% in Australian children (*Dalal et al*. 2002; *Adatia et al*., 2017). Sesame-related anaphylaxis rates vary greatly by geographic location, with rates in the Middle East being substantially higher than those in North America. Sesame has been identified as the second most frequent meal to trigger anaphylaxis in Israeli children, accounting for 43% of cases, and the third most frequent food to trigger anaphylaxis in Saudi Arabia, although it was only shown to be the source of 2.8% of food-induced anaphylaxis cases in Canadian children. At least 8 allergenic epitopes associated with IgE-mediated reactions have been found, to date, in sesame seeds, and three sesame oil constituents have been connected to allergic contact dermatitis (*Adatia et al*., 2017). Members of the seed storage compounds, the oleosin, and profilin families have been identified as epitopes that can act as mediators of rapid hypersensitivity, whereas lignins are linked to delayed-type hypersensitivity. Sesame allergy is important to recognize due to the rarity of sesame allergy outgrowth and the high danger of unexpected reactions, despite sesame allergy's relatively low frequency in the EU and North America (*Segal et al*., 2017).

2.7 Peanuts and peanut products

Peanut allergy is a common, enduring, and sometimes fatal food allergy that is becoming more prevalent in Western countries. It is one of the most frequent IgE-mediated food reactions (*EFSA*, 2014). Only 20% of people acquire a tolerance to peanuts, it usually manifests in infancy, and it is often identified between the ages of 6 and 24 months. Additionally, it lasts longer than allergies to milk or eggs. Numerous (n = 18) peanut allergens have been identified so far: All allergens cause significant peanut allergies: Ara h 1: cupin, Ara h 2: conglutin (2S albumin), Ara h 3: cupin, Ara h 4: renamed as Ara h 3.02, Ara h 5 is profilin, Ara h 6 and Ara h 7 are conglutin, Ara h 8 is a pathogenesis-related protein, and PR-10 is a member of the bet v1 family. Ara h 9 is nonspecific lipid-transfer protein type 1, Ara h 10, 1, 14, and 15 are oleosins, Ara h 12 and 13 are defensins, Ara h 16 and 17 are nonspecific lipid transfer protein 2 and 1, and Ara h 18 is cyclophilin, peptidyl-prolyl cis-trans-isomerase (www.allergen.org/allergen nomenclature).

2.8 Nuts

Nuts can be found in many different forms, from raw seeds to baked appetizers. The average daily intake of nuts and peanuts for the overall population in the EU was 2.23 g. Total daily nut intake in Europe ranged

from 0.61 g in Sweden to 4.83 g in Spain, from northern to southern regions. Walnuts, almonds, pistachios and hazelnuts are the most popular nuts in Europe (*Lack*, 2008). Both children and adults develop dietary allergies due to this common cause, and the clinical reaction can be lethal. In the UK, 1.7% of people in the overall population had a documented allergy to nuts and almonds. Around 9% of people, including individuals who have had severe reactions in the past, outgrow this type of allergy (*Fleischer*, 2012). Like fish and peanut allergies, stone fruit allergies are lifelong, and because the majority of stone fruit allergens are homologous to one another, there is frequently cross-reactivity. According to estimates by *Siecherer et al.* (2003), 20–50% of those who are allergic to peanuts are also allergic to nuts.

3. Conclusion

Food allergy is a significant problem for public health. The severity of allergic reactions can range from gastrointestinal issues and skin rashes to anaphylaxis, shock and even death. Allergy sufferers must avoid foods that contain allergenic components to prevent allergic reactions. Customers, therefore, rely on food labels to alert them to the existence of allergenic ingredients. The controls needed to ensure that allergens that are intended to be present in a food have been identified on the label, and that unexpected allergens are absent, must be developed, put into position, and maintained by food manufacturers. The use of warning phrases like “may contain [allergen]” or “produced on equipment that also processes [allergen]” is insufficient to prevent contact with allergens. Prerequisite programs need to be used, along with HACCP plan controls that guarantee proper product labelling, to manage allergens. In order to improve the health and quality of life of Serbians with allergic diseases, as well as reduce the burden of allergic diseases on individuals, healthcare systems and the community, a national allergen strategy (NAS) must be developed in Serbia in collaboration with key stakeholder organizations.

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