

Chapter 38

Management of Food Allergies and Intolerance using Traditional and Advanced Methods

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ABSTRACT

Food allergies and celiac disease are examples of adverse food reactions with an immunological basis. A food allergy is an adverse immune-mediated reaction that always arises when exposed to a specific food and goes away when it is avoided. Food allergies affect between 0.5 to 9% of the population overall and have a negative impact on health, particularly in young people. Milk and milk products, wheat products, shellfish, tree nuts, eggs and egg products, peanuts, fish and fish products these are the common foods that trigger food allergy. Foods associated with intolerance are gluten- containing products, chemicals and foods with additives and dairy products. Immunoassays, ELISA, Lateral flow immunoassay, xMAP techniques. These methods are used to detect food allergens. The majority of commercially accessible foods may contain chemicals that cause allergies or intolerances as an unidentified ingredient.

KEYWORDS

Food Allergies, Intolerance, Traditional, Advanced Methods

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INTRODUCTION

Food allergies and celiac disease are examples of adverse food reactions with an immunological basis. Food intolerances, on the other hand, are examples of adverse food reactions without an immune base. Despite being a T-cell mediated (Type 4 hypersensitivity) immunological response to gluten, celiac disease is not typically considered a food allergy (Turnbull et al., 2015).

What is Food Allergy?

A food allergy is an adverse immune-mediated reaction that always arises when exposed to a specific food and goes away when it is avoided. To diagnose food allergies, one must find evidence of sensitization and unique symptoms after consuming a particular meal. IgE-mediated, non-IgE-mediated, or a mix of the two types of immune responses can be brought on by food allergies. Food allergen sensitization—the formation of a serum-specific IgE antibody to a food allergen—and the manifestation of symptoms upon exposure to the food allergen are prerequisites for IgE-mediated food allergies. T-cell-mediated mechanisms are predominant in non-IgE-mediated food allergies, and histological evidence of an underlying immunological process, such as eosinophilic inflammation of the gastrointestinal tract, may be present (Turnbull et al., 2015).

What is Food Intolerance?

Dietary intolerances refer to several categories of unwanted dietary reactions. The immunological system is not involved in these non-allergic food reactions. A lack of an enzyme that breaks down lactose results in lactose intolerance, one example of a dietary intolerance involving an organic pathophysiological process. Nevertheless, a number of dietary intolerances observed in people with irritable bowel syndrome (IBS) cannot be easily explained by currently recognized organic mechanisms (Turnbull et al., 2015).

Food allergies affect between 0.5 to 9% of the population overall and have a negative impact on health, particularly in young people. All the following are major food allergies: milk, eggs, peanuts, tree nuts, shellfish, wheat, soybeans, fish, and other food products that either directly or indirectly include these allergens (Boye, 2012). Ninety percent of food allergy cases globally are linked to these foods, according to the US Food and Drug Administration. In addition to the top eight

allergens, a number of foods have a high potential to cause allergy reactions, such as corn, sesame, pork, celery, honey, fruits, and vegetables (Fu et al., 2019).

Common Foods that Trigger Allergies

1-Milk and Milk Products

Milk is a staple food consumed by people worldwide, even young toddlers and babies. It is the incredibly nourishing nourishment that postpartum female mammals' mammary glands make. For newborns between the ages of five and six months, breast milk is their only nutritional source. Other foods are gradually introduced after that. It fulfills the essential nutrient requirements for newborn growth and development as the major source of nutrient supplements (Walsh et al., 2016). Milk is an essential part of every adult's diet, including babies and young toddlers. It is the incredibly nutritious material that postpartum female mammals' mammary glands generate. For a newborn between the ages of five and six months, breast milk is their only dietary source. One food at a time after that is added. It fulfills the essential nutrient requirements for the growth and development of neonates and is the main source of vitamin supplements (Ramachandran et al., 2020). All adults, even infants and young toddlers, eat milk as a staple diet. It is the extraordinarily nourishing substance produced by the mammary glands of postpartum female mammals. Breast milk is the only food that newborns between the ages of five and six months may consume. After that, other foods are added one at a time. As the primary source of vitamin supplements, it satisfies the vital nutrient requirements for the growth and development of newborns (Pilolli et al., 2020). Furthermore, a variety of vegan milk alternatives are offered for sale as a fast-growing trend to replace cow's milk (Elsabie and Aboel Einen, 2016). To extract milk, vegan milk sources including rice, almond, soy, oats, hemp, coconut, etc. are soaked in water for a few hours, crushed, and then filtered. Additionally, vegan milk meets all of the nutritional requirements of conventional milk, and fortification is a method that may be used to further improve the nutritional profile. In the rare event of an allergy, heated or baked milk products are typically advised as safe (GRAS). The heat process denatures or modifies the proteins in milk, making it impossible for the immune system to identify them as allergens (Upton and Nowak-Wegrzyn, 2018). The greatest defense against newborn milk allergy is breastfeeding. It is vital to note that lactose intolerance and milk allergy have completely different pathophysiologies and are frequently undiagnosed.

2- Wheat Products

Roughly 75% of wheat-based products are thought to be utilized as dietary food for humans, with the remainder going toward animal feed and non-food uses (Bird and Regina, 2018). Gluten, globulins (salt soluble), and albumins (water soluble) are the three types of wheat proteins. The main protein found in wheat is gluten, which is further divided into two types based on solubility: gliadin, which is soluble in ethanol, and glutenin, which is soluble in acid or alkali. IgE-mediated food allergies are triggered by gluten, and depending on the dosage consumed, the symptoms can be minor to severe (Cabanillas, 2020). Dermatitis, rashes, and skin redness are the most common allergic reactions. Skin, lip, and throat irritation are also common, as are digestive issues such as diarrhea, vomiting, abdominal pain, and nasal congestion, as well as severe wheat-dependent exercise-induced anaphylaxis. The latter takes place right after consuming wheat or its products and is contingent upon how long the exercise is performed following the ingestion of wheat, often lasting between 10 and 60 minutes (Cianferoni, 2016).

3- Shellfish

The symptoms of shellfish allergy can range from mild to severe and are typically an onsite reaction. After tree nuts and peanuts, it is the third allergy that can result in anaphylaxis. The primary allergen causing shellfish allergies is tropomyosin, a muscle protein found in shellfish (Gupta et al., 2019). It's crucial to understand that, despite their shared misconception, fish allergy and shellfish allergy are quite distinct from one another. Allergy reactions induced by shellfish are unpredictable because even a small amount of the substance might result in symptoms like hives, itching, swelling, breathing difficulties, diarrhea, and unconsciousness. Allergy responses can also be brought on by handling procedures and steam inhalation during clam cooking (Pedrosa et al., 2015). It is preferable to prepare and eat shellfish at home rather than dining out, where there is a greater risk of cross-contamination.

4- Tree Nuts

Tree nuts are edible seeds that are used as a vegan milk substitute and as a small-scale garnish for cooked food. They also have a strong flavor. Most tree nuts are 50–60% fat and enhanced with important nutrients (Vanham et al., 2020). But they are a strong and common food allergy that causes unfavorable health effects that are rarely fatal. A person who has an allergy to one type of nut need not have an allergy to all nuts. Walnut, hazelnut, cashew, and almond allergens can induce life-threatening reactions. Numerous seed storage proteins, including vicilin, legumins, albumins, and others, are abundant in tree nuts and function as major allergies; guard proteins and profilins, on the other hand, are regarded as minor allergens (Geiselhart et al., 2018). Oral or pollen food allergy syndrome is the name given to the mild symptoms that arise from the cross-reactivity of birch pollen and tree nuts (Wangorsch et al., 2017). Tree nuts are an ingredient in many commercial products, such as baked goods, candies, cereals, soup mixes, high-energy bars, and homemade meals. Allergic responses can be caused by these products (Eigenmann et al., 2017).

5- Egg and Egg Products

Eggs are a cheap, easily accessible food that's rich in vitamins, proteins, and lipids. As stated by Godbert and colleagues (2019). They help regulate weight loss and enhance the strength of the heart, muscles, brain, skin, eyes, and immune system. Although chicken eggs have many beneficial health impacts, they are categorized as one of the top eight food allergens. The main allergens identified in the egg yolk are vitellus, apoprotein B, and alpha-livetin; ovalbumin, ovomucoid, conalbumin, and lysozyme enzymes are present in the egg white. Chicken serum albumin, or alpha-livetin, is the main allergen source that contributes to cross-reactivity (Hemmer et al., 2016). Egg whites trigger more allergic reactions than egg yolks because of their higher protein content. The proteins found in egg whites are heat-labile and retain their allergenic qualities even after processing (Onoda et al., 2020). Anaphylaxis, breathing difficulties, skin rashes and hives, and digestive issues are among the symptoms of egg allergy that appear right after ingestion (Ballmer-Weber et al., 2016).

6- Peanuts

The legume family that includes peanuts is widely utilized as an ingredient and part of our daily diet in a variety of forms, such as a single nut, filler, and alternative to more costly food items. The flour made from peanuts is typically used to make chocolate bars, baked goods, and other culinary products since it is high in protein and low in carbohydrates. Nut oils are derived from peanuts and employed in nutritious cooking methods (Akram et al., 2018). But among the eight common dietary allergen sources that cause severe allergic reactions, peanuts are one. According to (Chan et al., 2019), some of the linked allergy symptoms include inflammation, tingling of the tongue, itching in the mouth and throat, breathing difficulties, and low blood pressure. Anaphylactic shock is a potentially fatal condition. It is possible for pregnant women to eat peanuts, however, avoiding peanut-containing foods during pregnancy can limit the risk of exposure to the fetus. According to some research, applying peanut oil topically to the skin to treat wounds may also cause allergic reactions (Palladino et al., 2018). While highly processed oil from peanut is safe to eat, crude peanut oil is thought to cause allergies since it contains the majority of the allergens in the final product (Blom et al., 2017).

7- Fish and Fish Products

Eating fish and fish products is essential for human nutrition and can help prevent shortages in certain micronutrients. They have increased protein content, vitamins and minerals that are fat-soluble, good fats like eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and alpha-linolenic acid (ALA) that are necessary for a balanced diet (Kvasnicka et al., 2019). Fish with fins can produce a variety of allergic reactions, including the deadly anaphylaxis. In areas where fish and fish products are consumed in large quantities, the allergic reactions have a higher prevalence rate. About 40% of adults suffer from allergies connected to fish, which is typically a chronic illness. Various fish species' muscle, skin, bone, blood, and bodily fluids include allergens (Kobayashi et al., 2016). There have been reports that food processing procedures, such as applying physicochemical techniques, can reduce fish's allergenicity; however, the exact mechanism at work is yet unknown (Fernandes et al., 2015).

Foods Associated with Intolerance

1- Gluten-containing Products

A gluten-free diet cannot include bread, cereals, or similar products made with wheat, oat, dinkel, barley, triticale, kamut, or rye flour. The bulk of processed food items, such as cheese, pasta, pizza, hot dogs, cream sauces, salad dressings, and soup mixes, contain thickeners and fillers made from gluten derivatives (El Khoury et al., 2018). Unexpectedly, malt-based products such as malt extract, malt flavoring, or malt vinegar, licorice, beer, broth, soy sauce, and imitation crab meats can all contain gluten. Furthermore, consuming various forms of wheat—including spelt, cracked wheat, wheat germ, wheat bran, emmer, farina, einkorn, faro, graham flour, and so on—is not advised (Jnawali et al., 2016). In addition, those who adopt a gluten-free diet need to take precautions to prevent gluten from contaminating food in their own kitchens and other eating locations. Bread, biscuits, soups, cookies, bagels, cakes, pasta, and other frequently consumed foods are made of wheat and contain gluten. But avoiding these goods would require a complete lifestyle adjustment, which may not be feasible for all people with gluten intolerance. These restrictions are driving up demand for gluten-free goods. It is important to stress, nonetheless, that the nutritional profile of gluten-free goods must be equivalent to that of gluten-containing products (Gobbetti et al., 2018). The rules and guidelines set forth by numerous national and international organizations must be followed by the gluten-free products. A food product can be labeled as gluten-free in accordance with FDA rules and regulations if it satisfies the following necessary requirements. It has to be naturally free of gluten. It can't be made from a grain that contains gluten, such as wheat, barley, etc. It shouldn't be produced using a gluten-containing grain that hasn't had the gluten eliminated. The final product's gluten concentration shouldn't be higher than 20 parts per milligram if the raw grain containing gluten is used (Jnawali et al., 2016).

2- Chemicals and Foods with Additives

The food business uses a variety of food additives to extend the shelf life, enhance taste, and improve appearance of processed foods (Trasande et al., 2018). Natural and synthetic food additives are further divided into groups based on the specific roles they play in the food industry, such as flavor enhancers, thickeners, stabilizers, glazing agents, humectants,

colorants, gelling agents, or preservatives. Merely a handful of the aforementioned are connected to disagreeable sensations and responses mediated by immunity, non-immunology, or IgE. Amines are naturally occurring dietary chemicals found in bananas, seafood, chocolate, cheese, and ham. Apples and tomatoes contain salicylates, whereas tomatoes have glutamate. Examples of artificially incorporated chemicals include antioxidants found in oil and margarine, benzoates found in cordials and soft drinks, colorants found in candy, jellies, and spices, monosodium glutamate (MSG) found in packaged and processed foods, nitrates found in meats, propionates found in bread, sorbic acid found in processed cheese, and sulfites found in cordials, soft drinks, and dry fruits (Blekas, 2015). Tartrazine (FDandC Yellow #5, commonly called Yellow 5) (E102), which is yellow in appearance and is widely used in the food business, is the artificial food coloring that has been studied the most. The recommended daily intake (RDI) or acceptable daily dose (ADI) for tartrazine is 7.5mg/kg of body weight per day. It is commonly found in baked goods, drinks, cereals, and desserts (Khayyat et al., 2017). Cheese, dried fruits, and alcoholic beverages contain azolabine (E122); In cereals, sausages, and baked foods, sunset yellow (E110); Erythrosine (E127) in baked products, sweets, sausages, and maraschino cherries; Allura Red (E129) in drinks, candies, and cereals; Brilliant Blue (E133) in cereals, drinks, candies, and baked goods; Other coloring chemicals that are commonly added to meals and associated with adverse responses include Brilliant Black (E151) in sweets, ice creams, and jams; and Fast Green (E143) in drinks, candies, and ice creams (Ramesh and Muthuraman, 2018). A sodium salt of glutamic acid, monosodium glutamate (MSG) improves the taste and acceptance of savory foods by the senses. Pickles, spices, sauces, candies, soups, meats, and baked goods are common foods that contain MSG. In addition, rice syrup, gelatin, tomatoes, cheeses, and malted barley all naturally contain MSG (Ramesh and Muthuraman, 2018).

3- Dairy Products

Lactose, the main ingredient in most dairy products on the market, causes lactose intolerance. One popular treatment recommended lowering the risk of long-term consequences related to lactose intolerance is a lactose-free diet (Szilagyi and Ishayek, 2018). All the milk components are present in yogurt, but the lactose content is reduced. Yogurt is more tolerant of lactose than other milk products because the fermentative bacteria partially hydrolyze the lactose to produce glucose and galactose. Because they include more lactase and less lactose, a variety of fermented milk products, including labaneh, kefir, sour cream, viili and mursik, offer benefits comparable to those of yogurt (Silanikove et al., 2015). It is recommended to stay away from lactose-containing sweets and desserts such a pudding, biscuits, pastries, cheese-filled pastries, covered candies, chocolate bars, and ice cream (Piccolo et al., 2016). The nutritional content of a broad variety of milk products that are decreased or lactose-free is being compromised in the process of being commercialized. The items undergo treatment with the enzyme lactase, which breaks down the lactose into glucose and galactose for easy digestion. This process leaves the final product lactose-free and preserves its shelf life (Suri et al., 2019).

Detection Method of Food Allergens

- **Immunoassays**

ELISA, lateral flow immunoassay (LFIA), and multianalyte profiling are among the immunoassays commonly employed in food allergy detection because of the specific antibody interactions and high affinity with target allergens (Xu et al., 2021).

- **ELISA**

Because of its great sensitivity and ease of use, ELISA is the most often used technology for food allergy testing in food safety risk management. (Holzhauser et al., 2020) state that the identification and binding of specific antigen regions to antigen-specific antibodies is the foundation of ELISA. Usually, enzymes such as horseradish peroxidase (HRP) and alkaline phosphatase are attached to the antibodies. These enzymes can react with certain substrates to produce concentration-dependent color changes (Sena-Torralba et al., 2020). The analytes can be discovered on the work surface (Galan-Malo et al., 2017) or in complex food matrices. They can be any food allergen or a mixture of many allergies (Holzhauser and Vieths 1999).

- **Lateral Flow Immunoassay**

Using a semiquantitative approach, food allergy detection with LFIA provides a visual representation of test results. Based on the specific interaction between allergens and antibodies, LFIA acts similarly to ELISA, despite the fact that the visual signal is based on colored particles coated with antibodies. The test strip, which usually comprises of a sample pad, a test line (T line), and a control line (C line), is the most widely used technique for administering LFIA. When a sample solution is applied to the pad, the T line indicates which allergens are present in the sample. The test strip's legitimacy is confirmed by the C line, which is coated in anti-primary mAb antibodies and displays a red bond when allergens are present (Xu et al., 2021).

- **xMAP Techniques**

An accurate, sensitive, and high-throughput immunoassay that can multiplex the assessment of several allergens is the xMAP technique. Filep et al. (2018) and Oliver et al. (2017) state that the foundation of xMAP is fluorescence or MBs conjugating biotinylated antibodies with allergen-specific antibodies and using streptavidin-labeled fluorochrome as

detectors. The xMAP's modular design opens up possible applications in a wide range of industries. Single-laboratory validation and multilaboratory testing confirmed the xMAP assay's excellent performance under significantly altered settings or when using analysts with varying degrees of expertise. This suggests that the assay is sufficiently stable to meet real world analytical needs (Xu et al., 2021).

Conclusion

The increased prevalence of food allergies and intolerances is indicative of aberrant clinical reactions to specific food consumption. The majority of commercially accessible foods may contain chemicals that cause allergies or intolerances as an unidentified ingredient. The partial or total avoidance of such foods in daily diet intake is one potential preventive and therapy technique, as there is currently no known comprehensive cure. Even when allergenic and intolerant foods are removed from the diet, it's crucial to maintain a balanced diet to make up for the lost nutrients from the foods you must avoid. The scientific community has a greater grasp of the unpleasant reactions caused by consuming specific foods, but public awareness of the different foods linked to food allergies and intolerances still needs to advance.

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