TS 2: Food allergens

1. Introduction

Food allergens hold a particular place in food safety due to their potential severity, their unpredictability, and the fact that they can provoke severe reactions in otherwise healthy consumers.

Unlike other types of hazards, allergens:

- are not systematically destroyed by heat treatments,
- do not alter the appearance, odor, or taste of foods,
- can cause severe effects at extremely low doses (µg to mg).

2. Definition

A food allergen is a substance found in foods, most often of a protein or glycoprotein nature, capable of triggering a specific and excessive immune reaction in sensitized individuals, following ingestion, inhalation, or skin contact.

Food allergens share several common characteristics:

- molecular mass generally between 10 and 70 kDa,
- partial or total resistance to gastrointestinal digestion,

3. Notion of at-risk populations

Allergic individuals represent a vulnerable population. Allergens present in food constitute a hazard for people with food allergies. In these individuals, exposure to an allergen can lead to:

- **Mild reactions**: pruritus, urticaria, skin rashes, or eczema
- **Moderate reactions**: digestive disorders (abdominal cramps, vomiting, diarrhea), respiratory disorders (wheezing or bronchospasm)
- **Severe, life-threatening reactions**: edema, anaphylactic shock

4. Food Intolerance

It is essential not to confuse food allergies with food intolerances, as their mechanisms, severity, and management differ.

- **Food allergy:**

→ Involves the immune system (often IgE-mediated)

→ Can cause rapid and sometimes severe reactions (urticaria, edema, anaphylaxis)

→ Even very small amounts of the allergen can trigger a reaction

- **Food intolerance:**

→ Does not involve the immune system: Most often linked to an enzyme deficiency or absorption disorder

→ Symptoms are dose-dependent and primarily digestive

Common examples:

- Lactose intolerance
- Fructose intolerance

5. List of Allergens

Although many different foods (particularly those high in protein) can provoke allergic reactions in sensitive individuals, **fourteen (14) different allergens** are identified as major.

- **Cow's milk;** This is a true food allergy, to be clearly distinguished from lactose intolerance, which is due to an enzyme deficiency and does not involve the immune system.

The main allergens in milk are: Casein and β-lactoglobulin

Depending on the individual, some products may be better tolerated:

✓ Highly heated milk

✓ Fermented products (yogurts, cheeses), as some allergens may be partially denatured by heat or fermentation.

- **Peanut:** it is one of the most potent food allergens. Very small amounts can trigger severe reactions.

Main characteristics:

- Often severe reactions
- High risk of anaphylaxis
- Allergens are very stable to heat and digestion

It is important to emphasize that peanut allergy does not systematically imply an allergy to tree nuts, although co-sensitization can occur.

- **Tree nuts**: they include: almonds, hazelnuts, walnuts, cashews, pecans, pistachios, Brazil nuts. Allergies to tree nuts are among the most severe forms of food allergies.

In allergic individuals, the proteins in these foods can cause:

- Rapid drop in blood pressure
- Swelling of the respiratory tract
- Anaphylactic shock

A person may be allergic to only one type without being allergic to others.

- **Eggs:** Allergens are mainly found in egg whites, particularly ovalbumin. Some allergens are heat-sensitive, while others remain active even after cooking. Egg allergy is common in children and may sometimes resolve with age.
- **Soy:** It is a legume rich in protein, widely used in the food industry. Soy proteins can cause allergic reactions, particularly in individuals already allergic to other legumes.
- **Fish:** Fish allergy can lead to severe reactions. The main allergen (parvalbumin) is heat-stable. Cooking, smoking, or roasting does not inactivate it. Cooking vapors can sometimes trigger respiratory symptoms.
- **Crustaceans** (shrimp, lobster, langoustine, crab): they are responsible for often very intense allergic reactions. The main allergen is also heat-stable, requiring strict avoidance in allergic individuals.
- **Mollusks:** The most commonly involved mollusks are: squid, mussels, oysters, and snails. Allergic reactions to mollusks are generally less severe than those induced by crustaceans.

Fish is generally well tolerated by individuals allergic to crustaceans or mollusks, although exceptions exist.

- **Mustard:** Mustard allergens are stable to heat and technological processes**.** Mustard may be present in many products: Deli meats, sauces and marinades, spice blends and some cheeses and spreads.
- **Celery:** It is a common allergen, especially in powder or extract form. It is frequently found in spice blends, broths and prepared meals.
- **Sesame:** In allergic individuals, a few milligrams of sesame proteins are sufficient to trigger symptoms. Sesame is found in: Bakery products, cereal bars, Asian sauces and pastes and mixed dried fruits
- **Lupin:** it is a legume rich in protein. Lupin flour is used as an additive in wheat flours, as an emulsifier, or as an alternative to milk proteins. Lupin can cause allergic reactions, particularly in individuals allergic to legumes.
- **Wheat:** it is a cereal frequently involved in food allergies. A distinction must be made between: Wheat allergy and Celiac disease (gluten intolerance).
- **Special case: Sulfites (SO_2)** are used as food additives (preservatives).

Foods containing ≥ 10 mg/kg or 10 mg/L of SO_2 must bear the statement "contains sulfites" Sulfites are not protein allergens but can induce in sensitive individuals' asthma attacks and skin reactions

6. Risk factors

The development of a food allergy results from a complex interaction between individual factors (genetic, physiological) and environmental and behavioral factors.

a. Heredity: A child with one or two allergic parents (asthma, allergic rhinitis, atopic eczema, food allergy) has an increased risk of developing a food allergy.

b. Age: Infants and young children have an immature immune system and a still permeable intestinal barrier. This period represents a phase of heightened vulnerability, particularly for allergies to cow's milk, egg, and peanut. With age, immunological tolerance may develop for certain allergens.

c. Gut microbiota: A poor or unbalanced gut flora is associated with an increased risk of allergy. Several factors can alter the microbiota, including early antibiotic use and a poorly diversified diet.

d. Lifestyle and environment: According to the hygiene hypothesis, an overly sanitized environment during childhood, with low exposure to microorganisms, may promote the development of allergic diseases. Conversely, diversified microbial exposure (rural environment, contact with animals) appears to exert a protective effect**.**

7. Allergenic contamination in the food chain

1. Sources of contamination

- Uncontrolled raw materials
- Shared production lines
- Insufficient cleaning
- Human errors

2. Cross-Contamination

Cross-contamination is one of the main causes of allergic accidents in the food industry. It refers to the involuntary transfer of an allergen to a product that should not contain it. This contamination can be direct (contact between foods) or indirect, via equipment, surfaces, air, or personnel.

8. Allergen control in the food industry

- Allergen management in HACCP

Allergens must be considered **specific hazards** requiring:

- Precise identification
- Risk assessment
- Adapted control measures

- Hygiene control measures for allergens

The main control measures include:

- Physical separation of allergenic raw materials
- Organization of production flows (production sequencing)
- Validated cleaning and disinfection between productions
- Dedicated equipment when possible
- Staff training on allergen risks

- Written and enforced procedures

- **Traceability and documentation**

Traceability is a fundamental tool for allergen risk management. It enables:

- Identification of allergens present in a product
- Tracing back to raw materials in case of non-compliance
- Efficient management of product recalls

Traceability tools include:

- Supplier technical data sheets
- Allergen registers
- Non-compliance management procedures

- **Labeling**

The objectives of labeling are to **inform the consumer** and ensure **regulatory compliance**.

Labeling must:

- Clearly mention mandatory allergens
- Highlight them typographically
- Be reliable and consistent with the actual product formulation

Precautionary statements**:** *"May contain traces of..."*
Label controlling

9. Detection and analysis of food allergens

Analytical testing supports allergen management but does not replace good manufacturing practices, supplier control or accurate labelling. The method must be selected according to the allergen, the food matrix, the processing conditions and the question being asked.

- **ELISA (enzyme-linked immunosorbent assay)**

ELISA uses antibodies that recognize specific allergenic proteins or protein fragments. It can be sensitive and relatively practical, but results may be affected by the food matrix, protein degradation, heat treatment, extraction efficiency and the specific kit used.

- **PCR (polymerase chain reaction)**

PCR detects DNA sequences associated with an allergenic source, such as peanut or soy. However, it doesn't detect the allergenic protein itself.

- **Mass spectrometry**

Often coupled with liquid chromatography, can identify characteristic peptides from allergenic proteins.

- **Rapid tests**

Some rapid immunological tests are designed for on-site screening of surfaces, rinse water or selected foods. They can provide quick results, but their performance depends on the target allergen, sampling method and matrix.