TS 1: Physical hazards in food safety

1. Introduction

In everyday life, consumers ingest a wide variety of foods to meet their nutritional requirements. However, it is essential to recognize the potential risks that may compromise health. Food products can contain various hazards, such as biological agents, chemical substances, or allergens, which may cause serious foodborne illnesses. Among these risks, physical hazards represent a significant concern for food safety.

2. Definitions

- Hazard

According to the *Codex Alimentarius*, a hazard is defined as "a biological, chemical, or physical agent in, or condition of, food with the potential to cause an adverse health effect."

- Physical hazards

In a broad sense, a **foreign body** is defined as any material particle present in a food product whose nature or texture is not expected (undesirable) by the consumer or customer and that may compromise food safety or wholesomeness.

The term **"dense contaminant"** is also frequently used to distinguish physical foreign bodies from other types of contaminants of chemical origin (such as pesticide residues, heavy metals, mycotoxins) or biological origin (microorganisms, parasites).

The introduction of unwanted materials may occur through objects or individuals that come into contact with food, particularly during handling, processing, transportation, or storage. These unwanted materials constitute physical hazards when they are capable of causing injury or illness to the consumer.

3. Sources of physical contamination in foods

Physical contamination of food may originate from multiple sources and can occur at different stages of the food chain. In general, two main categories are distinguished:

3.1. Endogenous foreign bodies

These originate from the food product itself and include:

- Stones, pits, seeds
- Bones and cartilage
- Fish bones
- Mollusk shells
- Plant stems or fibers

These elements are normally removed from the edible portion during manual or automated processing operations but may occasionally bypass sorting or separation systems and remain in the final product.

3.2. Exogenous foreign bodies

These contaminants do not naturally belong to the food product and are unintentionally introduced at any point in the food chain. The most common include:

- **Stones, sand, gravel, rocks, and soil:** Frequently incorporated into crops grown close to the ground (e.g., peas, beans) during harvesting.
- **Glass:** Fragments originating from uncovered light fixtures, broken bulbs, or shattered glass food containers.
- **Metal:** Debris from tools and processing equipment, such as blade fragments, needles, utensils, staples, nails, and screws, commonly associated with cutting, slicing, or chopping operations. This category also includes stainless steel needles found in meat from vaccination guns and lead pellets in game meat.
- **Plastic:** Packaging materials (strings, plastic bags) and fragments of plastic utensils or cleaning equipment.
- **Jewelry and personal objects:** Resulting from poor hygiene and handling practices.
- **Wood:** Splinters from wooden structures, packaging materials, or pallets used during storage and transportation.
- **Flaking paint:** From deteriorating structures or suspended equipment.
- **Insect fragments:** Resulting from pest contamination during storage or processing.

4. Consequences associated with physical hazards

Physical hazards in food can lead to several serious consequences, affecting both consumers and food producers.

4.1. Health Consequences

Foreign bodies present in food are not necessarily toxic by nature; however, when they are introduced during handling, processing, storage, or preparation stages, their presence constitutes a significant hazard. These consequences may be classified as direct or indirect.

- Direct health effects:

According to the *Codex Alimentarius*, only hard and sharp particles are considered to pose a direct risk to public health. Such physical hazards may cause:

- Abrasions and cuts to the mouth or throat
- Damage to the gastrointestinal tract, including lacerations or perforations
- Injuries to teeth or gums
- Choking or suffocation

- Indirect health effects:

Foreign bodies may also act as vectors for bacteria or other pathogenic agents, thereby increasing the risk of foodborne illness and secondary contamination.

4.2. Economic consequences

The presence of foreign bodies in food products has become the leading cause of consumer complaints in the agri-food industry. Such incidents may:

- Result in the loss or withdrawal of food products
- Damage the reputation of the brand and the company
- Generate additional costs related to recalls, investigations, and corrective actions

5. Factors determining potential risk

Several factors influence the level of potential risk to consumers associated with physical hazards in food products. These include:

Size: It is generally considered that any foreign material present in a food product with a size of 2 millimetres or greater may pose a potential health risk. The probability and severity of injury tend to increase with the size of the foreign body.

Type of consumer: Foods intended for vulnerable populations, such as infants, young children, elderly individuals, or immunocompromised persons, are associated with a higher level of risk. These consumer groups are more susceptible to injury, choking, or other adverse health effects.

Type of product: The physical nature and presentation of the food product can significantly influence risk. Products with a soft texture, such as infant foods, purées, and beverages, may increase the likelihood of ingestion of foreign bodies without detection, thereby raising the potential risk.

Physical characteristics of the foreign body: The hardness, shape, and sharpness of the foreign material are critical determinants of risk severity. Hard, sharp, or pointed objects are more likely to cause injuries to the oral cavity, gastrointestinal tract, or respiratory system.

6. Prevention of common physical hazards

The control of foreign bodies in food products involves all stakeholders throughout the food chain. It is an integral part of the overall HACCP approach implemented by food businesses, which aims to prevent, eliminate, or reduce hazards to acceptable levels. The prevention of physical hazards is addressed through the following key steps:

- Supplier selection: Establishing detailed specifications and quality requirements for raw materials and ingredients is essential to ensure conformity and minimize the introduction of physical contaminants from the outset.
- Identification and analysis of potential foreign bodies: At each stage of the production process, from raw material reception to the finished product, potential foreign bodies must be identified. This includes determining their nature, origin, causes, conditions of occurrence, and frequency, as part of the hazard analysis phase within the HACCP system.
- Upstream prevention measures:

- Primary production (agriculture): Selecting suitable fields, maintaining harvesting machinery and storage containers and applying Good Agricultural Practices (GAP) help reduce the risk of contamination by stones, soil, or plant debris.
- Transport: Ensuring proper cleaning and maintenance of vehicles, protecting foodstuffs during transport, and preventing contamination by metal fragments through regular equipment inspection.

- Inspection of raw materials and ingredients: Raw materials should be visually and mechanically inspected to detect foreign bodies that may have escaped earlier controls, such as stones in cereals or plant residues in agricultural products.
- Food handling in accordance with Good Manufacturing Practices (GMP): Strict adherence to hygiene and handling rules is essential to prevent the introduction of physical hazards during processing. Examples include:
  - Avoiding the presence of jewellery, artificial nails, or other personal items that may fall into food products.
  - Enforcing appropriate staff clothing policies, such as hairnets and protective garments without external pockets.
  - Proper wound management, including the use of blue or fluorescent waterproof bandages containing metal strips that can be detected by metal detectors.
- Elimination of potential sources of physical hazards in processing and storage areas: All unnecessary or high-risk items should be removed from production environments. Examples include:
  - Using shatterproof or protected light bulbs fitted with acrylic covers.
  - Using non-removable pens and secured personal protective equipment, and prohibiting the use of staples, paper clips, pins, or similar objects.
- Installation of effective detection and removal systems: Appropriate technologies should be implemented to detect and eliminate physical hazards along the production line. For example:
  - Metal detectors and magnetic systems are used to identify and remove metallic fragments, while sieves and filters can eliminate foreign bodies at raw material reception.
  - X-ray inspection systems can detect stones, bones, hard plastics, and metal within food products.
  - Food radar systems transmit low-power microwave signals through food to detect foreign objects such as metals, plastics, bones, or grains.
- Equipment maintenance programs: An effective preventive maintenance program must be established to reduce the risk of physical contamination originating from worn, damaged, or poorly maintained equipment.
- Traceability, alert, and product recall measures: Clear traceability procedures, along with alert and recall plans, must be defined and coordinated with suppliers and customers to ensure rapid response in the event of a detected physical hazard.