4. PHYSICAL HAZARDS, WHOLESOMENESS AND ECONOMIC FRAUD

Dr. Femeena Hassan

HACCP is a science based , pro-active system of ensuring product safety by identifying specific hazards in the food processline and taking suitable measures to control the identified hazard at Critical Control Points. Hazard Analysis is the assessment of all hazards that are associated with a product at each of the operational steps within the process. This analysis is performed on the product as it relates to the end user (consumer) of the product. For the purposes of HACCP, hazards refer to agents in or conditions of food that can cause illness, injury or death of a person. These hazards fall into three categories: biological, chemical and physical.

Microbiological organisms like bacteria, virus, fungi, protozoa and parasites are the main biological hazards in food products,Chemical hazards can either be naturally occurring such as scombrotoxins, ciguatoxins, PSP, ASP and DSP or man made or introduced chemicals including PCB's, DDT, Heavy metals, machine grease, diesel oils and cleaning agents. A physical hazard is any physical material not normally found in food which causes illness or injury to the individual consuming the product.

What are physical hazards?

Physical hazards are either foreign materials unintentionally introduced to food products (eg:metal fragments in mince meat) or naturally occurring objects (eg: bones in fish) that are a threat to the consumer. A physical hazard can enter a food product at any stage of production. The adverse health effect of physical hazards may be choking, injury including laceration and perforation of tissues in the mouth, throat, stomach or intestines. It may also cause broken teeth and damage to gums. Foreign objects less than 7mm dimension rarely cause trauma or serious injury except in special risk groups such as infants, elderly and surgery patients.

What are some common physical hazards?

The main types of physical hazards in food include:

- Glass: common sources found in food processing facilities are light bulbs, glass containers and glass food containers
- Metal: common sources of metal include metal from equipment such as splinters, blades, broken needles, fragments from worn utensils, staples, etc.

- Plastics: common sources of soft and hard plastics include material used for packaging, gloves worn by food handlers, utensils used for cleaning equipment or from tools used to remove processed food from equipment.
- Stones: field crops, such as peas and beans, are most likely to contain small stones picked up during harvesting. Concrete structures and floors in food processing facilities can also be a source of small stones.
- Wood: common sources of wood come from wood structures and wooden pallets used to store or transport ingredients or food products

How can common physical hazards be prevented?

There are many ways food processors can prevent physical hazards in food products, including:

- Inspect raw materials and food ingredients for field contaminants (eg: stones in cereals) that were not found during the initial receiving process.
- Follow good storage practices and evaluate potential risks in storage areas (eg: sources of breakable glass such as light bulbs, staples from cartons, etc.) and use protective acrylic bulbs or lamp covers.
- Develop specifications and controls for all ingredients and components, including raw materials and packaging materials. Specifications should contain standards for evaluating acceptability of ingredients or packaging materials (eg: recycled cardboard used for packaging sometimes contains traces of metals that can be detected by metal detectors. A limit for metal detection should be established to avoid false positive detection of metal in food).
- Set up an effective detection and elimination system for physical hazards in your facility (eg: metal detectors or magnets to detect metal fragments in the production line, filters or screens to remove foreign objects at the receiving point).
- Properly and regularly maintain the equipment in your facility to avoid sources of physical hazards such as foreign materials that can come from worn out equipment.
- Periodic employee training on shipping, receiving, storing, handling, equipment maintenance and calibration will also help prevent physical hazards from being introduced into food products.

How are physical hazards detected and eliminated?

There are several methods available to detect foreign bodies in food on processing production lines:

- Metal detectors will detect metal in food products. They should be set up to reject products from the food production line if metal is detected. Proper maintenance should be given to this equipment to ensure they are always accurate and don't produce false positives.
- Magnets can be used with metal detectors on food production lines to attract and remove metal from products.
- X-Ray machines can be used on food production lines to identify hazards such as stones, bones and hard plastics, as well as metal.
- Food radar systems transmit low-power microwaves through food products to identify foreign bodies such as metals, plastics, bones, kernels and organic materials in food on production lines.

Wholesomeness and Economic Frauds

Physical hazards include a variety of foreign materials or objects, such as glass, metal, stone or plastic. However, foreign objects which cannot or do not cause illness or injury are not hazards, eventhough they may not be aesthetically pleasing to the consumer. The other related problems include wholesomeness which include decomposition and adulteration of the products and Economic Fraud which include short net weights, incorrect labels, species substitution , short counts etc.

Wholesomeness and Economic Frauds in Seafoods

1. Stones, sand and mud

The critical control point is receiving. This can be controlled by the proper verification of the raw material at the time of receipt and also by washing the raw material thoroughly with water to remove stones, sand and mud.

2. Glass pieces

Here also the critical control point is raw material receiving.

This can be controlled by avoidance of glass from the premises of seafood processing plants and also by providing proper covering to the electric bulbs, tubes or other lighting equipment.

3. Bones, shell pieces, legs, veins, antennae, skin etc.

This results from the improper dressing of the raw material. Proper dressing of the raw materials to be carried out to remove bones, shell pieces, skin, legs, antennae, veins etc.

4. Health hazards from pests

Effective pest control regimes play a key role in a company sanitation programme because insects, rodents and birds can easily enter an establishment and contaminate food. Pests may be divided into three groups: insects and other invertebrates, mammals and birds. Relatively few species are encountered in a food plant.

4.1 Cockroaches

The health hazards presented by cockroaches arise from the micro-organisms they transfer onto the food. In addition to carrying pathogens, cockroaches are also objectionable because of their offensive odour.

4.2 Flying insects

Flying insects are very efficient vectors of disease causing micro-organisms due to their mobility. Flies carry the microbes responsible for diseases such as typhoid fever (*Salmonella typhi),* cholera (*Vibrio cholerae*), anthrax (*Bacillus anthracis*), tuberculosis (*Mycobacterium tubercule*) and poliomyelitis.

4.3 Rodents

The health risks presented by rodents are plague, salmonellosis, infectious jaundice, rat fever etc.

4.4 Common bats

Common bats sometimes invade food plants as they can enter through any crack 0.5 inch or wider. They deposit large quantities of excreta below their hiding places.

4.5 Birds

Of much greater concern are the micro-organisms that inhabit the intestinal tracts of birds. *Salmonellae* in droppings of birds may be transferred to food constituting a serious health risk.

5. Identification of control measures

Control of pests in a food processing plant can be effected at three levels: the situation of the plant, the design and operation, and the destruction within the plant. There are certain places where it would be unwise to locate a food plant. Proximity to a refuse dump increases the likelihood of rat and bird problems. Downward wind of an aerobic effluent treatment plant may result in fly menace. The design of the plant is important in limiting the attractiveness to pests and providing barriers to their entry. No matter how good the first two measures, there will always be pests of one kind or another. So their destruction must be the final line of defence.

5.1 Cockroaches

Best method to control cockroaches is to eliminate their habitat. The removal of food sources, keeping premises dry, sealing cracks and crevices and, expert application of insecticides is often carried out to control the menace.

5.2 Flying insects

Effective control measures for flying insects include the removal of habitat to prevent feeding and breeding. Domestic and industrial wastes must be removed form the premises regularly and efficiently. Fly screens on windows and openings, polythene strips and/or air curtains on doorways, insect electrocutors and insecticide sprays may be used as required.

5.3 Rodents

Rodent proofing of the plant and, baiting and trapping are the most common type of control.

5.4 Common bats

Bats can be excluded by closing all the openings through which they may enter.

5.5 Birds

Controlling pest birds involves the control of environment. Food is a major attractant and should be limited. Repellents, physical barriers and hindrances are most effective in keeping a site free from bird problems.

Pesticide residues will become increasingly unacceptable probably to the same extent as pest themselves. So pest control without chemical pesticides is probably the ultimate wish of the food industry.

6. Metal inclusion

Metal-to-metal contact, especially in mechanical cutting and blending operations, has the potential for the introduction of metal fragments into the product. Such fragments serve as a hazard to the consumer. As a result, the processor should subject the product to metal detection devices to minimize the risk from this hazard. These devices can detect small metal fragments lodged within the product.

Control Point : Packaging

Control Measure

Subject all products that undergo mechanical cutting or blending to a metal detection process. The metal detection device should be at a point on the process line preceded by all cutting and blending equipment.

Test the effectiveness of the device at least daily according to the test procedures suggested by the manufacturer.

7. Filth

Contamination of raw material at receipt with filth, extraneous materials, and noxious substances

Filth, such as rodent excreta and hair, are preventable contaminants in many foods. Soluble filth, such as urine, cannot be removed by subsequent processing. Some other types of particulate filth may be readily removed by the intended processing.

Some contaminants are characteristic of certain products. Dried shark fin, for example, is frequently contaminated with insects and mites that are usually associated with stored products. Sea-bird excreta, a source of bacteria including *Salmonella* spp., and *Listeria monocytogenes*, is a hazard typical for many bulk-handled fish.

The harvest, transport, transfer, and handling of raw materials should be conducted with due careto avoid contamination. Raw products should be evaluated at receipt for the presence of such contaminants. The buyer specifications can aid this evaluation process.

FDA is charged with monitoring food for such contamination in USA. These hazards can be controlled by those who harvest, transport, process, and store fish. Failure to control avoidable contaminants can result in a non marketable product with the added liability providing for its destruction.

Control Point : Receiving

Control Measure

1. Visually examine representative portions of each lot or batch of fish upon receipt for evidence of rodent, bird, or insect filth, trash, and non-marine debris.
2. Do a sensory examination on representative portions of each lot or batch of fish upon receipt for contaminants such as fuel and oil.
3. Reject lots or batches of fish that exceed the critical limits.
4. When filth is found during the receiving examination and the lot is processed to remove the filth, visually examine representative portions of each lot of the processed product immediately after the application of the ingredient processing step for evidence of filth.
5. Reject lots or batches of processed fish of fishery product that exceed the critical limits.

Guidelines for filth in imported fresh or frozen raw shrimp (US FDA)

Samples of imported fresh or frozen raw shrimps may be detained when analysis of six 2-3 pound slabs show filth at or above the following levels:

A. Flies (whole or equivalent)

1.	Filth flies	2 in a sample
2.	Incidental flies	10 in a sample

B. Fly fragments

1. Three fragments in 5 of 6 slabs (These fragments are clearly identified as parts of filth flies)
2. Large body parts (thorax, abdomen) 1 in 3 of slabs

C. Cockroaches

1. One whole or equivalent in the sample
2. Excreta 1 in 2 of 6 slabs

D. Hairs

1. Rat or mouse, 3 of any size in a sample
2. Straited but not rat or mouse, 4 of any size in a sample.

8. Decomposition

Decomposition of raw material

Decomposition in fish and fishery products can be categorized as: (1) enzymatic spoilage, caused by the tissue enzymes of the fish itself, (2) oxidative deterioration, appearing as rancid odours and colour changes, and, (3) spoilage due to bacterial growth and its secondary products, primarily enzymes, causing decomposition of protein. The most efficient way to prevent decomposition in fish and fishery products is to quickly cool the fish immediately after capture and to hold it at a low temperature, ideally at –2°C (28°F) for marine species, -1°C (30°F) for freshwater species, and 10°C (50°F) for in-shell molluscan shellfish.

The state of an organism after death is an important indicator of freshness. Immediately after the organism is killed, its muscles are relaxed and its condition is known as pre-rigor. Soon rigor mortis sets in and the muscles contract and the spine becomes rigid. This state can be prolonged by quick cooling of the flesh. Decomposition of the flesh is greatly retarded

during rigor. After rigor ends (post-rigor), the fish muscles relax and decomposition occurs much more rapidly.

Decomposition of seafood causes an adulterated, unwholesome product. It is the responsibility of all processors to provide consumers with a wholesome product.

Shark, dogfish, and their kind contain urea and trimethylamine oxide in their blood to balance the saltiness of the seawater. They must be bled quickly and thoroughly to prevent the formation of ammonia and trimethylamine that are indicators of decomposition.

Bacteria can be found on the gills, slime and intestinal contents of fish. The boats and the equipment used to harvest the fish also contribute to bacterial contamination. The flesh of living fish is usually free of bacteria, but the normal barriers that protect the fish muscle from invasion by bacteria crumble rapidly after death. Initially there are many kinds of bacteria present. During spoilage the kinds of bacteria change dramatically due to competition between the bacteria. These bacteria produce a group of metabolic products and a certain set of odours that vary depending on several factor, including the time and temperature of spoilage. Spoilage at high temperatures (eg. 32.2°C [90°F]) occurs more rapidly than at lower temperatures (eg. 10°C [50°]).

When decomposition occurs, it may not occur evenly within a single fish or between individual fishes in a catch. Generally, decomposition occurs, at first, in the anterior end of a fish and in the belly flaps, but exceptions have been observed. The presence of decomposition can appear as: odours, especially in the gill and belly cavity area at first, and later in the muscle, changes in colour of gills, eyes and skin, and, softening and loss of resiliency of the muscle.

The rate and type of spoilage can vary with the time of year, species being harvested, and method of harvest. However, all fish and fishery products are susceptible to decomposition when mishandled, through: delays in removing fish from the lie or net; allowing product to remain on deck in the sun, storage in warm, contaminated water in the hold, and, poor sanitation and temperature control during transportation and storage. Thus, when loss of quality occurs and spoilage begins, the process cannot be reversed and the product quality is lost. There is a limited quality and shelf life for fish and fishery products. Early preventive measures are, therefore, essential and benefit from low temperature storage.

This hazard does not apply when raw material is received alive.

Control Point : Receiving

Control Measure

1. Find out whether each lot or batch of fish is decomposed. Perform an external sensory examination of representative portions of each lot or batch, or find out if slaughtered animals are in rigor or pre-rigor state. Where frozen raw material is used, it may be appropriate to do the sensory examination at the time the lot is used.

2. Unless the fish are received frozen, find out whether the fish are properly iced or refrigerated. Check there is enough ice surrounding the product (for iced product) and monitor the internal temperature of the product for a representative number of fish in each lot (for iced or refrigerated product). Large aquatic animals (ie. Alligators) received in rigor or pre-rigor need not be refrigerated at the time they are delivered.

3. Calibrate the thermometer used for checking product temperatures at least once in a year against a thermometer traceable to a National Standard.

4. Replace thermometers that cannot be adjusted to within the critical limits.

5. Reject individual fish that are decomposed and reject lots or batches of fish that exceed the critical limits

9. Short weight

Short weight, addition of water, standard of fill and over-glazing

Most fish and fishery products are sold by weight. Accurate weight statements on labels and on shipping documents relating to bulk shipments of fish and fishery products are necessary for the maintenance of product integrity. The processor should, therefore, exercise control over such statements. Additionally, standards of fill exist for certain canned fish and fishery products (shrimp, salmon and tuna) to minimize the risk of deception that could result from an unduly large can size. Because oysters readily absorb water, which has a profound impact on the oyster's volume, weight, and count, it is important to control their contact with water in order to maintain product integrity. Similarly, a layer of water (or solution of cryoprotectants) is often added to frozen products to reduce the incidence of freezer burn. If glazing is done after weighing, there is no impact on product integrity. However, if glazing is done before weighing, controls should be used to ensure that a true net weight is given for the product. Scales must be calibrated with weight traceable to the National Standards.

For this hazard, control should be exercised at all of the following critical control points: packaging; processing (for oysters); and additive batching and application (for products containing an additive that causes water adsorption).

Control Point : Packaging

Control Measure

1. Check-weigh manually or electronically, each mechanically filled finished product package if the package is sold by weight. If the packages are weighed manually, they need not be check-weighed.

2. Examine representative samples of each lot for net weight, net volume, or count, as appropriate. This should be done by a representative of management or QC, either at packaging or as a finished product assessment.

3. Check the accuracy of scales on a daily basis using a set of NIST traceable weights.

4. For products glazed before weighing, conduct pilot studies to find the quantity of water added during the glazing process, so that the appropriate increase can be made to the packing weight, and to establish a relationship between pre-glaze and post-glaze weights for the QC net weight examinations.

5. When oysters are packed by count, grade oysters by size according to the provisions of the "Grade size misrepresentation" hazard and control, and label them accordingly.

10. Grade size misrepresentation

Product size can have a significant impact on its value. Examples of this phenomenon include oysters and canned shrimp for which, standards have been set by regulation. However, whenever size is declared on a label, or on a shipping document for bulk product, it becomes a material fact for that product and it should then accurately represent the product being offered. The processor should exercise control over grading operations to ensure that they are accurately represented by the labelling.

Control Point : Grading

Control Measure

When size is declared, check grade size at each grading device at least once an hour. Calibrate scales used in the testing procedure at least daily using a set of National Standards traceable weights. Grade oysters sold by grade or by count at least once an hour for each size.

11. Incorrect proportions

Incorrect proportions of species can occur for blended products, cocktails and other products containing multiple fish components.

Many similar appearing species have dramatically different economic values due to their relative supply and demand. When such species are combined in a blended product, cocktail, or other products containing multiple fish components, the ability of the consumer to easily differentiate between them is essentially lost. It is important for the processor to control the blending operation to ensure that the relative proportion of the valuable ingredients is as declared on the label.

Control Point : Blending

Control Measure

1. Manually or electronically check-weigh each fish component before blending (eg. before placement into the finished product contained in a cocktail-type product).
2. Check scales for accuracy against a set of National Standards traceable weights at least daily.

12. Species substitution

Statement:

Many species of fish and fishery products cannot be readily identified, especially after partial or complete processing or when they are examined by untrained consumers or processors. Many similar appearing species have dramatically different economic values, due to their relative supply and demand. These factors have lead to an ongoing problem with species substitution, undermining the maintenance of product integrity. Species substitution was reported as the number one concern among industry respondents to a mail in survey in a recent trade journal. Such concern among the industry members is an indication of the difficulty, faced even by those most knowledgeable in the field, to be sure that the commodities they buy are not falsely labelled. Consequently, the processor should exercise control over the packaging and labelling operations to minimize the risk of substitution.

For this hazard, control should be exercised at both the following critical control points: labelling and receiving.

Control Points : Labelling, receiving

Control Measure

Check the labels at the start and end of production of each lot and compare them to the product being processed.