
UNIT 3 FOOD SAFETY HAZARDS

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3.0 OBJECTIVES

After reading this unit, you will be able to:

- justify the importance of the knowledge of food safety hazards;
- identify the physical hazards;
- discuss about the chemical hazards; and
- analyze the biological hazards.

3.1 INTRODUCTION

You must understand that Food Safety is gaining great importance and the common man is more and more aware of the public health problems arising from food. Almost all the developed countries, along with a few developing countries, have already enacted rules and regulations for ensuring food safety for all food items produced and marketed for public consumption. Hazard is defined as “a physical, chemical, or biological agent that is reasonably likely to cause illness or injury in the absence of its control”. Currently, Hazard Analysis Critical Control Point (HACCP), Good Manufacturing Practice (GMP), Standard Sanitation Operation Procedures (SSOP) etc. are in force in many countries. These quality assurance programmes are also guidelines for achieving certain standards formulated by national and international regulatory agencies. In this way, the HACCP and the Pre-requisite Programmes (PRPs) of USFDA, ISO 22000 Food Safety Management Systems of the International Standards Organization and Food Safety Regulations of many countries aim at attaining absolute safety of food to ensure public health. Fish and fish products provide nearly 14% of the world’s need for animal protein. For countries like India, Thailand, China & Vietnam, export of fish is a source of valuable foreign currency. Hence, it is beneficial for you to have an in-depth knowledge of food safety hazards. This unit attempts to do this.

3.2 IMPORTANCE OF GUIDELINES ON PREVENTION OF FOOD SAFETY HAZARDS

In food safety, more emphasis is laid on prevention of food safety hazards at the source itself. Even though, it began as a voluntary system, the national and international regulatory agencies decided to implement these guidelines as a mandatory requirement so that all food for public consumption will be safe. The food safety hazards are intrinsic/extrinsic factors of the food, which cause infection, injury or toxicity to the consumer. Accordingly, three classes of food safety hazards are identified *viz.*, physical hazards, chemical hazards & biological hazards. The food safety standards and the relevant quality assurance programmes aim to identify and control all possible hazards associated with a food group so that the food products will be free from food safety problems. In this way, the implementation of HACCP and the PRPs or the so-called ISO 22000 can lead to safe food products. However, for elimination of lapses on the part of food producers and processors and for ensuring safety to public health, it will be important to monitor the significant hazards associated with a food and certify that the hazards are below the tolerance levels. In India, there is no comprehensive guideline for food safety. For analysis of the relevant hazards, suitable methods are available and the parties interested can refer to them for more details.

3.3 WHY FOOD SAFETY?

Do you know why we should worry about food safety? Food safety is gaining more and more importance throughout the world. Global food trade and the introduction of WTO Agreement have prompted many countries to adopt modern quality assurance programmes to make food safe for human consumption. In an effort to achieve food safety and prevent food-borne public health problems, almost all countries are enacting laws to enforce and implement procedures for ensuring safety and quality of all food items produced, processed and distributed for human consumption. In this context, a detailed idea, about the hazards which make food unsafe, as well as the quality problems or defects, which will indicate the adverse effect on wholesomeness of food, will be very much useful to the personnel in the food industry, regulatory authorities as well as the general public.

You must be aware of the fact that the suitability of a food for human consumption can be judged based on the occurrence of food safety hazards and quality problems. For your information, a food safety hazard can be defined as a physical, chemical or biological parameter, the presence of which in the food can cause infection or injury or toxicity to the consumer. On the other hand, a quality defect is also a chemical or microbiological or physical parameter, which will only reduce consumer acceptability without causing infection or injury or toxicity to the consumer. For a food to be safe and acceptable, it should be free from hazards and quality defects.

The standards stipulate tolerance limits for each hazard and tolerance limits for quality defects. Periodic evaluation of food samples at critical stages of production to meet the requirements of such standards will be effective in controlling food borne diseases and public health problems. The availability of safe and quality food will not only promote good public health but also considerably augment tourism and international trade in food commodities.

3.4 THE FOOD SAFETY HAZARDS AND QUALITY DEFECTS

The food safety hazards and quality defects fall under mainly three categories, viz. Physical Hazards, Chemical Hazards and Biological Hazards.

3.4.1 Physical Hazards

This type of hazard are caused by the following items:

a) Stones, wood and plastic pieces

These items can come with raw material during harvest and if not properly sorted they can appear in the food prepared for human consumption and cause injury to the customers. The critical control point for these hazardous substances is during receiving time. This can be controlled by the proper inspection of the raw material along with supplier guarantee at the time of receipt.

b) Glass pieces

Glass pieces arise out of breakage of glass containers and glass fittings and can be avoided by conducting a glass audit. This can also be controlled by avoidance of glass in the processing and packing activities in the food processing plants and also by providing proper covering to the glass electric fittings followed by glass audit.

c) Bones, shell pieces etc.

This results from the careless pre-processing of the raw material. Proper dressing of the raw materials to remove bones, shell pieces, etc. followed by inspection can exclude these food borne physical hazards. Shells, particularly crab shells can easily be detected by screening through Ultra Violet (UV) light.

d) Metallic objects

Metal-to-metal contact, especially in mechanical cutting and blending operations, as well as loose nuts, bolts, stapler pins etc. have the potential for the introduction of metal fragments into the food product. Such fragments can cause injury to the customers as a physical hazard. To avoid such metal based hazards, the processing line shall operate a metal detection device at the end of the production line for detection and elimination/correction of products with metallic hazard. As a general guidance, the tolerance for physical hazards is absence of physical hazards mainly metal and glass pieces in the size range of 7 mm to 25 mm.

 **Check Your Progress 1**

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of the unit.

1) Name a few physical hazards?
.....
.....

2) How to avoid metal-based hazards?
.....
.....

3.4.2 Chemical Hazards

Can you define chemical hazards? Chemical hazards are toxic chemical compounds that appear in food either as a contaminant or a food additive or as a genetic constituent. Most of the chemical hazards are either immediate toxins or cumulative toxins, which are non-bio-degradable. In the case of the immediate toxins, the amount of toxin consumed in one day through one or more meals can result in toxicity. Chemical toxins like Histamine, Paralytic Shellfish Poison (PSP), Diarrhetic Shellfish Poison (DSP), other Biotoxins and bacterial toxins come under this category. Smaller doses of these toxins will be detoxified by body. You will be surprised to know that in the case of bio-accumulative toxins, the bodies of the consumers lack the mechanism to detoxify or excrete the daily doses of small quantities of these toxic substances. Consequently, with periodic consumption, the level of these toxic chemical residues accumulates in body to toxic concentrations. Heavy metals, chlorinated pesticide residues etc. come under this category of chemical hazards. There is also a third category of chemical hazards, the continued consumption of which can lead to diseases like cancer and sometimes cause defects in the metabolism of the body. Antibiotic residues like Chloramphenicol, Nitrofurantoin and their metabolites, polynuclear aromatic hydrocarbons etc. come under this category.

- a) **Heavy metals:** The most important heavy metals causing public health problems through food are lead, cadmium and mercury. In most of the food commodities, these metal residues are found in extremely low levels, especially in food crops of an annual nature. However, for crops from perennial species of plants and animals, accumulation of these metals is possible. Hence, there is need for monitoring of such plant products, farmed animals and poultry on a batch basis, to ensure that the toxic elements of lead, cadmium and mercury are below tolerance levels. In the case of certain marine food organisms like cephalopods, there is a preferential accumulation of cadmium. Consequently, for foods involving cephalopods and their products, there shall be lot wise monitoring to ensure that cadmium levels are below the permitted level. In a similar fashion, big fishes (above 5 kg) are reported to contain significant levels of the toxic element mercury, necessitating a routine monitoring of all such fish species for the level of mercury. In inland fishes, lead is also found to occur at significant levels.
- b) **Pesticide Residues:** Like heavy metals, pesticides, particularly chlorinated pesticides, are found to be bioaccumulative as they are not bio-degradable. Further, there is no mechanism for their excretion from body. Pesticides are generally used against plant and animal pests. Consequently, their presence is likely to occur in food products from plants and land-based animals. Due to rain, wind, birds etc., these pesticides from cultivation areas will find their way into inland water bodies at first and then into the sea causing the fish and other aquatic animals to pick up and retain the pesticide residues in their lipid pool. Even though the level of pesticides in marine fishes is quite insignificant, the fresh water specimens are found to harbour significantly higher levels. Poultry farming heavily depend upon fishmeal and, quite often, the fishmeal will be containing fish and fishery products rejected on account of health problems. In this way, contaminants like heavy metals, pesticide residues, etc. are also encountered in poultry meat. To take care of these health problems, fish, animal and poultry raised

in land-based farms shall be subjected to lot wise monitoring for heavy metals and pesticides before they leave the farm.

- c) **Antibiotic residues:** You know very well that antibiotics are used for controlling diseases when life is threatened. Studies have shown that some of the antibiotics are carcinogens even at small doses. On account of this, many developed countries, particularly the members of the European Union, regulate the level of certain antibiotic residues in farmed fish, animal and poultry meant for human consumption. Antibiotics are widely used for protection of the farmed organisms against certain diseases. In the absence of good farming practice and non-observance of withdrawal period, the antibiotic residues can appear in the products of the farm.
- d) **Hormone residues:** Further, due to ignorance or misguidance, the farmers can also use-prohibited hormones along with some antibiotics to promote infection-free accelerated growth of farmed animals. This can also lead to the presence of residues of anabolic steroids in the farm products, which in turn can result in unusual physiological problems in consumers. To exclude such hazards there shall be periodic monitoring for hormone residues also at production source (farms).
- e) **Histamine:** Histamine is an allergic compound. Certain fishes, particularly *Scombroidae* (e.g. mackerel) and some species of *Clupeidae* (e.g. sardine) are found to accumulate histamine during spoilage. This actually happens due to temperature abuse in respect of scombroid fishes and fishes like sardine (fishes with lateral red muscle). Histamine is an allergen causing pain, inflammation and irritation and very severe cases of histamine toxicity can lead to suffocation and death. To avoid such toxic problems from consumption of these fishes, the species of *Scombroidae* and *Clupeidae* shall be subjected to direct or indirect monitoring of histamine. The indirect monitoring of histamine is based on the fact that histamine is produced as a result of spoilage. Therefore, to identify presence of histamine one needs only to look at the degree of spoilage or freshness of these fishes by organoleptic methods. Detection of spoilage in *Scombroidae* and *Clupeidae* by organoleptic evaluation is an indication of the presence of histamine. Histamine does not form in fresh fish if they are used immediately and kept below 15°C.
- f) **Bio-toxins:** Bio-toxins are naturally occurring toxins synthesized by certain living organisms. The Paralytic Shellfish Poison (PSP) and the Diarrhetic Shellfish Poison (DSP) are such bio-toxins produced by marine algae. The bivalve mollusk in marine waters feed on these algae and these organisms have the remarkable capacity to withstand the toxins and retain it in their body for nearly 14 days. During these 14 days, if the affected bivalves are picked up and used for consumption, the consumers will get poisoned resulting in muscular paralysis or diarrhoea. So, wherever shellfish harvesting and consumption is prevalent, there shall be a surveillance to see that the shellfish harvest areas are free from the toxic algal blooms. These toxins also appear in organisms like crab, rays etc. which feed on bivalves. Batch wise, the bivalve meat and bivalve eating species can also be analyzed for PSP and DSP so that the relevant lots can be certified free from PSP and DSP.

- g) Aflatoxins:** Aflatoxins are toxic carcinogens produced by certain fungus growing in dry food items particularly nuts, oilseeds, cakes and related products. Consequently, all such foods shall be subjected to a batch-wise monitoring for aflatoxins. In food processing, to improve physical properties of the food, some chemical additives are used. For example, various colours for improving product colour, meta-bisulphite for prevention of blackening, sodium tri-polyphosphate for improving softness and water holding capacity and certain antibacterials like sodium benzoate for preservation. Almost all such food additives are generally regarded as safe chemicals without any adverse impact on the health of the consumers. However, use of such food additives shall be subject to Good Manufacturing Practice (GMP), which will ensure the residues of such chemicals to the lowest minimum. The number and variety of food additives are too many depending upon the nature of food processing as well as the nature of the product. Therefore, a description of all the food additives and their accepted level as per GMP is beyond the scope of this material.

For all the above chemical hazards, tolerance levels are fixed by national and international agencies like, USFDA, EU norms and *Codex Alimentarius* Commission. Based on these standards, appropriate tolerance levels are prescribed for various food groups as shown in Table 3.1. While fixing these tolerance limits, the per capita consumption of each food group in Indian condition is also taken into consideration.

Table 3.1: Typical Chemical Hazards and Defects of Common Food Items and their Tolerances Limits

Sl. No.	Chemical Food Safety Hazards	Tolerance Limit
1.	PSP	0.8mg/kg ^a
2.	DSP	0.2mg/kg ^a
3.	Histamine	25-50mg/kg ^b
4.	Staphylococcus toxin	Absent
5.	Botulinum toxin	Absent ^c
6.	Lead	0.5mg/kg
7.	Cadmium	0.5mg/kg
8.	Mercury	0.5-1mg/kg
9.	Pesticides*	0.5mg/kg
10.	Antibiotics**	Absent ^d
11.	Hormone residues	Absent ^d
12.	Sanitizers & lubricants	Absent
13.	TMA-N	10-15mg/100g
14.	TVB-N	35-40mg/100g
15.	Aflatoxins	<20ng/g ^e
16.	Physical hazards (7mm – 25mm pieces of glass, metal, wood etc.)	Absent
17.	Food additives: Phosphate (frozen foods) Sulphite (shell fishes) pH (pickles and marinades) Alkalinity (all types of milk)	<400mg/kg <25mg/kg >4.5 – <6.5 <250mg/kg

- a) For bivalves only
- b) For scombroid fishes only
- c) For thermal processed foods only
- d) For farmed animals, poultry, fish & shellfish only
- e) For cereals, dry oilseeds and nuts only.
- * Total organochlorine pesticides.
- ** Prohibited antibiotics like chloramphenicol, nitrofurantoin, sulpha drugs etc. and their metabolites.

? Check Your Progress 2

- Note:** a) Use the space given below for your answers.
b) Check your answers with those given at the end of the unit
- 1) are toxic chemical compounds that appear in food either as a contaminant or as a genetic constituent.
 - 2) Some chemical toxins are
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.....
 - 3) are generally used against plant and animal pests?
 - 4) Tell the names of two heavy metals?
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.....
 - 5) Name an allergic compound?
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.....
 - 6) What are Aflatoxins?
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3.4.3 Biological Hazards

The biological parameters important in food safety and quality are Total Plate Counts of bacteria such as *Escherichia coli*, *E. coli* 0157, *Staphylococcus aureus*, *Vibrio cholerae*, *Salmonella*, *Listeria monocytogenes*, *Vibrio parahaemolyticus*, *Campylobacter* spp., *Clostridium* spp. and *Bacillus cereus*. Out of these Total Plate Count (TPC), *E.coli* and *Staphylococcus aureus* counts are considered quality defects and classified as indicator organisms as their presence above the tolerance limit is indicative of either spoilage or contamination from unhygienic workers or unclean contact surfaces. Other listed organisms and the parasitic worms, *Anisakis* etc. are considered hazards and shall be absent in all food items.

- a) **TPC:** It will be interesting for you to know that Total Plate Count (also known as Total Bacterial Count, Total Viable Count, Heterotrophic Plate

Count or Aerobic Plate Count) is a count of viable bacteria per gram of the food based on counting of the colonies that develop on agar plate. This is commonly considered as an index of bacterial spoilage. The normal incubation period for determination of TPC is 48 hours at 30°C and the tolerance limit for TPC vary with the type of food and range from 10^3 to 10^7 cfu/g.

- b) ***E. coli***: *E. coli* is a faecal indicator organism. You should understand that the presence of *E. coli* in food generally indicates direct or indirect contamination with faecal matter from human or animal origin. The tolerance limit for *E. coli* for different food items can vary from zero to <100 cfu/g for raw food and <10 cfu/g for cooked and ready-to-eat foods. The presence of *E. coli* above the tolerance limit is a sure indication of poor cleanliness of food contact surfaces and/or poor hygiene of food handlers. The presence of organisms like total coliforms, faecal *coliforms*, faecal *streptococci*, is also indicative of faecal contamination.
- c) ***Staphylococcus aureus***: *S. aureus* is simultaneously an indicator organism as well as a food poisoning organism. *S. aureus* has its origin from oral secretions and skin of human beings and animals. Their presence in above tolerance limit suggests poor hygiene of workers, which lead to the occurrence of this toxigenic organism in food contact surfaces, as well as food materials. However, for toxin production and food poisoning, the *S. aureus* count shall be of the order of 10^5 or more organisms per g. of the food.
- d) ***Specific pathogens***: The other species of bacteria indicated under biological hazards in Table 3.3 can be generally called as specific pathogens which are involved in food poisoning. They can cause public health problems either by production of toxin or by actual infection through the intestines of the consumers. The symptoms of food poisoning vary from nausea and vomiting (typical of *staphylococcus aureus*) and diarrhoea and dehydration (*Salmonella* and *Campylobacter*) or a combination of vomiting and diarrhoea (*Vibrio cholerae*) or paralysis, respiratory failure and death in extreme cases of botulism (*Clostridium* species). The infectious doses of the specific pathogens vary from a few organisms to 10^6 organisms/g. All these pathogens as far as possible shall be absent in raw as well as cooked products.

You must know that for assessment of microbiological quality, the food can be grouped into raw and ready-to-eat items depending upon the nature and degree of processing of the food before sale. The ready-to-eat items can be raw (in certain cases), preserved or thermal processed. Common categories of food depending upon the nature of processing are indicated in Table 3.2. Depending on the type of processing, the tolerance for microbiological parameters, particularly TPC, *E. coli* and *S. aureus*, will be varying. These three parameters will give us a fairly good idea about the freshness of the food; extend of faecal contamination as well as the hygiene and sanitation of the food contact surfaces and food handlers involved in the processing and production of the food items. A detailed list of the tolerance limits in case of TPC, *E. coli*., *S. aureus* and specific pathogens for specific food groups is given in Table 3.3.

By cross checking Tables-3.2 and 3.3, it is easy to find out the tolerance limit for each of the microbiological criteria for a given food item.

Table 3.2: Common Food Categories for Microbial Assessment (TPC)

Food Group	Food item	Category
Meat	Beef burgers and kebabs	1
	Poultry (unsliced)	4
	Preserved meat	4
	Salami and fermented meat products	5
	Sausages	2
	Sliced meat (beef, haslet, pork, poultry, etc.)	3
	Sliced meat (ham and tongue) (cold)	4
	Steak and kidney/meat pies	2
	Fried meat & meat products	1
Fish & shellfish	Crustaceans	3
	Pickled fish	1
	Other fish (cooked)	6
	Oysters (raw)	5
	Seafood meals	2
	Shellfish (cooked)	6
	Smoked fish	4
	Fried fish & shellfish	1
	Coated products (raw)	3
Desserts	Cakes, pastries, slices and desserts-with dairy cream	3
	Cakes, pastries, slices and desserts-without dairy cream	2
	Cheesecake	2
	Tarts, flans and pies	2
Ready-to-eat meals & Snacks	Meals (Veg/Non-veg.)	1
	Meals (Fried & Dry type)	1
	Snacks (Cooked/fried)	2
Cooked & frozen products	Cooked and frozen meat, fish, shellfish, poultry & dairy products	6
Sterilized products	Canned fish/meat/vegetables/poultry etc. Retort pouch processed fish/meat/poultry/veg. products etc.	7
Raw frozen/fresh products	Frozen meat, fish, shell fish, poultry, dairy products etc.	8

Table 3.3: Microbiological Quality for Some Food Items

Criterion	Food Category (see table 3.2)	Microbiological Quality		
		Colony-forming unit (cfu) per gram unless specified		
		Class A Satisfactory	Class B Acceptable	Unsatisfactory
Total Plate Count*	1	<10 ³	10 ³ - <10 ⁵	>10 ⁵
	2	<10 ⁴	10 ⁴ - <10 ⁵	≥10 ⁵
	3	<10 ⁵	10 ⁵ - <10 ⁶	≥10 ⁶
	4	<10 ⁶	10 ⁶ - <10 ⁷	≥10 ⁷
	5	N/A	N/A	N/A
	6	<10 ³	10 ³ - <10 ⁵	>10 ⁵
	7	0	0	>1
	8	<10 ⁵	10 ⁵ -<10 ⁷	>10 ⁷

Indicator organisms	1 3,4,5	<1 <20	1-<10 20-<100	>10 >100
<i>E.coli</i> (total)*	2,6 7	<1 0	1-<10 0	>10 >1
	8	<20	20-<100	Present in 25 g
Pathogens*				
1. <i>Campylobacter</i> spp. ^{a **}		Not detected in 25g	Not detected in 25g	Present in 25 g
2. <i>E. coli</i> 0157 ^{b **}		-do-	-do-	Present in 25 g
3. <i>L. monocytogenes</i> ^c		-do-	-do-	Present in 25 g
4. <i>Salmonella</i> spp. ^d		-do-	-do-	Present in 25 g
5. <i>V. cholerae</i> ^e		-do-	-do-	Present in 25 g
6. <i>V. parahaemolyticus</i> ^{f **}		<20	20-<10 ³	≥10 ³
7. <i>S. aureus</i> ^g		<20	20-<10 ³	≥10 ³
8. <i>C. perfringens</i> ^{h **}		<20	20-<10 ³	≥10 ³
9. <i>B. cereus</i> ^{i **}		<10 ³	10 ³ -<10 ⁴	≥10 ⁴

N/A denotes “Not applicable”

* Absent in case of thermal processed foods in cans and pouches.

^a Relevant for fruits, vegetables, raw milk, meat and poultry.

^b Relevant for almost all drinking water and food items.

^c Relevant for almost all semi-solid and solid food items.

^d Relevant for egg, milk, soy flour, yeast, spices, coconut candy, gelatin, meat, fish and products containing these ingredients.

^e Relevant for all solid and liquid foods of aquatic origin.

^f Relevant for all food items.

^g Relevant for all food items.

^h Relevant for all cooked meat and poultry products.

ⁱ Relevant for cooked meat, vegetables, rice, sauce, fries, custard, soup, raw vegetable sprouts etc.

** To be tested only for mass produced ready-to-eat food items.



Activity 1

Visit a fish product development unit. Go around the unit with the supervisor/ manager of the unit. Ask specific questions on details of preventive measures adopted for reducing food safety hazards in the said unit.

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? **Check Your Progress 3**

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of the unit.

1) What is TPC?
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2) Name one of the poisoning organisms?
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.....

3) Name the three specific pathogens?
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.....

3.5 LET US SUM UP

For the last so many years, technologists have been endeavouring to draw some general rules from observations and experimentation on fish and fishery products to control and protect their properties under a vast variety of circumstances. The two major themes for their efforts have been safety and quality. Safety deals with the issue of ensuring that the fish products are safe for human consumption. Safety of a food product means, it is free from pathogenic organisms at infective levels including parasites of various kinds. It also covers contaminants such as heavy metals and other residues, allergens as well as toxins. These are reviewed from the perspectives of detection, identification, quantification, evaluation and implication. As such this includes all aspects of processing, safety monitoring and management and ultimately risk assessment. HACCP system identifies the food safety hazards, controls these hazards and provides relevant documentation. In this unit, you have understood the various hazards that can cause harm and thus upset food safety. Quality and its upkeep are of increasing concern and importance in all segments of the fishing chain i.e., from fish to dish. If deterioration in quality is noticed in the finished product, customers will reject it and will indirectly lead to rejection during export or marketing.

3.6 GLOSSARY

Algae	:	Water plants of simple structure.
Allergen	:	Anything that causes an allergy.
Augment	:	Become greater.
Bio-accumulative	:	Stored inside the animal body.
Bivalve mollusk	:	Animals having two shells like oyster.
Botulism	:	Food poisoning caused by <i>Clostridium botulinum</i> .
Carcinogens	:	Which can lead to cancer.

<i>Clupeidae</i>	: A group of food fishes eg. Sardine.
Contamination	: Make dirty or impure.
Detoxified	: Removing toxicity.
Diarrhoea	: Frequent emptying of the bowels.
Enact	: To make into a law or pass a law.
Extrinsic	: Operating from the outside.
Faecal	: Related to human waste.
Hazards	: An agent which is likely to cause illness or injury.
Incubation	: Hatching by artificial warmth.
Intrinsic	: Operating from inside.
Mandatory	: To be followed essentially.
Nausea	: Uneasy feeling.
Parameter	: Related factors.
Pathogens	: Organisms causing infection/disease.
Rays	: Fishes related to sharks – living on bottom of sea.
Perennial	: On a continuous basis.
<i>Scombroidae</i>	: A group of food fishes (mackerel).
Toxigenic	: Leading to poisoning.
Viable	: Capable of living, developing, or germinating under favourable conditions.



3.7 SUGGESTED FURTHER READING

Mukundan, M.K. and Balasubramaniam, S. 2007. *Seafood Quality Assurance*. CIFT Training Manual 1

3.8 REFERENCES

Gopakumar, K. 2002. *Textbook on Fish Processing Technology*, Indian Council of Agricultural Research (ICAR), New Delhi.

3.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

- 1) Stones, glass pieces, bones and metallic objects.
- 2) This can be avoided by operating a metal detection device at the end of process line.

Check Your Progress 2

- 1) Chemical hazards.
- 2) Histamine, Paralytic Shellfish Poison(PSP), Diarrhetic Shellfish Poison (DSP).
- 3) Pesticides.
- 4) Cadmium and mercury.
- 5) Histamine.
- 6) Aflatoxins are toxic carcinogens produced by certain fungi growing in dry food items particularly nuts, oil seeds, cakes and related products.

Check Your Progress 3

- 1) TPC means Total Plate Count.
- 2) *Staphylococcus*.
- 3) *L. monocytogenes*, *V. cholerae* and *Salmonella spp.*