

# HACCP, Physical, chemical and biological hazards in seafood, Important biotoxin in seafood, Histamine

## Chapter 1: Hazard analysis and critical control point- A detailed approach

### 8.1.1 Introduction to the codex Alimentarius commission

The Codex Alimentarius Commission (CAC) was established by FAO in 1961. CAC is an intergovernmental body with 158 member Governments as on 31<sup>st</sup> August, 1997. The Codex Alimentarius ('Food Code' or 'Food Law' in Latin) is a collection of food standards, codes of practice and other recommendations presented in a uniform way. Codex standards, guidelines and other recommendations ensure that food products are not harmful to the consumer and can be traded safely between countries. The Codex Alimentarius has resulted in evaluation of the safety of over 760 food additives and contaminants and setting of more than 2500 maximum limits for pesticide residues and more than 150 for veterinary drug residues.

CAC has adopted the guidelines for the application of the Hazard Analysis Critical Control Point (HACCP) system through its committee on Food Hygiene. It has recognized HACCP as a tool to assess hazards and establish control systems that focus on preventive measures instead of relying primarily on end product testing.

The Uruguay Round of Multi lateral Trade Negotiations which concluded in 1994 established the World Trade Organization (WTO) to replace the General Agreement on Tariffs and Trade (GATT).

1. The Agreement on the Application of Sanitary and Phyto Sanitary Measures (SPS Agreement) The SPS Agreement confirm the right of WTO member countries to apply measures necessary to protect human, animal and plant life and health.
2. The Agreement on Technical Barriers to Trade (TBT Agreement). The TBT Agreement basically provides that all technical standards and regulations.

### 8.1.2 Work of the codex alimentarius commission

The work of the codex Alimentarius Commission – including the guidelines for the application of HACCP system – has become reference for international food safety requirements. The application of the General Principles of Food Hygiene and Good Manufacturing Practices (GMPs) allows the producer to operate with in environmental conditions favourable to the products.

The main objectives of the Codex General Principles of Food Hygiene are

1. Identify the essential principles of food hygiene, applicable throughout the food chain to achieve the goal of ensuring that food is safe and suitable for human consumption
2. Recommended an HACCP based approach as a means to enhance food safety
3. Indicate how to implement those principles and
4. Provide guidance for specific codes which may be needed for sectors of the food chain, processor, or commodities and to amplify the hygiene requirements specific to those areas.

### 8.1.3 History of HACCP

Dr.Deming and others developed total quality management (TQM) systems for Japanese products in the 1950's.NASA wanted a "Zero defects" programme to guarantee the safety of the foods that astronauts would consume in space. Pillsbury presented the HACCP concept publicly at a conference for food protection in 1971. The use of HACCP principles in the promulgation of regulations for low-acid canned food was completed in 1974 by the United States Food and Drug Administration (FDA). In the early 1980's the HACCP approach was adopted by other major food companies.

The International Commission on Microbiological Specifications for Foods (ICMSF) and the International Association of Milk, Food and Environmental Sanitaries (IAMFES), have recommended the broad application of HACCP to food safety.

*ADVANTAGES OF HACCP*

The HACCP system, as it applies to food safety management, uses the approach of controlling critical points in food handling to prevent food safety problems. The system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. The application of the HACCP system can aid inspection by food control regulatory authorities and promote international trade by increasing buyers' confidence.

#### *Guidelines for the application of the HACCP system*

Management commitment is necessary for implementation of an effective HACCP system. During hazard identification, evaluation and subsequent operations in designing and applying HACCP systems, consideration must be given to the impact of raw materials, ingredients, food manufacturing practices, role of manufacturing process to control hazards, likely end use of product, categories of consumers of concern, and epidemiological evidence relative to food safety.

The intent of the HACCP system is to focus control at CCPs by all means.

### **8.1.4 Principles of the HACCP system**

1. Conduct a hazard analysis
2. Determine the critical control points (CCPs)
3. Establish critical limit(s)
4. Establish a system to monitor control of the CCP
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control
6. Establish procedure for verification to confirm that the HACCP system is working effectively
7. Establish documentation concerning all procedures and records appropriate to these principles and their applications

#### **Logic sequence of application of HACCP**

- Assemble HACCP
- 
- Describe product
- 
- Identify intended use
- 
- Construct flow diagram
- 
- On-site confirmation of flow diagram
- 
- List all potential hazards conduct a hazard analysis, consider control measure
- 
- Determine CCPs
- 
- Establish critical limits for each CCP
- 
- Establish a monitoring system for each CCP
- 
- Establish corrective actions
- 
- Establish verification procedures
- 
- Establish documentation and record keeping

### **8.1.5 The HACCP team**

#### ***Team composition:***

When selecting the team, the coordinator should focus on:

- Person who will be involved in hazard identification
- Person who will be involved in determination of critical control points
- Person who will monitor CCPs
- Person who will verify operations at critical control points
- Person who will examine samples and perform verifications procedures

**Knowledge required:**

Selected personnel should have a basic understanding of:

- Technology and equipment used on the processing lines
- Practical aspects of the food operations, the flow and technology of the process
- Applied aspects of food microbiology and HACCP principles and techniques

**Product description:**

1. Product name (common name) or group of product names (the grouping of like products is acceptable as long as all hazards are addressed)
2. Important end-product characteristics: properties or characteristics of food under review those are required to ensure its safety (e.g.  $a_w$ , pH, preservatives)
3. How the product is to be used (*i.e.* ready to-eat, further processing required, heated prior to consumption)
4. Type of package, including packaging material and packaging conditions (e.g. Modified atmosphere)
5. Shelf-life, including storage temperature and humidity if applicable
6. Where the product will be sold ( e.g. Retail, institutions, further processing)
7. Labelling instructions (e.g. Handling & usage instructions)
8. Special distribution control ( e.g. Shipping conditions)

### 8.1.6 Form. 2 Product ingredients and incoming material

List the product ingredients and incoming materials (including raw material, product ingredients, processing aids, and packaging materials) that are used during the manufacturing process. This exhaustive listing is required for proper identification of all potential hazards that could apply.

**Flow diagram: - (will identify the important process steps)**

- All ingredients and packaging used (biological, chemical, physical data)
- Sequence of all process operations (including raw material addition)
- Time/ temperature history of all raw materials and intermediate and final products, including the potential for delay.
- Flow conditions for liquids and solids
- Product cycle/rework loops
- Equipment design features

**Plant schematic:**

This plan should aid in the identification of any areas of potential cross-contamination within the establishment. The plant schematic/floor and equipment layout should be considered in detail and assessed. Data may include but is not restricted to:

- Personnel routes
- Routes of potential cross – contamination
- Area segregation
- Flow of ingredients and packaging materials
- Location of changing rooms, wash rooms, lunch rooms and hand-washing stations

### 8.1.7 Hazard analysis: (Principle 1)

Hazard will vary among firms making the same products because of differences in:

- Source of ingredients
- Formulations
- Processing equipments
- Processing and preparation methods
- Duration of process
- Storage conditions
- The experience, knowledge and attitude of personnel

Therefore hazard analysis must be done on all existing and new products. Changes in raw materials, product formulations, processing or preparation procedures, packaging, distribution and/or use of the product will require review of the original hazard analysis.

<p><i>Examples of biological hazards:</i></p> <p><b>Bacteria (Spore forming):</b></p> <p><i>Clostridium botulinum</i></p> <p><i>C.perfringens</i></p> <p><i>Bacillus cereus</i></p> <p><b>Bacteria (Non-spore forming):</b></p> <p><i>Brucella abortis</i></p> <p><i>B.suis</i></p> <p><i>Campylobacter spp</i></p> <p><i>Cryptosporidium parvum</i></p> <p>(E.coli 0157; H7, EHEC,EIEC, TEC, EPEC)</p> <p><i>Listeria monocytogenes</i></p> <p><i>Salmonella spp.</i></p> <p><i>S.typhimurium S. enteriditis</i></p> <p><i>Shigella spp .</i></p> <p><i>Staphylococcus aureus</i></p> <p><i>S. pyogenes</i></p> <p><i>Vibrio cholerae</i></p>	<p><b>Viruses</b></p> <p>Hepatitis A &amp; E</p> <p>Norwalk virus group</p> <p>Rotavirus</p> <p><b>Protozoa &amp; parasites:</b></p> <p>Diphyllobothriumlatum</p> <p>Entamoeba histolytica</p> <p>Giardia lamblia</p> <p><i>Ascaris lumbricoides</i></p> <p><i>Taenia solium</i></p> <p><i>Taenia saginata</i></p> <p><i>Trichinella spiralis</i></p>
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<i>V. Parahaemolyticus</i>	
<i>V. vulnificus</i>	
<i>Yersinia enterocolitica</i>	

**Examples of chemical hazards:**

<p><b>Hazards</b></p> <p><i>Naturally occurring chemicals</i></p> <p><i>Allergens</i></p> <p><i>Mycotoxins (eg. aflatoxin)</i></p> <p><i>Scombrototoxin (histamine)</i></p> <p><i>Ciguatoxin</i></p> <p><b>Biogenic toxins</b></p> <ul style="list-style-type: none"> <li>• <i>Paralytic shellfish poisoning (PSP)</i></li> <li>• <i>Diarrhoetic shellfish poisoning (DSP)</i></li> <li>• <i>Neurotoxic shellfish poisoning (NSP)</i></li> <li>• <i>Amnesic shellfish poisoning (ASP)</i></li> <li>• <i>Phyrolizidine alkaloids</i></li> <li>• <i>Phyrohaemagglutinin</i></li> </ul>	<p>Polychlorinated biphenyls (PCBS)</p> <p>Agricultural chemicals:</p> <ul style="list-style-type: none"> <li>• Pesticides</li> <li>• Fertilizers</li> <li>• Antibiotics</li> <li>• Growth hormones prohibited substances</li> <li>• Direct</li> <li>• Indirect</li> </ul>
<p><b>Toxic elements and compounds</b></p> <ul style="list-style-type: none"> <li>- <i>Lead</i></li> <li>- <i>Zinc</i></li> <li>- <i>Cadmium - Mercury</i></li> <li>- <i>Arsenic</i></li> <li>- <i>Cyanide</i></li> </ul> <p><b>Food additives vitamins &amp; Minerals contaminants</b></p> <ul style="list-style-type: none"> <li>- <i>Lubricants</i></li> <li>- <i>Cleaners</i></li> <li>- <i>Sanitizers</i></li> <li>- <i>Coatings</i></li> <li>- <i>Paints</i></li> </ul>	<p><b>from packaging materials</b></p> <ul style="list-style-type: none"> <li>- <i>Plasticizers</i></li> <li>- <i>Vinyl chloride</i></li> <li>- <i>Printing/coding inks</i></li> <li>- <i>Adhesives</i></li> <li>- <i>Lead</i></li> <li>- <i>Tin</i></li> </ul>

- Refrigerants	
- Water or steam treatment chemicals	
- Pest control chemicals	

### 8.1.8 How to conduct a hazard analysis

After listing all the hazards (biological, chemical or physical) that may be reasonably expected at each step from primary production, processing, manufacturing and distribution until the point of consumption, the HACCP team should assess the potential significance or risk of each hazard by considering its likelihood occurrence and severity. The estimate of the risk of a hazard occurring is based upon a combination of experience, epidemiological data and information in the technical literature. **Severity is the degree of seriousness of the consequences of a hazard if the hazard is not controlled.**

Hazard addressed under the HACCP system must be of such a nature that their prevention, elimination or reduction to acceptable levels is essential to the production of safe foods. Hazards of a low probability of occurrence and a low severity should be addressed under the HACCP system but may be addressed through the good manufacturing practices (GMPs) contained in the codex general principles of Food Hygiene.

### 8.1.9 Hazard assessment

#### Severity:

Severity is the magnitude of a hazard or the degree of consequences that can result when a hazard exists. Disease causing hazards can be categorized according to their severity. One system uses the categories of:

- High (life-threatening ) ex. include illness caused by *C.botulinum*, *S.typhi*, *Listeria monocytogenes*, *E. coli* 0157 H7, *V.cholerae*, *V. vulnificus*, paralytic shell fish poisoning and amnesic shell fish poisoning.
- Moderate (severe or chronic) eg. include illness caused by *Brucella* sp. *Campylobacter* sp. *Salmonella* sp, *Shigella* sp, *Streptococcus* sp, *Yersinia enterocolitica*, hepatitis A virus, mycotoxins, Ciguatera toxin
- Low (moderate or mild) – ex. include illness caused by *Bacillus* sp. *C.perfringens*, *Staphylococcus aureus*. Norwalk virus, most parasites, histamine – like substances and most heavy metals that cause mild acute illnesses.

Risk is a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard(s) in food. Degrees of risk can be categorized as high (H), Moderate (M) low (L) & negligible (N).

### 8.1.10 Critical control points: Determination (Principle 2)

The determination of CCPs is the 2<sup>nd</sup> principle of HACCP. The codex guidelines define a CCP as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. The determination of a CCP in the HACCP system can be facilitated by the application of a decision tree such as that included in the codex HACCP system and guidelines for its application which indicates a logical reasoning approach.

#### Fig. Example of decision tree to identify critical control points.

Q1. Do control preventive measures exist?

Yes       No

Is control at this step       Yes  Modify step, process or products

-      Necessary for safety?

No       not a CCP  Stop \*

Q2. Is the step specifically designed to eliminate or reduce the likely occurrence of hazards to an acceptable level?



Acidification	<b>pH 4.6</b>	pH 4.3
Drying	0.84 A <sub>w</sub>	0.80 A <sub>w</sub>
Hot fill	80°C	85°C
Slicing	2.0cm	2.5cm

#### 8.1.12 Establish a monitoring system for each CCP (Principle 4)

##### What will be monitored?

**Monitoring may mean measuring characteristics of the product or of the process to determine compliance with a critical limit.**

Examples are:

- Measurement of the time and temperature of a thermal process
- Measurement of cold-storage temperature
- Measurement of pH
- Measurement of A<sub>w</sub>

Monitoring may also mean observing whether a control measure at a CCP is being implemented. Eg. i) Visual examination of sealed cans, and ii) Verification of vendor's certification of analysis

##### Establish corrective Actions (Principle 5)

The codex HACCP system and guidelines for its application defines corrective action as “any action to be taken when the results of monitoring at the CCP indicate a loss of control”

**Loss of control is considered as a deviation from a critical limit for a CCP.** Deviation procedures are predetermined and documented. All deviations must be controlled by taking actions to control the non-compliant product and to correct the cause of non-compliance. Product control includes proper identification, control and disposition of the affected product. The control and disposition of the affected product and corrective actions taken must be recorded and filed.

#### 8.1.13 Establish corrective actions (Principle 5)

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#### 8.1.14 Establish verification procedures (Principle 6)

##### Verification:

Verification is embodied in HACCP principle 6. The codex guidelines define verification as “the application of methods, procedures, tests, and other evaluations, in addition to monitoring to determine compliance with the HACCP plan”, Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working correctly.

#### 8.1.15 Establish Documentation and Recorded keeping (Principle 7)

Four types of records should be kept as part of the HACCP programme:

- Support documentation for developing the haccp plan
- Records generated by the HACCP system
- Documentation of methods and procedures used
- Records of employee training programme

## Chapter 2: Physical, chemical and biological hazards in seafood

### 8.2.1 Introduction

Hazard analysis is the assessment of all hazards that are associated with the operational steps of the process. Three hazards under the food safety are

- Physical
- Chemical and
- Biological

**Physical hazards:** Bones, staples, wood, metal pieces. Other related hazards are short weight, incorrect labels, species substitution, short counts and decomposition.

**Chemical hazards:** Heavy metals, pesticides, detergents, disinfectants, diesel oil, machine oils, PSP and DSP .

**Biological Hazards:** Various bacteria of public health significance, virus and metabolites formed by bacterial action.

### 8.2.2 Hazard Analysis

#### Physical hazards-Analysis

##### a. stone, sand and mud

- The critical control point is receiving
- This can be controlled by proper verification of the raw material at time of receipt
- Also by washing the raw material thoroughly with water(GMP).

##### b. Glass pieces:

- The CCP is raw material receiving
- This can be controlled by avoidance of glass from premises of seafood processing plants.
- By providing cover to bulbs, tubes etc.

##### c. Bones, shell pieces, legs, veins, antennae etc

- This is due to improper dressing of the material Rectification – proper dressing of the material and improving the quality of supervision(GMP).

#### 8.2.2.1 Health Hazards from Pests

##### Health hazards from pests:

- Effective pest control programme play a key role in overall sanitation of seafood processing factories.
- Insects, rodents and birds can easily enter the processing premises and contaminate the food
- Pest may be divided into 8 groups. Insects and other invertebrates, mammals and birds.
- Relatively few species are encountered in food plant.

Cockroaches	Flying insects	Rodents	Birds
They transfer microorganisms to food. Objectionable also due to their offensive smell.	Flies – good carriers of bacteria like <i>Salmonella</i> , <i>Vibrio cholera</i> etc.	Health risks from rodents – plague, salmonellosis, Jaundice etc.	They transmit microorganisms to foods through their droppings.

Identification and control measures of pests can be effected at following levels

- Proper plant design and operation
- Design and operation
- Destruction within the plant
- Proximity to a refuse dump increases chances of pests
- By proper design pests can be controlled
- Final line of defense is destruction

**Best method of control**

Cockroaches	Flying insects	Rodents	Birds
To eliminate habitat, Remove food sources, Keeping premises dry, Sealing of cracks and crevices and Application of insecticides	Removal of breeding habitat, Removal of garbage, Fly screens, Air curtains at entry, Electrocutors and insecticides	Avoid garbage, Avoid chances for entry, Use of traps and rodenticides	Repellents and physical barriers
	<b>e. Metal pieces</b>	<b>f. Filth</b>	<b>g. Decomposition of fishery products</b>
	From machines, From outside, Metal detectors – final solution	Those engaged in harvest, transport and processing to be are careful.	Enzymatic action, Oxidative changes, Due to bacteria
	CCP	Packaging	Raw material, Receiving-monitoring needed

**8.2.2.2 Prevention**

**Prevention**

- Checking at the raw material receiving stage

**Short weight**

- Due to drip loss

**CCP: Packaging**

**Preventive measures**

- Use calibrated balance/weight
- Check each days production for weight

**Grade size misrepresentations**

- Product size has significant impact on its value

## **Prevention**

- Hourly grade checking
- Calibration of weighing scales

## **Species substitution**

- Affect maintenance of product integrity

## **Control measure**

- Checking at the time of receipt and at the time of packing and labelling

### **8.2.3 Chemical hazards-analysis**

Presence of a chemical may not always be a hazard. The amount of chemical present is important, Regulatory limits are set for some of these chemicals.

#### **Chemical hazards belong to 3 groups**

##### **i. Naturally occurring chemical hazards**

- Scombroid (histamine) poisoning
- Ciguatoxin
- PSP / DSP

##### **ii. Unintentionally added chemical**

- Pesticides
- Fungicides
- Toxic elements

##### **iii. Intentionally added chemical**

- Antibiotics -Aquaculture
- Sulphites -Melanosis control
- Nitrites -Preservatives
- Detergents -Cleaning
- Colouring agents -For bright colour
- Antioxidants -prevention of rancidity

Among the Naturally occurring chemical hazards Histamine production is significant in scombroid fishes.

### **8.2.4 Biological hazards-analysis**

#### **Biological Hazards-Analysis**

It includes:

- Pathogenic bacteria
- Viruses
- Parasites

These hazards come from Raw materials and food processing steps

- Pathogenic bacteria cause illness in human being either by Infection (by swallowing bacteria) or by Intoxication ( by swallowing free formed toxins). Pathogenic bacteria – mostly absent in fish caught from off shore waters. Contamination occurs during handling / processing. Time – temperature conditions, if favorable multiplication is at faster rate.

## Bacteria of public health significance

- *E. coli*
- Faecal streptococcus
- *Staphylococcus aureus*
- Salmonella
- Shigella
- *V. cholerae*
- *Parahaemolyticus*
- *V. vulnificus*
- *L. monocytogenes*
- Campylobacter
- *B. cereus*
- *Cl. botulinum*
- *Cl. perfringens*

## Chapter 3: Important biotoxin in seafood

### 8.3.1 Tetrodotoxin

This toxin occurs in different animal species such as pufferfish (*Tetraodontidae*), a goby, Atelopid frogs *Taricha* salamanders, octopus and two Japanese shellfishes. This toxin is mainly found in the liver, ovaries and intestines in various species of pufferfish. The muscle tissue of the fish is normally free of toxin but there are exceptions. The occurrence is mainly from ovaries and liver. In octopus, the toxin is present in the posterior salivary venom glands and will be used for paralyzing the prey. The toxin was isolated as maculotoxin, chemically similar to tetrodotoxin but distinct.

The poisoning leads to neurological symptoms 10-45 minutes after ingestion. It acts by preventing nerve conduction by an internally specific and reversible blockage of the inward movement of sodium ions through the cell membrane of an activated neuron. Symptoms are tingling sensation in face and extremities, paralysis of respiratory system and cardiovascular collapse. In fatal cases, death takes place within 6 hours.

#### *Tetrodotoxin (TTX) distribution*

1. Fish: pufferfish, Fugu (*Tetraodontidae*), Goby (*Gobius criniger*)
2. Amphibians: Newts, *Taricha* (*Salamandridae*) frogs, *Atelopus varius*, *Atelopus chiriquiensis* (*Atelopidae*)
3. Octopus, *Haplaochlae maculosa* (*Octopoda*)
4. Shellfish (*Gastropoda*) Ivory shell, *Babylonia japonica*; trumpet shell, *Charonia sauliae*
5. Star fish, *Astropeeton polyacanthus* (*Echinodermata*)

### 8.3.2 Ciguatera toxin

This poisoning results from the ingestion of fish that have become toxic by feeding on toxic dinoflagellate, *Gambierdiscus toxicus*, which is living around coral reefs closely attached to macroalgae. Increased production of toxic dinoflagellates are seen when reefs are disturbed (hurricanes, blasting of reefs etc.). The toxin ciguatera accumulates in fish that feed on the toxic algae. Toxin can be detected in gut, liver and muscle tissue by means of mouse assay and chromatography. The pharmacological action of ciguatera toxin is due to cholinesterase inhibition. According to Taylor (1988), some fish may be able to clear the toxin from their systems. The clinical picture varies but onset time is a few hours after ingestion of toxin.

Gastrointestinal and neurological systems are affected due to the toxin. Duration of illness may be 2-3 days but some may also persist for weeks or even years in severe cases. Death results from circulatory collapse. The most consistently reported symptoms are

1. Moderate to severe neurological disorders that may persist for days, weeks, or months and/or
2. Moderate to severe gastrointestinal disorders of relatively short duration
3. In some cases, death due to respiratory failure.

Ciguatera may be caused by over 400 species of marine fishes, including many that are highly priced for food.

Five species of organisms namely *Gambierdiscus toxicus*, *Prorocentrum concavum*, *P. mexicanum*, *Gymnodinium sanguineum* and *Gonyaulax polyedra*, produced one or more toxic fractions which killed mice within 48 hours.

### 8.3.3 Paralytic shellfish poisoning

Intoxication after consumption of shellfish is a syndrome that has been known for centuries, the most common being paralytic shell fish poisoning, PSP is caused by a group of toxins [saxitoxins and derivatives] produced by dinoflagellates of the genera *Alexandrium*., *Gymnodinium* and *Pyrodinium*.

Historically, PSP has been associated with the blooming of dinoflagellates [ $10^6$  cells/liter], which may cause reddish or a yellowish discoloration of the water.

The dinoflagellate blooms are a function of water temperature, light, salinity, presence of nutrients and other environmental condition. However, the precise nature of factors eliciting a toxic colour is unknown. Water temperature must be  $>5-8^{\circ}\text{C}$  for blooms to occur. When temperature decrease to below  $4^{\circ}\text{C}$ , the dinoflagellate will survive as cysts buried in the upper layer of sediments.

Mussels, clams, cockles and scallops that have fed on toxic dinoflagellates retain the toxin for varying periods of time depending on the shellfish. Some clear the toxin very quickly and are only toxic during the actual bloom, other retain the toxin for a long time, even years.

PSP is a neurological disorder and the symptoms are tingling, burning and numbness of lips and fingertips, ataxia, drowsiness and incoherent speech. In severe cases, death occurs due to respiratory paralysis. Symptoms develop within  $\frac{1}{2}$  hour to 2 hours after consumption and victims who survive more than 12 hours generally recover.

Toxin is found in their siphon. *Gonyaulox tamarensis* & *Alexandrium catanella* the toxin is known as saxitoxin. Toxin is heat stable not destroyed by cooking. One gram toxic meat can kill 5 people. Estimated lethal dose for man is 1-4mg, respiratory failure followed by death. Occurrence of this toxin in tropical water is scarce. US FDA limit is 80mg poison /100g.

### 8.3.4 Diarrhetic shellfish poisoning(DSP)

Thousands of cases of gastrointestinal disorders caused by diarrhetic shell fish poisoning (DSP) have been reported in Europe, Japan and Chile [WHO 1984]. The causative dinoflagellates which produce the toxins are within the genus *Dinophysis* and *Aurocintrum*. These dinoflagellates are widespread which means that this illness could also occur in other parts of the world. At least seven toxins have been identified including Okadaic acid. Onset of disease is within  $\frac{1}{2}$  hour to a few hours following consumption of shellfish which have been feeding on toxic algae. Symptoms are gastrointestinal disorder and victims recover within 3-4 days. No fatalities have ever been observed.

### 8.3.5 Neurotoxic shellfish poisoning(NSP)

Neurotoxic shellfish poisoning [NSP] has been described in people who consumed bivalves that have been exposed to red tides of the dinoflagellate [*Phycodiscus breve*]. The disease has been limited to the Gulf of Mexico and areas of Florida. Brevetoxins are highly lethal to fish and red tides of this dinoflagellate is also associated with massive fish kills. The symptoms of NSP resembles PSP except that paralysis does not occur, NSP is seldom fatal.

### 8.3.6 Amnesic shellfish poisoning(ASP)

*Amnesic shellfish poisoning [ASP] has only recently been identified [ Todd 1990, Addison and Slenart 1989]. The intoxication is due to domoic acid, an amino acid produced by the diatom Nitzschia pungens. The first reported incidence of ASP occurred in the winter of 87/88 in eastern Canada, where, over 150 people were affected and 4 deaths occurred after consumption of cultured blue mussels.*

The symptoms of ASP vary greatly from slight nausea and vomiting to loss of equilibrium and central neural deficit including confusion and memory loss. The short-term memory loss seems to be permanent in surviving victims, thus the term amnesic shellfish poisoning.

### 8.3.7 Control of disease caused by biotoxin

The control of marine biotoxins is difficult and disease cannot be entirely prevented. The toxins are all of non-protein nature and extremely stable (Gill et al.1985). Thus, cooking, smoking, drying, salting does not destroy them, and one cannot tell from the appearance of fish or shellfish flesh whether it is toxic or not.

The major preventive measure is inspection and sampling from fishing areas and shellfish beds and analysis for toxins. The mouse bioassay is often used for this purpose and confirmatory HPLC is done if death

occurs after 15 min.

To be effective, the monitoring required reliable sampling plans and efficient means of detection of the toxins. Reliable chemical methods for detection of all toxins are at present available. Also the toxicity can vary within a growing location of shellfish according to geography of water currents and tidal activity.

Toxin	Tolerance	Method of analysis
Ciguatera	Control not possible	No reliable method
PSP	8.0 ug/100g	Mouse bioassay, HPLC
DSP	0.60 ug/100g	Mouse bioassay HPLC
NSP	Any detectable level/100 g is unsafe	Mouse bioassay no chemical method
ASP	20 ug/g demoic acid	HPLC

### 8.3.8 Toxic metals

Toxic metals like Cd, Hg, Se, Pb etc. above normal level affect the safety and marketability of foods. Many countries have standards. Older ones have higher levels than younger ones of the same species. Presence of cadmium in cephalopods exported from India is reported. Control by minimizing pollution & environmental monitoring

Organochlorine pesticides & polychlorinated biphenyls

- OCP & PCBs now common in all environments

**Important compounds of concern are**

- DDT and its derivatives
- Aldrin and Dieldrin
- Benzene hexachloride
- Polychlorinated biphenyl

**It poses special problems in the environment because they are**

- Extremely persistent
- They are lipophilic in nature
- Filter feeders like oysters, mussels & clams accumulate these compounds

*Permitted levels in seafood*

Compounds	Max. residue limit (mg/kg)
DDT and its derivatives	5
Dieldrin	3
PCB	2
Mercury	0.5
Cadmium	3-Crustacean; 4- mollusc
Lead	1-5-crustacean; 1-7 bivalves

**Control**

- Prevention of contamination and Environmental monitoring

### 8.3.9 Antibiotic Residues

Widely used in shrimp culture to prevent disease. Usual practice to withdraw the drug in advance before harvest to enable the animal to clear off the residue. Sometime cultural shrimp contains high quantities. In-1992 – 1994 Japan rejected many shrimp consignments from Thailand. Japanese food sanitation act prohibits antibiotic residues in food. From 1994 November onwards US FDA insists testing antibiotic residues in fish

**Control:**

- Avoid misuse of antibiotics
- Give sufficient time to clear – off the residue

**Food additives:**

- Food additives including colours are used in various fish & fishery products ( Council directive 95/2 EC on Food Additives )

**Chapter 4: Histamine**

**8.4.1 Biogenic Amines**

Histamine poisoning is a chemical intoxication following the ingestion of foods that contain high levels of histamine. Historically, this poisoning was called scombroid fish poisoning because of the frequent association with scombroid fishes including tuna and mackerel. The most common symptoms are cutaneous such as facial flushing, urticaria, edema, but also the gastrointestinal tract may be affected ( nausea, vomiting, diarrhea) as well as neurological involvement ( headache, tingling, burning sensation in the mouth).

Histamine is formed in the fish post mortem by biological decarboxylation of the amino acid histidine.

The histamine-producing bacteria are certain enterobacteriaceae, some *Vibrio* sp. A few *Clostridium* and *Lactobacillus* sp. The most potent histamine producers are *Morganella morgani*, *Klebsiella pneumoniae* and *Hafnia alveii* ( Ertatten and Taylor, 1991). These bacteria can be found on most fish, probably as a result of post-harvest contamination they grow well at 10° C but at 5° C growth is greatly retarded.

The principal histamine producing bacteria *M.morganii* grow best at neutral pH, but they can grow in the pH range 4.7-8.1. The organism is not very resistant to NaCl, but at otherwise optimal conditions growth can take place in upto 5% NaCl. It should be emphasized that at once the histamine has been produced in the fish, the risk of provoking disease is very high. Histamine is very resistant to heat, so even if the fish are cooked, canned or otherwise heat-treated before consumption, the histamine is not destroyed.

The human body will tolerate a certain amount of histamine without any reaction ingested histamine will be detoxified in the intestinal tract by at least 2 enzymes the diamine oxidase (DAO) and histamine N-methyl transferase (HMT) (Taylor, 1986).

Their protective mechanism can be eliminated if intake of histamine and / or other biogenic amines is very higher if the enzymes are chocked by other compounds as shown in figure. Other biogenic amines such as cadaverine and putriscine which are known to occur in spoiled fish may therefore act as potentiators of histamine toxicity. Presumably inhibition of intestinal histamine catabolism will result in greater transport of histamine across cellular membrane and into the blood circulation.

**8.4.2 Control of Disease caused by biogenic amines**

Low temperature storage and holding of fish at all times is the most effective preventive measure. All studies seems to agree that storage at 0° C or very near to 0° C limits histamine formation in fish to negligible levels. Several countries have adopted regulations governing the maximum allowable levels of histamine in fishes. e.g.

**Regarding limit for histamine in fish**

	Hazard action allowable level mg/100g	Defect action allowable level mg/100g	Maximum allowable level mg/100g

USA (FDA)	50	10-20	--	
EEC	-----	10	20	

<b>Toxin</b>	<b>Where/when produced</b>	<b>Animals/organisms involved</b>
Tetradotoxin	Fish	Puffer fish, mostly ovaries, liver, intestine
Cignatera	Marine algae	Tropical/subtropical fish
PSP	Marine algae	Filter feeding shellfish
DSP	Marine algae	Filter feeding shellfish