

## Chapter 29

### **Biological hazards in fish and fishery products**

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Fish and fishery products consumption trend has increased in recent times because of globalization and healthy food awareness. Changes in life style of human has also contributed for pace in consumption. Foodborne illness (commonly known as food poisoning) is often caused by consuming food contaminated by bacteria and/or their toxins, parasites, viruses, chemicals, or other agents. Fish and fishery products may get contaminated with various pathogenic bacteria due to unhygienic handling practices which may results in food poisoning. Biological contaminants of food are harmful and hazardous substances of biological origin in the food that can cause foodborne illness when they are consumed. Each year worldwide, unsafe food causes 600 million cases of foodborne diseases and 4,20,000 deaths. 30% of foodborne deaths occur among children under 5 years of age. WHO estimated that 33 million years of healthy lives are lost due to eating unsafe food globally each year, and this number is likely an underestimation.

Contributing to this underestimation is that many foodborne illnesses lack the severity, duration, and specific diagnosis required for definitive identification and intervention. Biological contaminants could be microorganisms, so small that only can be seen by a microscope such as bacteria and versus, or could be large such as some parasites. Bacteria can grow and multiply rapidly if food is not taken care for temperature. Bacterial and viral Pathogens are the primary food safety concern with regard to fish and fishery products. Some types of fish may also contain naturally occurring parasites. Poor handling practices, such as failure to prevent raw foods from coming in contact with cooked or ready-to eat foods (cross contamination), and lack of proper temperature control are significant factors that can lead to pathogen growth and foodborne illness. To prevent the outbreak of foodborne illnesses, it is crucial for food service professionals to understand all aspects of biological contaminants from how they grow and reproduce to how they contaminate food and infect humans. These hazards can come from raw materials or from food processing steps.

## **Bacterial Pathogens**

Bacterial Pathogens are very common in fish and fishery products including viral pathogens and parasites. Bacterial Pathogens Pathogen contamination and growth is often an important factor in food-borne illness. Pathogenic bacteria can cause illness in human, either by infection or intoxication. Food borne infections are caused by swallowing live pathogens that grow within the body, usually in the intestinal tract. Intoxication is a condition caused by swallowing preformed toxins means toxins produced by microorganisms in the food before it is eaten. Most of the pathogenic bacteria are not present in fish caught from off-shore waters, but contamination occurs during handling of the material. If the time and temperature conditions are favourable, these organisms get an opportunity to grow and multiply at a faster rate. Consumption of such fish is dangerous and it will lead to food poisoning.

Bacterial Pathogens:

1. *Aeromonas spp.*
2. *Bacillus cereus*
3. *Campylobacter jejuni*
4. *Clostridium botulinum*
5. *Clostridium perfringens*
6. *Pathogenic Escherichia coli*
7. *Listeria monocytogenes*
8. *Salmonella spp.*
9. *Shigella spp.*
10. *Pathogenic Staphylococcus aureus*
11. *Faecal Streptococci*
12. *Plesiomonas shigelloides*
13. *Pathogenic Vibrio spp.*
  - a. *Vibrio cholerae*
  - b. *Vibrio parahaemolyticus*
  - c. *Vibrio vulnificus*
14. *Yersinia enterocolitica*

### ***Aeromonas spp.***

The genera *Aeromonas* comprise Gram-negative, facultatively anaerobic, oxidase-positive, glucose-fermenting rod-shaped bacteria, generally motile. *Aeromonas* species viz. *A. hydrophila*, *A. sorbia* and *A. caviae* has been described as emerging food-borne pathogens. Besides gastroenteritis *A. hydrophila* may cause cholera like infections. *Aeromonas spp.* are natural members of aquatic environments and is commonly found in fish and fish products of all aquatic environments. *A. hydrophila* is very resistant organism and it can survive in food items stored in cold for long period. Oysters have been implicated in food-borne disease. *Aeromonas* associated diarrhoea has been reported from different parts of India. Some *Aeromonas spp.* are psychrotrophs and some others are enteropathogenic. Studies have shown that very high percentage of the isolates from fish and fishery products produced hemolysin (79.2%) and cytotoxin (91.7%). Psychrotrophic *Aeromonas* strains are able to grow at 4-5°C and produce toxin in oysters at 5°C. Combination of chilling, salting and/or acidification is effective means of preventing the growth of *Aeromonas*.

### ***Bacillus cereus***

*Bacillus cereus* is a facultative anaerobic, catalase-positive, toxin-producing gram-positive bacterium found in soil, vegetation, and food. It commonly causes intestinal illnesses with nausea, vomiting, and diarrhea. However, it has been associated with serious infections in immuno-compromised hosts and can cause septicemia as well as endophthalmitis, which can lead to vision loss. *Bacillus cereus* is a well-known cause of food-borne illness, but infection with this organism is not commonly reported because of its usually mild symptoms. A fatal case due to liver failure Food poisoning caused by *B. cereus* may occur when foods are prepared and held without proper refrigeration for several hours before being served. *B. cereus* is an aerobic spore-forming bacterium. It is commonly found in soil, on vegetables, and in many raw and processed foods. Two types of illnesses have been attributed to *B. cereus*. The first is characterized by abdominal pain and diarrhea. It has an incubation period of 4-16 hours and symptoms that last for 12-24 hours. The second is characterized by an acute attack of nausea and vomiting. It has an incubation period of 1-5 hours. Diarrhea is not common with the second type of illness. Colonies of *B. cereus* have an irregular perimeter and are opaque on sheep blood

agar. When grown on an egg yolk agar, a zone of opacification will be noted due to lecithinase production.

*B. cereus* is a common food contaminant. Effective control measures depend on Notes: destruction by a heat process and temperature control to prevent spore germination and multiplication of vegetative cells in cooked, ready-to-eat foods. Measures to reduce or eliminate the threat of food poisoning by *B. cereus* include: 1) Avoid preparing food too far in advance of planned service, 2) Avoid holding cooked foods at room temperature, 3) Use quick chill methods to cool foods below 45°F (7.2°C) within 4 hours of preparation; store in shallow pans/ small quantities with the food less than 4 inches deep; if food is especially thick (e.g., refried beans), store no more than 3 inches deep, 4) Hold/store hot foods above 140°F (60°C) until served, and 5) Reheat foods rapidly to 165°F (74°C) or above.

### ***Campylobacter jejuni***

They are very small, Gram-negative, microaerophilic, curved thin rods with corkscrew motility. *C. jejuni* is widely distributed in the intestinal tract of poultry, livestock, and warm-blooded domestic animals. It is a very common and important cause of diarrheal illness in humans. Symptoms include profuse diarrhea (sometimes bloody), abdominal pain (intensity and duration can be somewhat severe), headache, weakness, and fever. Many infections occur without symptoms. *C. jejuni* is transmitted through: contaminated foods, including raw clams, mussels and oysters; person-to-person contact; and contaminated water. Cross-contamination of foods by dirty food-contact surfaces, including cutting boards and hands, may be the most frequent route of transmission. Since the infective dose of *C. jejuni* is thought to be small, time/temperature abuse of food products is not necessary to result in this illness. *Campylobacter jejuni* is widely distributed in the intestinal tract of poultry, live-stock and warm-blooded domestic animals.

Contaminated food including raw clams, mussels and oysters, person to person contact, cross contamination of food by dirty food contact surface etc. Incubation period is 3-5 days. Profuse diarrhoea, abdominal pain, headache and fever and meningitis in neonates. Infective dose ranges from 500 to 10,000 cells. This organism survives refrigeration and freezing.

*C. jejuni* can be controlled by thoroughly cooking fish and fishery products and by stressing the importance of proper (and frequent) hand and equipment washing and sanitary food-handling practices.

### ***Clostridium botulinum***

*Clostridium botulinum* is a dangerous food poisoning organism and it produce a very deadly, exotoxin when grows in food. The food poisoning is known as 'botulism'. It is an anaerobic, Gram-positive, spore-forming rod. The spores are highly heat resistant. Eight different toxins i.e. A, B, C1, C2, D, E, F & G known to exist. Type- E is present in sea mud and is mostly involved in botulism food poisoning in fish and fishery products. Food poisoning is due to the ingestion of toxin.

*C. botulinum* is found throughout the environment and has been isolated from soil, water, vegetables, meats, dairy products, ocean sediments, the intestinal tracts of fish, and the gills and viscera of crabs and other shellfish. *C. botulinum* is a spore-forming bacteria that grows in the absence of air. These characteristics allow it to survive normal cooking temperatures and to grow in a vacuum packaged and modified-atmosphere environment. *C. botulinum* produces a powerful neurotoxin that causes botulism. Growth is necessary for *C. botulinum* to produce toxin. Symptoms include diarrhea, vomiting, abdominal pain, nausea and weakness. These are followed by double, blurred vision and dilated, fixed pupils. In severe cases, paralysis of the muscles responsible for breathing can cause death. The type of *C. botulinum* Type E that is most common in fish and fishery products is of particular concern because it grows at temperatures as low as 38 F and produces little noticeable evidence of spoilage. *C. botulinum* Type A is the form of this bacteria that is most common in land-based products. It is a common contaminant on processing equipment. It will grow at temperatures no colder than 50 F and produces a putrid odor in products in which it grows. However, its spores are much more heat-resistant than the Type E form of the bacteria.

Because *C. botulinum* produces heat-resistant spores and requires the absence of oxygen for growth, botulism has been most commonly associated with improperly canned food (usually home canned). Semi-preserved fish and fishery products, including smoked, salted and fermented fish, have also been identified as causes of botulism.

*C. botulinum* can be controlled by inhibiting growth of the bacteria or by destroying it in fish and fishery products. Proper thermal processes for canned fish and fishery products destroy the bacteria. Heavy salting or drying to reduce the water activity below 0.93 and fermentation or acidification to below pH 4.6 are effective means of preventing *C. botulinum* growth. Maintaining proper storage temperatures alone is not considered an adequate control measure for *C. botulinum* Type E because of its ability to grow at low temperatures and because of the severity of the illness. Nonetheless, in many products, it is an important second barrier to growth.

### ***Clostridium perfringens***

*C. perfringens* is commonly found in soil, dust, and the intestinal tract of animals. It is a spore forming, anaerobic (oxygen-free growth conditions) bacterium. Food poisoning caused by *C. perfringens* may occur when foods are cooked and held without maintaining adequate heat or refrigeration before serving. The illness is a self-limiting gastroenteritis with an incubation period of 8-15 hours and a duration of 12-24 hours. The symptoms, which include intense abdominal cramps, gas, and diarrhea, have been attributed to a protein enterotoxin produced during sporulation of the organism in the intestine. The presence of small numbers of *C. perfringens* is not uncommon in raw meats, poultry, dehydrated soups and sauces, raw vegetables, and spices. Because the spores of some strains are resistant to temperatures as high as 100°C for more than 1 hour, their presence in foods may be unavoidable. Furthermore, the oxygen level may be sufficiently reduced during cooking to permit growth of the clostridia. Spores that survive cooking may germinate and grow rapidly in foods that are inadequately refrigerated after cooking. Thus, when clinical and epidemiological evidence suggests that *C. perfringens* is the cause of a food poisoning outbreak, the presence of hundreds of thousands or more of these organisms per gram of food substantiates the diagnosis.

Control measures emphasize proper food preparation and storage techniques, especially temperature control. Control measures include: Rapid, uniform cooling of cooked foods of cooked foods to < 10°C (50°F) within 2-3 hours; Hot holding of cooked foods at or above 60°C (140°F); Reheating cooled or chilled foods to a minimum internal temperature of 75°C (167°F) immediately before serving; Not leaving foods at room temperature or thawing frozen foods at room temperature; Preventing cross-contamination of cooked foods with bacteria from raw foods by using separate food-contact surfaces for preparing raw and cooked foods items, or by

thoroughly cleaning and sanitizing food contact surfaces after being used for raw products; Maintaining food preparation areas so that they are free of soil and dust; Cleaning and sanitizing meat slicers, meat-cutting equipment, food contact surfaces, and other equipment after use; and Using good personal hygiene methods, and thoroughly washing hands frequently when handling food products, especially after handling raw products and before handling cooked products.

### ***Escherichia coli***

*E. coli* are Gram-negative, rod-shaped, non-spore forming facultative anaerobic bacteria. *E. coli* are naturally found in the intestinal tracts of all animals, including humans. Most forms of the bacteria are not pathogenic and serve useful functions in the intestine. Pathogenic strains of *E. coli* are transferred to fish and fishery products through sewage pollution of the coastal environment or by contamination after harvest. *E. coli* food infection causes abdominal cramping, water or bloody diarrhea, fever, nausea, and vomiting.

Generally this organism is harmless: Pathogenic strains of *E. coli* are considered to be harmful.

- Enterotoxigenic *E. coli* (ETEC) - Gastroenteritis
- Enteropathogenic *E. coli* (EPEC) - Infant diarrhoea
- Enteroinvasive *E. coli* (EIEC) - Bacillary dysentery
- Enterohemorrhagic *E. coli* (EHEC) - Newly added category
- Enteroadherent *E. coli* (EAEC) - Hemorrhagic colitis (*E. coli* 0157:H7)

*E. coli* can be prevented by heating fish and fishery products sufficiently to kill the bacteria, holding chilled fish and fishery products below 40°F, preventing post cooking cross-contamination, and prohibiting people who are ill from working in food operations. The infective dose of *E. coli* is dependent upon the particular strain from only a few organisms to millions. For this reason, time/temperature abuse of food products may or may not be necessary to result in illness.

### ***Listeria monocytogenes***

It is generally accepted as a food borne pathogen. Outbreak of disease is very rare but considered to be very serious due to high rate of mortality. *L. monocytogenes* is widely distributed in nature. A variety of animals can serve as hosts for this organism. The bacterium is often associated with the intestinal tract of domestic animals, birds and humans. About 1% of human population is

known to carry *L. monocytogenes*. This organism is Gram-positive, micro-aerophilic, non-spore forming, motile rods. It can survive freezing and thawing; if the load is more than  $5 \times 10^4$  /ml. in milk it can withstand pasteurization. *L. monocytogenes* grows in refrigerated temperatures (even  $1^\circ \text{C}$ ) and it can survive both acidic and alkaline pH. This is the most heat resistant pathogenic bacteria among non-spore formers.

*L. monocytogenes* is widespread in nature and has been isolated from soil, vegetation, marine sediments and water. In the early 1900s, *L. monocytogenes* was recognized as a bacterium that caused illness in farm animals. More recently, it has been identified as the cause of listeriosis in humans. Most healthy individuals are either unaffected by *L. monocytogenes* or experience only mild flulike symptoms. Victims of severe listeriosis are usually immunocompromised. Those at highest risk include: cancer patients, individuals taking drugs that affect the body's immune system, alcoholics, pregnant women, persons with low stomach acidity and individuals with AIDS. Severe listeriosis can cause meningitis, abortions, septicemia and a number of other maladies, some of which may lead to death.

The greatest threat of listeriosis is from ready-to-eat products that do not require further cooking at home. *L. monocytogenes* in raw food that will be cooked before consumption is less of a concern to the food industry since the bacteria are killed during cooking. *L. monocytogenes* has been isolated from raw fish, cooked crabs, raw and cooked shrimp, raw lobster, surimi and smoked fish. One of its most significant characteristics is its ability to grow at temperatures as low as  $31^\circ \text{F}$ . *L. monocytogenes* can be prevented by thoroughly cooking fish and fishery products and by preventing cross-contamination once the fish and fishery products is cooked. Since the infective dose of *L. monocytogenes* is thought to be small, time/temperature abuse of food products may not be necessary to result in illness.

### ***Salmonella* spp.**

*Salmonella* are enteric organisms producing enteric fever and food borne gastroenteritis. More than 2500 serotypes of this organism are known to exist at present and more are added to the list every year. Food poisoning due to *Salmonella* is known as "Salmonellosis" infants, elderly and the under nourished are more susceptible to the disease and in such individual salmonellosis is known to occur even from one single cell of *Salmonella*. *Salmonella* are non-spore forming,



mostly motile (exception *S. pullorum* and *S. gallinarum*) facultative — anaerobic, Gram-negative rods.

*Salmonella* is naturally found in the intestinal tracts of mammals, birds, amphibians and reptiles but not in fish, crustaceans or mollusks. *Salmonella* is transferred to fish and fishery products through sewage pollution of the harvest environment or by contamination after harvest. Freshly caught marine fish are usually free from *Salmonella*. However, fish from polluted coastal waters are usually contaminated with this organism. *Salmonella* food infection causes nausea, vomiting, abdominal cramps and fever. Outbreaks of *Salmonella* food infection have been associated with raw oysters, salmon, tuna salad, shrimp cocktail, stuffed sole and gefilte fish.

*Salmonella* can be prevented by: heating fish and fishery products sufficiently to kill the bacteria, holding chilled fish and fishery products below 40 F, preventing post-cooking cross-contamination and prohibiting people who are ill or are carriers of *Salmonella* from working in food operations. The infective dose of *Salmonella* is thought to be extremely variable, relatively high for healthy individuals and very low for at-risk individuals, such as the elderly or medically compromised. For this reason, illness could result even without time/temperature abuse, but abuse has been a contributing factor in many outbreaks.

### ***Shigella spp.***

The disease caused by *Shigella* is generally known as 'shigellosis' which is not indigenous in foods, transmitted through food or water contaminated with human excreta. *Shigella* are Gram-negative, facultative anaerobic, non-sporulating, non-motile, rod-shaped bacteria. They are the most difficult enteric pathogens to isolate. Man is the only known natural host for *Shigella*. The organisms pass the acid barrier of the intestine, multiply in the gut and produce ulceration of large intestine followed by dysentery. Four serological groups i.e. A, B, C, and D. The major species in *Shigella* comprises *Shigella dysenteriae*; *S. flexneri*; *S. boydi* and *S. sonnei*. *S. dysenteriae* causes the most severe illness They survive longest when food holding temperatures are 25°C or lower.

*Shigella* is naturally found in the intestinal tract of humans. *Shigella* is transferred to fish and fishery products through sewage pollution of the coastal environment or by contamination after harvest. *Shigella* produces an illness called Shigellosis, which causes mild diarrhea, fever, abdominal cramps and severe fluid loss. Hazards from *Shigella* can be prevented by eliminating

human waste contamination of water supplies and by improved personal hygiene for people who are ill or are carriers of *Shigella* and work in food operations.

### ***Staphylococcus aureus***

Since 1930, it is known that contamination of food with coagulase — positive staphylococci could cause food poisoning, as the organism growing in food materials in considerable numbers, secretes exotoxin. Staphylococcal food poisoning is caused only by certain well defined strains of *S. aureus*; such strains are known as enterotoxigenic strains. Food-borne out breaks due to coagulase-negative strains of Staphylococci are seldom reported. *S. aureus* are known to produce 9 different types of enterotoxins designated as enterotoxin A, B, C1, C2, D, E, F, G and H. This is the most drought resistant pathogenic bacteria and they cannot compete with general bacterial flora.

Humans and animals are the primary reservoirs for *S. aureus*. *S. aureus* can be found in the nose and throat and on the hair and skin of 50 percent of healthy individuals. However, the bacteria can be found in air, dust, sewage and surfaces of food-processing equipment. *S. aureus* can produce a toxin if allowed to grow in food. The toxin is not destroyed by the cooking or canning processes. *S. aureus* has the ability to grow and produce toxins in food with very little available water (.85 aw, 10 percent salt), which would prevent the growth of other pathogens.

*S. aureus* food poisoning causes nausea, vomiting, abdominal cramping, watery or bloody diarrhea, and fever.

Hazards from *S. aureus* can be prevented by: minimizing time/temperature abuse of fish and fishery products, especially after cooking, and requiring that food handlers engage in proper hygiene.

### **Faecal *Streptococci***

*Faecal streptococci* are Gram-positive, facultative anaerobic, non-spore forming non-motile and catalase negative cocci. Faecal streptococci are comparatively resistant to many adverse conditions. About 30% reduction of faecal streptococci takes place during freezing at -40°C, during subsequent storage at -18°C not much of reduction in count takes place even after 2 years of storage.

Primary habitat and source of contamination are same as in the case of *E. coli*. One gram of faeces contains  $10^6$  to  $10^8$  faecal streptococci, therefore their presence in food product is generally regarded as an indication of faecal contamination. Just like *E. coli*, faecal streptococci are absent in off-shore water but are present in considerable numbers in coastal waters. Unclean boat deck, utensils, water and ice are the major source of contamination.

### ***Vibrio cholerae***

It is the causative agent of cholera. The current definition of *V. cholerae* consists of the classical (non-hemolytic) and El Tor (hemolytic) biovars. The El Tor *vibrios* are generally more infectious than the classical *V. choleraeserotypes* and it can survive longer in the environment. The only natural habitat of *V. cholerae* is man. *V. cholerae* is found in estuaries, bays, and brackish waters. It is naturally occurring and is not necessarily related to sewage contamination. *V. cholerae* tends to be more numerous in the environment during warmer months.

There are a number of types of *V. cholerae*, and these produce very different symptoms. One type, *Vibrio cholerae* 01, initially causes abdominal discomfort and mild diarrhea. As the illness progresses, the symptoms may include: watery diarrhea, abdominal cramps, vomiting and dehydration. Death can occur. Susceptibility to cholera is enhanced in people who have had gastric surgery, take antacids or have type O blood. Outbreaks of this type of cholera have been associated with oysters, crabs and shrimp from the Gulf of Mexico. *V. cholerae* 01 has also been recovered from Chesapeake Bay waters, although no illness has been reported from that area. Another type of *V. cholerae*, non-01, causes diarrhea, abdominal cramps and fever. Nausea, vomiting and bloody diarrhea have also been reported. The severity of the symptoms is dependant, in part, upon the specific strain. In its most severe form, *V. cholerae* non-01 has resulted in septicemia (blood poisoning) in individuals with medical conditions that weaken their immune systems. The illness has been associated with consumption of raw oysters, but the bacterium has also been found in crabs. Hazards from *V. cholerae* can be prevented by cooking fish and fishery products thoroughly and by preventing cross-contamination once the fish and fishery products is cooked.

### ***Vibrio parahaemolyticus***

*V. parahaemolyticus* is a marine pathogen present in marine and brackish-water. They are Gram-negative, rod shaped bacteria which are non-sporulating, halophilic, motile, and oxidase-

positive. *V. parahaemolyticus* is naturally occurring in estuaries and other coastal areas throughout most of the world. In most areas, *V. parahaemolyticus* is more numerous in the environment during the warmer months and, as a result, most outbreaks occur during the summer. The most commonly experienced symptoms of *V. parahaemolyticus* illness include: diarrhea, abdominal cramps, nausea, vomiting and headache. Fever and chills are less frequently reported. The illness has been associated with consuming contaminated crabs, oysters, shrimp and lobster. Hazards from *V. parahaemolyticus* can be controlled by thoroughly cooking fish and fishery products and preventing cross-contamination after cooking. Control of time/temperature abuse is also an important preventative measure.

It can cause food poisoning when it is consumed in large numbers (more than  $10^5$ /g of Kanagawa-positive strains), along with food materials. This type of food poisoning is more in countries like Japan, where there is a habit of eating un-cooked fish and fishery products. In recent years, the incidence of *V. parahaemolyticus* infection has been increasing in many parts of the world, and this has been attributed to the emergence of a new clone of the O3: K6 serotype carrying only the *tdh* gene. The onset of symptoms is within 12 h of eating infected food. Icing the material immediately after catch, washing with potable water and improvement of hygiene are considered as remedial measures.

### ***Vibrio vulnificus***

*V. vulnificus* is a naturally occurring marine bacterium. It is an emerging pathogen, phenotypically similar to *V. parahaemolyticus*. Mortality is up to 60%. It is the part of the normal bacterial flora of estuarine and marine waters. *V. vulnificus* is Gram-negative, halophilic, lactose-positive, rod shaped bacteria. All strains are pathogenic; infection dose is not known! Infection is associated with the consumption of raw fish and fishery products particularly oysters. *Vibrio vulnificus* requires salt for survival and is commonly isolated at salinities of 7 ppt to 16 ppt. It is primarily found in the Gulf of Mexico, but it has also been isolated from the Atlantic and Pacific oceans. The numbers of the bacterium in the environment are highest during the warmer months of April through October.

The most common symptoms include: skin lesions, septic shock, fever, chills and nausea. Abdominal pain, vomiting and diarrhea are less frequently reported. Death occurs in about 50 percent of the cases. A number of medical conditions make individuals more susceptible to the

life threatening effects of this bacterium, including: liver disease, alcohol abuse, cancer, diabetes, chronic kidney disease, immunosuppressive drug or steroid usage, low stomach acidity and AIDS. *V. vulnificus* sepsis has been associated with the consumption of certain molluscan shellstock.

Hazards from *V. vulnificus* can be controlled by thorough cooking of shellfish and by preventing cross-contamination once the fish and fishery products is cooked. The risk of *V. vulnificus* infection may also be reduced by rapidly refrigerating oysters from the Gulf Coast during warm-weather months. Individuals in the “high risk” groups should not consume raw molluscan shellfish. Icing is very effective to reduce the load of the organism. This organism is closely associated with oyster tissues and is not removed fully by controlled purification methods such as UV light assisted depuration. No effective means commercially exist for elimination of the health hazard in oyster intended for raw consumption and so, it is advised to avoid raw fish and fishery products completely.

#### ***Yersinia enterocolitica***

*Y. enterocolitica* is naturally found in soil, water and domesticated and wild animals. Yersiniosis causes diarrhea, vomiting, abdominal pain and fever, often mimicking appendicitis. Outbreaks have been associated with oysters and fish. Hazards from *Y. enterocolitica* can be prevented by: heating fish and fishery products sufficiently to kill the bacteria, holding chilled fish and fishery products below 40° F and preventing post-cooking cross-contamination.

#### ***Plesiomonas shigelloides***

The genera *Plesiomonas* comprise Gram-negative, facultatively anaerobic, oxidase positive, glucose fermenting, rod shaped bacteria, generally motile. It is an emerging pathogen, mostly associated with fresh water and seawater in warm months. This organism is predominantly associated with fish and fishery products. *P. shigelloides* was implicated as the causative agent for diarrhoea after consumption of fish and fishery products in Hong Kong and USA. It cannot grow at chilled condition, but can survive. Growth can be prevented by chilling, moderate salting/acidification.

## **Fungal hazards**

The fungi associated with foods are generally yeasts and moulds. The greatest concern for food safety are mycotoxins eg. aflatoxin, fusarin, patulin, etc. which are produced by moulds and may be associated with chronic illness, such as cancer. Fungi needs lesser moisture for growth compared to bacteria. If the water activity (aw) is less than 0.60 there will not be any growth of fungi or other microorganisms. Water activity of biscuits is 0.30 and sugar is 0.10.

## **Viral Pathogens**

Viruses contaminate the foods same way as bacteria. It reproduces only within susceptible living cells. A ready to eat food containing a pathogenic virus is a health hazard. Viruses don't reproduce in food; it exists in foods without growing, so they need no food, water or air to survive. Viruses don't cause spoilage but may cause illness. It can survive in human intestine, water, frozen foods etc. for months. Viruses can be found in people who were previously ill. Adequate cooking can destroy it.

Major Viral Pathogens in fish and fishery products includes:

- Hepatitis A Virus
- Norwalk Virus

## **Hepatitis A**

This virus survives better at low temperatures and are killed at high temperatures. As a result, most outbreaks of hepatitis occur during winter and early spring. Viruses can remain alive for long periods of time in seawater and have been shown to survive over one year in marine sediments. Both raw and steamed clams, oysters, and mussels have been implicated in outbreaks of hepatitis A. Symptoms of hepatitis A include weakness, fever and abdominal pain. As the illness progresses, the individual usually becomes jaundiced. The severity of the illness ranges from very mild (young children often experience no symptoms) to severe, requiring hospitalization. The fatality rate is low, and deaths primarily occur among the elderly and individuals with underlying diseases.

Hepatitis A can be prevented by thoroughly cooking fish and fishery products and by preventing cross-contamination of cooked fish and fishery products. But hepatitis A appears to be more resistant to heat than other viruses. A laboratory study showed that hepatitis A virus in infected

oysters were inactivated after heating at 140 F for 19 minutes. Therefore, mollusks steamed only until the shells open (a common cooking practice) are not exposed to heat long enough to inactivate hepatitis A virus.

### **Norwalk Virus**

Norwalk virus is considered a major cause of nonbacterial intestinal illness (gastroenteritis). Illness from Norwalk virus has been associated with eating clams (raw and steamed), oysters and cockles. Norwalk virus causes nausea, vomiting, diarrhea, abdominal cramps, and occasionally fever in humans. Hazards from Norwalk virus can be prevented by thoroughly cooking fish and fishery products and by preventing cross-contamination of cooked fish and fishery products. Additionally, a recent outbreak has demonstrated that controlling overboard discharge of untreated sewage from shellfish harvesting vessels would reduce the incidence of illness attributable to Norwalk virus. Viruses can be prevented by thorough cooking and preventing cross contamination of cooked foods.

### **Parasites in fish and fishery products:**

Major parasites significant for human health includes:

- *Anisakis simplex*
- *Pseudoterranova decipiens*
- *Diphyllobothrium latum*

#### ***Anisakis simplex***

*Anisakis simplex*, commonly called herring worm, is a parasitic nematode or roundworm. Its final hosts are dolphins, porpoises and sperm whales. The larval (wormlike) stage in fish and squid is usually 18 to 36 millimeters in length, 0.24 to 0.69 millimetres in width and pinkish to whitish in colour.

Anisakiasis, the human illness caused by *Anisakis simplex*, is associated with eating raw fish (sushi, sashimi, lomi lomi, ceviche, sunomono, Dutch green herring, marinated fish and cold-smoked fish) or undercooked fish.

Parasites in fish are considered a hazard only in fish that the processor knows or has reason to believe will be served raw or undercooked. In other products, parasites are considered filth but

not hazardous. The FDA has established three freezing processes to kill parasites. Freezing and storing at -4°F (-20°C) or below for 7 days (total time), or freezing at -31°F (-35°C) or below for 15 hours, or freezing at -31°F (-35°C) or below until solid and storing at -4°F (-20°C) or below for 24 hours is sufficient to kill parasites. FDA's Food Code recommends these freezing conditions to retailers who provide fish intended for raw consumption. Note: these conditions may not be suitable for freezing particularly large fish (e.g. thicker than six inches).

### ***Pseudoterranova decipiens***

*Pseudoterranova decipiens*, commonly called “codworm” or “sealworm,” is another parasitic nematode or roundworm. The usual final hosts of *Pseudoterranova* are gray seals, harbor seals, sea lions and walruses. The larval stage in fish are 5 to 58 millimeters in length, 0.3 to 1.2 millimeters in width and yellowish, brownish or reddish in color.

These nematodes are related to *Anisakis simplex* and the disease associated with infections is also termed anisakiasis. These nematodes are also transmitted to humans through raw or undercooked fish. Control of *Pseudoterranova* is the same as for *Anisakis simplex*.

### ***Diphyllobothrium latum***

*Diphyllobothrium latum* is a cestode, or tapeworm, that parasitizes a variety of fish-eating mammals of the northern latitudes. A similar species is found in the southern latitudes and is associated with seal hosts. Cestodes have a structure that allows them to attach to the intestinal wall of their host and have segmented bodies. Cestode larvae found in fish range from a few millimeters to several centimeters in length and are white or gray in colour.

*Diphyllobothrium* tapeworms primarily infect freshwater fish. But salmon and related fish can also carry the parasites. *Diphyllobothrium* tapeworms are usually found unencysted and coiled in musculature or encysted in viscera. These tapeworms can mature and cause disease in humans. These cestodes are also transmitted to humans through raw or undercooked fish. Control of *Diphyllobothrium* is the same as for *Anisakis simplex*.



**Conclusion:**

Proper food handling can prevent most foodborne illness and diseases. Consumers must follow WHO's five keys to safer food -

**1. Keep clean:**

- Thoroughly wash raw fruits and vegetables with tap water.
- Keep clean hands, kitchen and chopping board all the time.

**2. Separate raw from cooked:**

- Do not mix raw food and ready-to-eat food.
- Do not mix raw meat, fish and raw vegetables.

**3. Cook thoroughly:**

- Thoroughly cook all meat, poultry and fish and fishery products, especially shellfish.
- Reheat all leftovers until they are steaming hot.

**4. Keep food at safe temperatures:**

- Refrigerate cooked food within two hours of preparation
- Never defrost food at room temperature. Defrost frozen food in the refrigerator, cold water or in the microwave.

**5. Use safe water and raw materials.**

- Use safe drinking water for food preparation.
- Check use-by dates and labels while buying packed food.