Biotoxins from marine origin in relation to food poisoning

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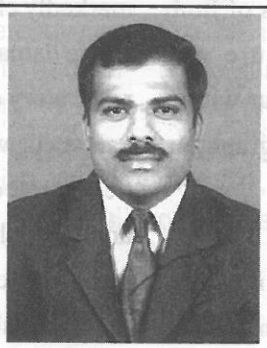

Fish eating population of the world is adversely affected by seafood poisoning which, results from consumption of seafood and is not reported unless and until large number of records have been observed. Seafood is widely consumed worldwide as a source of nutritious and healthy food. Along with increase in demand for seafood, there is a need to have more concern about seafood safety as well. Food poisoning caused by ingestion of toxin contained in the seafood still continued to be a serious threat for seafood safety. Seafood toxins are generally small molecules originating from various sources. Seafood toxins in relation to fish are referred as icthyotoxins whereas those in relation to shellfish are referred as shellfish toxins. Various types of toxins, poisoning and associated seafood types are given in Table 1.

Fish Poisoning

Ciguatera Poisoning

Ciguatera poisoning is associated with consumption of large varieties of tropical as well as sub-tropical fish belonging to coral reef areas and it can occur throughout the year. The toxic compounds associated include poly-ethers such as Ciguatoxin which is fat soluble and maitotoxin which is water soluble. Major source of this poisoning is dinoflagellate, *Gambierdiscus toxicus* from benthic origin. Large fish contains high concentrations due to progressive concentration of these toxins from small fish to large fish that eat small fish. Barracuda, groupers, seabass, snapper are the varieties associated with this toxin. These toxins are the potent activators of Na^+ or Ca^{2+} influx into the cytoplasm resulted in functional as well as in morphological changes in the target cells.

Symptoms associated with generally appear in few hours after ingestion of toxin. It affects gastrointestinal and neurological systems and patients affected with this toxin recover within three days. Detection is mainly by mouse bioassay, enzyme immune assay, etc.

Puffer fish poisoning

Puffer fish, which is also called fugu are considered as an esteemed delicacy in Japan despite the presence of a fatal toxin, tetrodotoxin in the gonad, liver and skin. It

Table-1

Seafood	Toxins	Source
Puffer fish	Tetrodoxin	Bacteria
Tropical fish species	Ciguatoxin	*Gambierdiscus toxicus*
Paralytic Shellfish Poisoning	Saxitoxin	*Alexandrium* spp.
Diarrhetic Shellfish Poisoning	Okadoic acid	*Dinophysis* spp.
Amnesic shellfish poisoning	Domoic acid	*Pseudonitzschic* spp.
Neurotoxic shell fish poisoning	Brevotoxin	*Gymnodinium breve*

is unclear whether the fish itself produces the toxin or like ciguatera, it is introduced to the fish by ingestion of toxic algae. Tetrodotoxin acts on both the central and peripheral nervous system. Approximately 80 species of puffer fish are known to contain tetrodotoxin. Symptoms of poisoning usually begin within 10 minutes of consuming puffer fish. The victim first experiences numbness and tingling of lips, tongue and inner surfaces of mouth. This followed by weakness, paralysis of limb and chest muscles, decreased blood pressure and quickened and weakness pulse. Death can occur within 30 minutes. High performance liquid chromatography is common detection technique used.

Scombroid Poisoning

During post mortem changes in fish, Amino acid histidine by bacterial decarboxylation is converted into histamine. Generally, scombroid fishes such as tuna, mackerel are associated with this type of poisoning. Certain bacteria such as *Proteus moganii* are believed to cause histamine formation in fish with scombroid toxicity. The weak histamine forming bacteria include: *Hafnia alvei*, *Klebsiella* sp. and the *Proteus* sp. other than *Proteus mogani*. This potential toxin is not destroyed by freezing, cooking, smoking, pickling or cooking.

Symptoms of scombroid poisoning can begin 10 minutes to few hours after consuming contaminated fish. The most common symptoms include metallic sharp or peppery taste, nausea, vomiting, abdominal cramps and diarrhea, oral blistering and perioral numbness, facial swelling and flushing, headache, dizziness, palpitations, rapid and weak pulse, thrust and difficulty in swallowing etc. Complete recovery usually occurs within 24 h of scombroid poisoning. Administration of antihistamines results in immediate improvement of patient condition. The most commonly used technique to detect histamine is fluorometric assay.

Palytoxin poisoning

Palytoxin was first discovered, isolated and purified from zoanthids belonging to the genus *Palythoa*. In tropical regions, filefish and triggerfish have been known to cause severe or even fatal poisoning among fisherman when the fish liver was eaten. The fish and related species occasionally cause severe or fatal intoxication in various parts of tropical sea.

Clinical symptoms of palytoxin poisoning include a spinal seizure like syndrome with toxic contractions of all muscle groups, muscle spasms associated with markedly elevated levels of serum enzyme associated with tissue damage, convulsion, extreme pain, myoglobinuria, respiratory distress, dyspnea and respiratory failure. Death can occur within 2-4 days of intoxication. Palytoxin can be detected and quantitatively measured by infrared analysis, ultraviolet absorption, mass spectrometry, high performance liquid chromatography etc.

Shellfish toxins

Paralytic shellfish poisoning (PSP)

This is the most widespread algal shellfish poisoning reported till today. Intoxication results from ingesting bivalve mollusks (mussels, clams, oysters, scallops etc.) that have consumed toxigenic dinoflagelltes. PSP is caused by many species of toxic algae. These include *Alexandrium*, *Pyrodinium* and *Gymnodinium*. The primary toxins include the carbamate toxins (saxitoxins, neosaxitoxins and gonyautoxins 1, 2, 3 and 4) and the sulfocarbomoyl toxins (B1, B2, C1, C2, C3 and C4). Decarbamoyl toxins (dc-saxitoxin, dc-neosaxitoxin and dc-gonyautoxin 1, 2, 3 and 4), which are derivatives of carbamate or sulfocarbonyl toxins, can also be present in shellfish.

The symptoms of PSP can appear within 5 minutes to 10 hours (generally 2 hours) after consuming the contaminated shellfish and are usually mild in nature. They begin with a tingling or numbness of the face, arms and legs followed by headache, dizziness, nausea and muscular incordinations. Severe causes of PSP have resulted in respiratory failure and death. It is very difficult to completely remove these toxins from the shellfish as it is both heat and acid stable and therefore will not be

removed by normal cooling, freezing or smoking. However, alkaline conditions can detoxify these compounds to some extent. The classical method used most often for analysis of saxitoxins is the mouse bioassay.

Neurotoxic shellfish poisoning (NSP)

This is occurred in human being by eating shellfish contaminated by brevetoxins produced by dinoflagellate, *Gymnodinium breve* (formely *Ptychodiscus breve*). The toxins are so potent that it causes irritation and serious health problem just by an inhalation of wind sprayed cells of *Gymnodinium* species. Brevetoxin congeners fall into two types based on backbone structure. The brevetoxin blocks neuromuscular transmission and depolarize muscle membrane potential. The toxin has three components and third one has hemolytic activity. The symptoms of NSP include numbness, tingling in the mouth, arms and legs, in coordination, stomach upset and severe muscle aches. It has never caused any fatalities and recovery normally occurs in 2-3 days. The brevetoxins are generally detected either by biological or chemical methods such as mouse bioassay and sodium channel competitive binding assay (Poli et al. 1986).

Amnesic shellfish poisoning (ASP)

It is rare syndrome caused by eating shellfish contaminated with the toxin, domoic acid, which is produced by the diatoms *Pseudo-nitzschia multiseries* (formely known as *Nitzschia pungens multiseries*). Domoic acid is known to concentrate in clams, mussels, oysters and scallops all over the world. The symptoms of ASP include gastro-intestinal and neurological effects including dizziness, headache, disorientations and possible permanent short-term memory loss usually appear 48 h after consumption of shellfish contaminated with domoic acid. This toxin can be detected by mouse bioassay techniques, capillary electrophoresis, immunochemical analysis, etc.

Diarrhetic shellfish poisoning (DSP)

Diarrhetic shellfish poisoning was recognized as a pathogen in Japan within the last decade. Several species of dinoflagellates have been associated with DSP including *Dinophysis fortii*, *D. acuminata*, *D. acuta*, *D. norvegica*. These species are omnipresent but their toxicity is variable and unpredictable. Dense blooms can sometimes be completely nontoxic, but at other times shellfish can become toxic even when only sparse dinoflagellate population are present. The acidic toxins are okadoic acid, dinophysistoxin-1 and -3 and the neutral toxins are pectenotoxin-1, -2, -3, -4 and -5. The symptoms of diarrhetic shellfish poisoning are gastrointestinal in nature. Symptoms usually begin within 3 to 7 h after ingestion of contaminated shellfish and includes diarrhea, nausea, vomiting, moderate to severe abdominal pain and cramps and chills. Generally it is not a life threatening disease and total recovery is expected within 3 days. It can be detected by cytotoxicity assay, immunological assay, etc.

Conclusion

In different parts of the world, the consumption of different varieties of finfish and shellfish is associated with an increasing number of human intoxications. Along with increasing demand for fish, the problem will become more severe in future. At present, only little intoxication have been identified and isolated and it is a need of an hour to develop highly sensitive diagnostic tools for seafood poisoning detection in order to mitigate their effect and occurrence in seafood from safety point of view.