بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

رَبِّ اشْرَحْ لِیْ صَدْرِیْ o وَیَسِّرْلِیْ اَمْرِیْ o
وَ ا حْلُلْ عُقْدَةً مِّنْ لِّسَانِیْ o یَفْقَهُوْا قَوْلِیْ o

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رَّبِّ زِدْنِی عِلْمًا

MY LORD! INCREASE ME IN KNOWLEDGE.

FST- 407. FOOD SAFETY AND LAWS 3(3-0)

***Program*:** **B. Sc. (Hons). Food Science and Technology**
***Semester*:** **IIV (SS + Ex-PPP)**
***Academic Year*:** **Fall -2020**
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17. Codex Alimentarius

FST-407. L # 11.
FOOD HAZARDS FROM NATURAL ORIGIN

- **FOOD CONTAMINANTS OF NATURAL ORIGIN**
  - **CONTAMINANTS**
  - **ADULTRANTS**
  - **ADDITIVES**
- **PLANT TOXINS**
  - **CUCURBITACINS**
  - **CYANOGENIC GLYCOSIDES**
  - **FUROCOUMARINS**
  - **GLYCOALKALOIDS**
  - **GRAYANOTOXIN**
  - **LECTINS**

PLANT TOXINS

Cucurbitacins

- Cucurbitacea family, including **Cucumber** and **Squash**, produce an intensely bitter group of compounds known as Cucurbitacins
- They are potent toxins with natural insecticidal and / or fungicidal properties.
- Cucurbitacins are toxic at high levels, but they are so bitter that it is almost impossible for anyone to eat sufficient quantity of the toxins to cause significant harm.

CYANOGENIC GLYCOSIDES

- Chemical compounds that occur naturally in many plants, including species of **Prunus** (wild cherry), **Sambucus** (elderberry), **Manihot** (cassava), **Linum** (flax), **Bambusa** (bamboo) & **Sorghum** (sorghum)
- Chemically, they are defined as **glycosides** of the **α-hydroxynitriles**
- These compounds are potentially toxic as they are readily broken down by **enzyme hydrolysis** to liberate **hydrogen cyanide** when the plant suffers physical damage

CYANOGENIC GLYCOSIDES..

- Cyanogenic glycosides, can be found in the edible parts of some important food plants. These include **amygdalin** (almonds), dhurrin (sorghum), lotaustralin (cassava), linamarin (cassava, lima beans), Prunus genus (stone fruit-Peaches, nectarines, plums, apricots, cherries) and taxiphyllin (bamboo shoots).
- The symptoms of acute Cyanide Poisoning include rapid **breathing**, drop in **blood pressure**, raised **pulse rate**, **dizz**iness, **he**adache, **sto**mach pains, **vom**iting, **di**arrhea, **con**fusion, **twit**ching and **convu**lsions. In extreme cases, **dea**th may occur.

FUROCOUMARINS

- The furocoumarins are a group of naturally occurring chemicals that are found in a wide variety of plants, but which are present at their highest concentrations in members of the Apiaceae / Umbelliferae family
- Ajwain, asafoetida, carrot, celery, coriander, cumin, fennel etc.
- They are also present in lower concentrations in other foods such as citrus fruit, celeriac and figs
- Furocoumarins are photo activated carcinogens

FUROCOUMARINS..

- This means that they absorb long wave ultraviolet radiation upon exposure of the skin to sunlight and are activated by the light to form carcinogens
- Prolonged exposure can result in cell damage, by binding pyrimidine bases and nucleic acids and thus inhibiting DNA synthesis
- Furocoumarins are produced by many plants in response to stresses such as bruising or injury caused by predation

GLYCOALKALOIDS

- Many plants in the **Solanaceae** family contain **glycoalkaloids**, and they are considered to be **natural toxins**
- They are active as **pesticides** and **fungicides** and are produced by the plants as a **natural defense** against animals, insects and fungi that might attack them
- Amongst the most widely cultivated food crops **tomatoes** and **potatoes** are in the Solanaceae family; however, the levels of glycoalkaloids in tomatoes and aubergines are generally quite low and are therefore not a concern

GLYCOALKALOIDS..

- **Potato Poisoning** involve only mild **gastrointestinal** effects, which generally begin within **8–12 h** after ingestion and resolve within one or two days.
- However, reported symptoms have included **nausea** and **vomiting**, **diarrhea**, **stomach** cramps and **headache**.
- More serious cases have experienced neurological problems, including **hallucinations** and **paralysis**, and fatalities have also been recorded.

GRAYANOTOXIN

- Grayanotoxins are natural plant toxins (**diterpenes polyhydroxylated** cyclic hydrocarbons that do not contain **nitrogen**) found in **rhododendrons** and other plants of the family **Ericaceae**.
- They can be found in **honey** made from the nectar produced by the flowers of these plants, and can cause a very rare poisonous reaction.

GRAYANOTOXIN..

- Symptoms include **dizziness**, **weakness**, **excessive perspiration**, **nausea**, and **vomiting** shortly after the toxic **honey** is ingested
- Other symptoms may include **low blood** pressure or **shock**, **brady-arrhythmia** and other **cardiac abnormalities**

LECTINS

- **Lectins** are **proteins** that are widely distributed in nature and occur in **many plants** commonly consumed in the diets of humans and animals.
- Most lectins are actually **glycoproteins** containing 2 or 4 subunits, each of which has a sugar-binding site.
- Lectins are generally identified by the plant species that they are derived from.
- **Leguminous** vegetables are the most frequently encountered food sources of lectins

LECTINS..

- The common foods include Peanut, Kidney bean, Fava bean (*Vicia faba*), Soya bean, Lentil Lens, Winged bean (*Psophocarpus tetragonolobus*), Garden pea, Horse gram, Lima bean (*Phaseolus lunatus*) and Navy bean (*Phaseolus vulgaris*)
- Symptoms include acute gastroenteritis, sickness and abdominal pain, which may be severe enough to require hospitalization
- The symptoms generally clear within 3–4 h and recovery is usually rapid and complete

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FST- 407. L # 12.
FOOD HAZARDS FROM NATURAL ORIGIN: FISH TOXINS

- Amnesic Shellfish Poisoning (ASP)
- Azaspiracid Shellfish Poisoning (AZP)
- Ciguatera Fish Poisoning (CFP)
- Diarrheic Shellfish Poisoning (DSP)
- Neurologic Shellfish Poisoning (NSP)
- Paralytic Shellfish Poisoning (PSP)
- Tetrodotoxin

FISH TOXINS - SHELLFISH

- Shellfish is a colloquial and fisheries term for exoskeleton bearing aquatic invertebrates used as food, including various species of Molluscs, Crustaceans, and Echinoderms.
- Although most kinds of shellfish are harvested from Saltwater environments, some are found in Freshwater
- **Shellfish are among the most common food allergens.**
- **Molluscs** used as a food source by humans include many species of **Clams**, **Mussels**, **Oysters**, **Winkles**, and **scallops**
- Some **Crustaceans** that are commonly eaten are **Shrimp**, **Lobsters**, **Crayfish**, and **Crabs**.

FISH TOXINS

Amnesic Shellfish Poisoning (ASP)

- ASP is a foodborne intoxication associated with the consumption of contaminated shellfish harvested from waters affected by growth of certain types of toxic algae
- ASP is an acute form of human poisoning, which causes a wide range of symptoms and can sometimes be fatal.
- ASP is caused by domoic acid (DA), a water-soluble acidic amino acid that has been isolated from a number of marine macro-algae / seaweed (feeds off the nutrients in the water.) and micro-algae (unicellular photosynthetic micro-organisms) species.

FISH TOXINS

Amnesic Shellfish Poisoning (ASP)

- DA is a powerful neurotoxin and belongs to the kainoid amino acids
- e.g. Humic Acid, Potassium Humate, Fulvic Acid
- The kainoid amino acids are a unique group of non-proteinogenic pyrrolidine dicarboxylic acids.

FISH TOXINS

Amnesic Shellfish Poisoning (ASP)

- Most human cases of ASP are related to bivalve molluscs, especially mussels, but DA has also been isolated from scallops, oysters and razor clams.
- DA is a potent neurotoxin, which can affect both central and peripheral nervous systems in humans and is also an emetic.
- It acts as an excitatory neurotransmitter (promotes the generation of an electrical signal) that binds to receptor proteins on nerve cells.

FISH TOXINS

Azaspiracid Shellfish Poisoning (AZP)

- Azaspiracid shellfish poisoning (AZP) is a foodborne intoxication associated with the consumption of contaminated shellfish harvested from waters affected by growth of certain types of toxic algae.
- Recorded cases of AZP have been associated with consumption of mussels, but AZAs have also been found in crabs, oysters, clams, scallops, razor clams and cockles.

FISH TOXINS

Ciguatera Fish Poisoning

- Ciguatera fish poisoning (CFP) is a foodborne intoxication associated with consumption of coral reef fish from tropical and subtropical waters in the Pacific and Indian Oceans and the Caribbean sea.
- Ciguatoxins are found in a broad range of fish that live in or around coral reefs in comparatively shallow tropical waters.
- Ciguatoxins cause a wide variety of neurological, gastrointestinal and cardiovascular symptoms.
- They are extremely powerful toxins and an oral dose of 0.1 mg may be enough to cause illness.

FISH TOXINS

Diarrheic Shellfish Poisoning (DSP)

- Diarrheic shellfish poisoning (DSP) is a foodborne intoxication associated with the consumption of contaminated shellfish harvested from waters affected by growth of certain types of toxic algae.
- DSP is a non-lethal form of food poisoning with symptoms typical of gastroenteritis, especially diarrhea.
- Most cases of DSP are related to mollusks, especially mussels, but also scallops, oysters and clams. These species are filter feeders and accumulate toxins when the water contains sufficient levels of toxin-producing algae.
- DSP toxins are powerful phosphatase inhibitors and this property is associated with inflammation of the gut in humans. This leads to fluid loss from intestinal cells resulting in diarrhea.

FISH TOXINS

Neurologic Shellfish Poisoning (NSP)

- Neurologic shellfish poisoning (NSP) is a foodborne intoxication associated with the consumption of contaminated shellfish harvested from waters affected by growth of certain types of toxic algae. It is also sometimes referred to as neurotoxic shellfish poisoning.
- Most human cases of NSP are related to mollusks, including oysters, clams and mussels, all of which can accumulate brevetoxins during feeding when the water contains sufficient levels of toxin-producing algae.
- Brevetoxins are neurotoxins that act by affecting the sodium channels in the membranes of nerve cells.
- This causes the cells to fire repeatedly, giving rise to various neurological symptoms.

FISH TOXINS

Paralytic Shellfish Poisoning (PSP

- Paralytic shellfish poisoning (PSP) is a foodborne intoxication associated with the consumption of contaminated marine shellfish harvested from waters affected by a sudden and rapid growth of certain types of toxic algae.
- Most cases of PSP are related to bivalve mollusks, especially mussels and clams, but also oysters and scallops
- PSP toxins are potent neurotoxins.

FISH TOXINS

Tetrodotoxin

- Tetrodotoxin (TTX), also known as tetrodonic acid, is a marine biotoxin associated with certain fish species, notably pufferfish.
- Consumption of these fish can cause very severe foodborne intoxication, often referred to as pufferfish poisoning or fugu poisoning.
- TTX is mainly associated with fish of the order Tetraodontidae (pufferfish, balloon fish, fugu, globe fish, blowfish, toad fish) from the Pacific and Indian Oceans.
- These fish are a traditional food in Japan, where they are sold as ‘‘fugu’’

FISH TOXINS

Tetrodotoxin

- In specialized restaurants employing specially trained and licensed chefs who are able to remove the most toxic parts of the fish to reduce the poisoning risk.
- The highest levels of TTX are found in the viscera, particularly the liver and ovaries, and skin of the fish, but the muscle tissue does not usually contain dangerous levels of toxin.
- TTX is a very potent neurotoxin, and operates in a similar way to the PSP toxin (saxitoxin) by selectively blocking the voltage-gated sodium channel – a large protein that extends across the plasma membrane of nerve and muscle cells.

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FST- 407. L # 12.
FOOD HAZARDS FROM NATURAL ORIGIN: BIOGENIC AMINES

- **Biogenic Amines (Excluding Histamine)**
- **Scombrotoxin (Histamine)**

BIOGENIC AMINES / BIOLOGICALLY ACTIVE AMINES

- Low-molecular weight organic compounds produced in biological systems by **enzymatic decarboxylation** of certain amino acids such as **histamine** and **tyrosine**
- Examples include **dopamine**, **histamine**, **norepinephrine**, **serotonin**, and **tyramine**
- They function in the body as **neurotransmitters** and relay signals between neurons across synapses to impact on **mental** functions, **blood pressure**, **body temperature**, **appetite**, and several other **physiologi**cal processes
- The levels of biogenic amines in the body are regulated for proper functioning of the various physiological processes that they are associated with

BIOGENIC AMINES / BIOLOGICALLY ACTIVE AMINES

- Certain **foods** contain biogenic **amines** that can add to the amounts naturally present in the body.
- **High** intake of these foods could upset the balance of biogenic amines in the body to cause health problems such as **hypotension**, **hypertension**, **gastrointestinal** distress, **headaches** and **migraine**, and others
- Thus, it is crucial to curtail the formation and levels of these compounds in certain food products
- The formation and occurrence of biogenic amines in selected food products, their effects of human health and significance to the food industry, their detection, and their fate during processing and storage

BIOGENIC AMINES

Biogenic Amines (Excluding Histamine)

- Biogenic amines are produced in a variety of foods by the decarboxylation of specific free amino acids.
- This may occur naturally as a result of the action of endogenous decarboxylase enzymes in the food, or more importantly as a byproduct of bacterial growth and the production of exogenous decarboxylases.
- The presence of significant amounts of biogenic amines, especially in meat and fish products, is often an indicator of bacterial spoilage.

BIOGENIC AMINES

Biogenic Amines (Excluding Histamine)

- Biogenic amines are known to occur in a wide variety of food products, but they are of particular significance in foods that contain a high level of free amino acids and high numbers of decarboxylase - producing bacteria.
- These include fish products, cheese, meat products (especially fermented meats), wine, beer and fermented vegetable products
- Certain biogenic amines are also found naturally in a range of fruit juices and fresh fruit and vegetables, including cocoa beans, mushrooms and lettuce.

BIOGENIC AMINES

Scombrotoxin (Histamine)

- Scombrotoxin is a foodborne toxin most often associated with the consumption of fish, particularly species belonging to the Scombridae and Scomberesocidae families (scombroid fish), such as mackerel and tuna.
- It can cause a mild, though sometimes distressing, form of foodborne intoxication (scombroid or scombrotoxic food poisoning) when ingested in sufficient quantities.
- Scombrotoxic poisoning is also known as histamine poisoning, since histamine is considered to be the toxic component of Scombrotoxin, although other compounds may be involved.
- Histamine is a biogenic amine and can be produced during processing and/or storage in fish and certain other foods, usually by the action of spoilage bacteria..

BIOGENIC AMINES

Scombrotoxin (Histamine)

- Scombrotoxin (histamine) poisoning is a chemical intoxication, in which symptoms typically develop rapidly (from 10 min to 2 h) after ingestion of food containing toxic histamine levels.
- The range of symptoms experienced is quite wide, but may include an oral burning or tingling sensation, skin rash and localized inflammation, hypotension, headaches and flushing.
- In some cases vomiting and diarrhea may develop and elderly or sick individuals may require hospital treatment.
- The symptoms usually resolve themselves within 24 h

- Biogenic amines (BA) are nitrogenous compounds of low molecular weight and are essential at low concentrations for natural metabolic and physiological functions in animals, plants, and microorganisms. Histamine, putrescine, cadaverine, tyramine, tryptamine, 2-phenylethylamine, spermine and spermidine are the most important BA in foods in which they are mainly produced by microbial decarboxylation of amino acids. Many factors influence BA production in foods, including food physico-chemical parameters (NaCl, pH and ripening temperature), storage, and distribution conditions, manufacturing processes and practices, presence of decarboxylase-positive microorganisms, raw material quality, and availability of free amino acids (Linares et al., 2012). Nonetheless, consumption of food or beverages containing high amounts of these compounds can have toxic effects such as hypertension, cardiac palpitations, headache, nausea, diarrhea, flushing, and localized inflammation; in extreme cases the intoxication may have fatal outcome. The degree of BA intoxication depends on the amount and type of BA ingested and the correct functioning of the detoxification system. In fact, after food consumption, small quantities of BA are commonly metabolized in the human gut to physiologically less active forms through the activity of the amine oxidizing enzymes, monoamine and diamine oxidases. So the toxic level of BA ingested is difficult to establish, as this depends on the individual sensitivity and health status of consumers. Moreover the malfunction or reduced activity of amine oxidase can result in high BA blood levels, whereas people taking drugs

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- Among intoxications related with BA there is the “Scombroid poisoning” caused by histamine which is the only BA with regulatory limits, set by European Commission, up to a maximum of 200 mg/kg in fresh fish and 400 mg/kg in fishery products treated by enzyme maturation in brine (Visciano et al., 2012, 2014). After fish, cheese is the next most commonly implicated food item associated with tyramine poisoning, so called “Cheese reaction,” related with its high content in aged cheeses (Schirone et al., 2012). Other potentially BA, specially histamine and putrescine are also present in milk-based fermented foods (Linares et al., 2012).
- Moreover in fermented beverages, such as wine, it is very difficult to minimize content of BA, that are produced mainly through the decarboxylation of amino acids by yeasts during fermentation and/or lactic acid bacteria during malolactic fermentation. In particular vintage, grape variety, geographical region, and vinification methods such as grape skin maceration are some of the variables that can lead to an increase of precursor amino acids and subsequently the BA content in wine (Smit et al., 2012). Recently, some *Lactobacillus plantarum* strains isolated from wine and other oenological source were tested for their ability to degrade BA. Two strains were selected for their potential ability to reduce BA in wine (putrescine and tyramine) and to design malolactic starter cultures (Capozzi et al., 2012).
- Among the approaches useful to control the formation of BA, such as the reduction of microbial growth through chilling and freezing or hydrostatic pressures, irradiation, controlled atmosphere packaging, or the use of food additives, etc., the use of selected starter cultures free of the potential to form BA, has been proposed as one of the best technological measures to control aminogenesis during traditional sausages production (Latorre-Moratalla et al., 2012). In fact in traditional dry sausages high content of BA can be produced by different microbial groups such as lactic acid bacteria and enterococci, but also by staphylococci and bacilli (Bermúdez et al., 2012).
- Among the food BA, polyamines are ubiquitous substances considered to be bioregulators of numerous cells functions and are involved in tissue repair and in intracellular signaling. Although many biological functions have been attributed to polyamines, high levels of these compounds in foodstuffs can have toxicological effects; however, no safe level for the intake of polyamines in a diet as yet been established. The polyamine agmatine, derived from arginine, is present at high

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- Biogenic amines (BA) are nitrogenous compounds of low molecular weight and are essential at low concentrations for natural metabolic and physiological functions in animals, plants, and microorganisms. Histamine, putrescine, cadaverine, tyramine, tryptamine, 2-phenylethylamine, spermine and spermidine are the most important BA in foods in which they are mainly produced by microbial decarboxylation of amino acids. Many factors influence BA production in foods, including food physico-chemical parameters (NaCl, pH and ripening temperature), storage, and distribution conditions, manufacturing processes and practices, presence of decarboxylase-positive microorganisms, raw material quality, and availability of free amino acids (Linares et al., 2012). Nonetheless, consumption of food or beverages containing high amounts of these compounds can have toxic effects such as hypertension, cardiac palpitations, headache, nausea, diarrhea, flushing, and localized inflammation; in extreme cases the intoxication may have fatal outcome. The degree of BA intoxication depends on the amount and type of BA ingested and the correct functioning of the detoxification system. In fact, after food consumption, small quantities of BA are commonly metabolized in the human gut to physiologically less active forms through the activity of the amine oxidizing enzymes, monoamine and diamine oxidases. So the toxic level of BA ingested is difficult to establish, as this depends on the individual sensitivity and health status of consumers. Moreover the malfunction or reduced activity of amine oxidase can result in high BA blood levels, whereas people taking drugs with amino oxidase inhibitor and/or alcohol show interaction with the detoxification system.

- Among intoxications related with BA there is the “Scombroid poisoning” caused by histamine which is the only BA with regulatory limits, set by European Commission, up to a maximum of 200 mg/kg in fresh fish and 400 mg/kg in fishery products treated by enzyme maturation in brine (Visciano et al., 2012, 2014). After fish, cheese is the next most commonly implicated food item associated with tyramine poisoning, so called “Cheese reaction,” related with its high content in aged cheeses (Schirone et al., 2012). Other potentially BA, specially histamine and putrescine are also present in milk-based fermented foods (Linares et al., 2012).

- Moreover in fermented beverages, such as wine, it is very difficult to minimize content of BA, that are produced mainly through the decarboxylation of amino acids by yeasts during fermentation and/or lactic acid bacteria during malolactic fermentation. In particular vintage, grape variety, geographical region, and vinification methods such as grape skin maceration are some of the variables that can lead to an increase of precursor amino acids and subsequently the BA content in wine (Smit et al., 2012). Recently, some *Lactobacillus plantarum* strains isolated from wine and other oenological source were tested for their ability to degrade BA. Two strains were selected for their potential ability to reduce BA in wine (putrescine and tyramine) and to design malolactic starter cultures (Capozzi et al., 2012).

- Among the approaches useful to control the formation of BA, such as the reduction of microbial growth through chilling and freezing or hydrostatic pressures, irradiation, controlled atmosphere packaging, or the use of food additives, etc., the use of selected starter cultures free of the potential to form BA, has been proposed as one of the best technological measures to control aminogenesis during traditional sausages production (Latorre-Moratalla et al., 2012). In fact in traditional dry sausages high content of BA can be produced by different microbial groups such as lactic acid bacteria and enterococci, but also by staphylococci and bacilli (Bermúdez et al., 2012).

- Among the food BA, polyamines are ubiquitous substances considered to be bioregulators of numerous cells functions and are involved in tissue repair and in intracellular signaling. Although many biological functions have been attributed to polyamines, high levels of these compounds in foodstuffs can have toxicological effects; however, no safe level for the intake of polyamines in a diet as yet been established. The polyamine agmatine, derived from arginine, is present at high