Dr. Rima Kumari: Date: 21/07/2020
Online class and e- content for B.Sc. Ist year students

Date and Time	Online class medium	E. content topic
21/07/2020 12:45 p.m to 01.30 p.m	Via Google meet Link: Meeting URL: https://meet.google.com/rey-uhrm-dpe	**Microbial contamination of Agricultural/ Food storage**

Microbial contamination of Agricultural/ Food Products:

1. Fruits and Vegetables spoilage:

Fruits and vegetables are generally contaminated by bacteria including species of *Bacillus, Enterobacter, Lactobacillus, Leuconostoc, Pseudomonas, Sarcina, Staphylococcus, Streptococcus* etc. Various moulds and yeasts also inhabit the fruits and vegetables. Fruits and vegetables get rotten as a result of the microbial degradation of pectin, the substance responsible for maintaining the firmness and texture of fruits and vegetables.

Above mentioned microbes produce pectin esterases and a polygalacturonases enzymes that hydrolyse pectins resulting in the formation of soft rots in fruits and vegetables. 20% of the harvested crops of fruits and vegetables are lost to spoilage mainly because of the activities of bacteria and micro-fungi.

1.1 Contamination through infection:

Fruits and vegetables are normally susceptible to bacterial, fungal and viral infections. These infections invade the fruit and vegetable tissue during various stages of their development and result in the subsequent spoilage.

Specific Spoilage Organisms:

1. Blue rot – Penicillium, fruits

2. Downy mildews – Phytophora, large masses of mycellium (grapes)

3. Black rot – Aspergillus, onions

4. Sour rot – Geotrichum candidum

1.2 Contamination through post-harvest handling:

Usually, mechanical handling of fruits and vegetables during post-harvest period produce “breaks” in them which invite microbial invasion. Since the pH of the fruits is relatively acidic (i.e., high in sugar), they are more susceptible to fungi in contrast to vegetables which are more susceptible to bacteria because of their pH being slightly higher (5.0 to 7.0; less in sugar).

2. Cereals:

Cereals and cereal products contain microorganisms from insects, soil and other sources. Bacillus, Lactobacillus, Micrococcus, Pseudomonas, etc. are the bacteria which are generally found on freshly harvested grains.

Wheat flours are contaminated mostly by bacteria such as species of Bacillus, Micrococcus, Sarcina, Serratia, coliforms, etc. Moulds like Aspergillus, Penicillium, Rhizopus, Neurospora, Endomyces are also very common.

B. Vegetables

In vegetables readily available mono- and disaccharides like glucose and maltose, as well as more complex oligosaccharides present, which are susceptible to fewer types of microorganisms i.e., yeasts, molds or bacteria. It is estimated that 20% of all harvested fruits and vegetables for humans are lost to spoilage by these microorganisms. Because bacteria grow more rapidly, they usually out-compete fungi for readily available substrates in vegetables. As a result, bacteria are of greater consequence in the spoilage of vegetables with intrinsic properties that support bacterial growth (favorable pH 6).

Microbes responsible for vegetable contamination is primarily G+ bacteria

like lactic acid bacteria (e.g. leuconostocs, lactobacilli, streptococci, Coryneforms and staphylococci

Soft rot

a. One of the most common types of bacterial spoilage.

b. caused by *Erwinia carotovora* and sometimes by Pseudomonas spp., which grow at 4oC

Softening can also be caused by endogenous enzymes

Mold spoilage

a. In vegetables where bacterial growth is not favored (e.g. low pH), molds are the principal spoilage agents.

b. Most molds must invade plant tissue through a surface wound such as a bruise or crack.

c. Spores are frequently deposited at these sites by insects like Drosophila melanogaster, the common fruit fly.

d. Other molds like *Botrytis cinerea*, which causes grey mole rot on a variety of vegetables, are able to penetrate fruit or vegetable skin on their own.

Soil-borne micro-organism such *as Clostridia* are common on raw vegetables, and some species, like *C. botulinum*, are of such great concern as food poisoning

D. Other Foods

1. Dairy Products - Milk is a very rich medium

a. All micro-organism found on the cow hide (which incl. soil and fecal bacteria), udder, and milking utensils

b. Can include G-, G+, yeasts and molds.

When properly handled and stored, the flora of pasteurized milk is primarily G+ bacteria.

Psychrotropic pseudomonads are common in bulk stored raw milk

-produce heat stable enzymes that can reduce milk quality and shelf life

Pasteurization kills most G- (incl. Pseudo.), yeasts and molds

-some G- enzymes, thermotolerant G+ bacteria and spores survive

-Psychrotropic Bacillus spp. are also common in raw milk

Pasteurized fluid milk – spoiled by a variety of bacteria, yeasts and molds.

a. In the past, milk was usually soured by LAB such as *enterococci, lactococci, or lactobacilli*, which dropped the pH to 4.5 where milk proteins coagulate (curdling).

b. Today, milk is more frequently spoiled by aerobic sporeformers such as *Bacillus*, whose proteolytic enzymes cause curdling.

c. Molds may grow on the surface of spoiled milk, but the product is usually discarded before this occurs.

Butter; high lipid content and low aw make it more susceptible to surface mold growth than to bacterial spoilage.

Some pseudomonads can be a problem; “surface taint” -putrid smell, caused by the production of organic acids (esp. isovaleric) from *P. putrefaciens*

Rancidity due to butterfat lypolysis caused by *P. fragi* are common.

Cottage cheese can be spoiled by yeasts, molds and bacteria.

The most common bacterial spoilage is “*slimy curd*” caused by *Alcaligenes* spp. (G- aerobic rod bound in soil, water, and intestinal tract of vertebrates).

Penicillum, Mucor and other fungi also grow well on cottage cheese and impart stale or yeasty flavors.

Spores of C. butyricum, C. sporogenes and others can germinate in cheeses (e.g. Swiss) with intrinsic properties that are less inhibitory (e.g. lower salt, higher pH).

-These organisms may metabolize citrate, lactose, pyruvate or lactic acid and produce butyrate or acetate plus CO2 or H2 gas which “blows” the cheese.

Cereal and Bakery Goods

These products when stored properly under low humidity, restricts all MO except molds. Rhizopus stolonifer is the common bread mold, and other species from this genus spoil cereals and other baked goods.

-Refrigerated frozen dough products have more water and can be spoiled by lactic acid bacteria.

Fermented Foods and Beverages

The low pH or ethanol content of these products does not allow growth of

pathogens, but spoilage can occur.

Beer and wine (pH 4-5) can be spoiled by yeasts and bacteria. Bacteria involved are primarily lactic acid bacteria like lactobacilli and Pediococcus spp., and (under aerobic conditions) acetic acid bacteria like Acetobacter and Gluconobacter spp. Acetic acid bacteria convert ethanol to acetic acid in the presence of oxygen.

The anaerobic bacterium Megasphaera cerevisiae can also spoil beer by producing isovaleric acid and H2S.

Spoilage in packaged beer is often due to growth of the yeast Saccharomyces diastaticus, which grows on dextrins that brewers yeast cannot utilize. Candida valida is the most important spoilage yeast in wine. In either case, spoilage by yeasts results in the development of turbidity, off flavors and odors.

Wines can also be spoiled by lactic acid bacteria which are able to convert malic acid to lactic acid (malo-lactic fermentation). This reduces the acidity of the wine and adversely affect wine flavor. In some areas (e.g. Northwest), wine grapes have too much malic acid so this fermentation is deliberately used to reduce the acidity of grape juice that will be used for wine.

Yeasts, molds and lactic acid bacteria can also spoil fermented vegetables such as sauerkraut and pickles, as well as other acid foods like salad dressings and mayonnaise. Spoilage in fermented vegetables is often manifest by off odors or changes in the color (chromogenic colony growth) or texture (softening) of the product. In mayonnaise or salad dressing, the first signs of spoilage are usually off odors and emulsion separation.

Mycotoxins and Aflatoxins:

Mycotoxins are the toxic substances produced by fungi on food materials. These are ‘secondary metabolites’. Some of these cause very severe effects on

animal, plant and microbial systems. These include aflatoxins, ochratoxins, sterigmatocystin, citrinin (Fig. 21.7) patulin, rubratoxin, zearalenone and trichothecens and are produced by the different species of Aspergillus, Penicillium, and Fusarium.

Aflatoxins are highly oxygenated heterocyclic compounds. They contain a coumarin structure fused to a bi-furan. In case of aflatoxin B, a pentanone structure which is substituted in aflatoxin G by a six membered lactone is present.

In some animals, aflatoxins B_1 and B_2 are partially metabolised to give hydroxylated derivatives, which have been called aflatoxins M_1 and M_2 or milk toxins. Other aflatoxins isolated from the cultures of Aspergillus flavus are aflatoxins B2a, G2a, aflatoxicol, aflatoxins H, aflatoxins P1 and aflatoxins Q1. More than two dozen aflatoxins and their derivatives are now known.

During metabolism the fungi not only produce mycotoxins in the substrates but they also cause considerable loss to the food substrates by changing the levels of some of their vital chemical components. Toxigenic strains of Aspergillus flavus and A parasiticus cause significant change during their infestations in the levels of sugar, protein, ascorbic acid and phenols of some fleshy fruits.

There are only three important mycotoxicoses for which there exist reasonable evidences to associate the toxins with human diseases. These are the well known diseases like ergotism, alimentary toxic aluki (ATA) and the liver cancer or Reye's syndrome caused by aflatoxins. Among all the three mycotoxicoses, human aflatoxicoses have received considerable attention in the recent years.

The concern about mycotoxins producing potentials of molds has increased since 1960 i.e. after the discovery of 'Turkey-K-disease' which was attributed to aflatoxin elaborated by Aspergillus flavus, All the strains of A. flavus, however, do not possess the capacity of elaborating aflatoxins. Screening of A.

flavus isolates for aflatoxin production also received considerable importance in India.

Among all the mycotoxins, aflatoxins occupy key position with regards to carcinogenic effects on animals and human systems. These are one of the potent hepatocarcinogens known so far and can induce carcinoma. they bind with DNA and affect the DNA transcription process and in such way protein synthesis inhibited. they causes liver cancer in animal and human being. Clinical symptoms Jaundice, partial hypertension, rapidly developing ascites etc

Algal toxins/ Algal Bloom

Algal toxins are toxic substances released by some types of algae when they are present in large quantities (blooms) and decay or degrade. High nutrient levels and warm temperatures often result in favorable conditions for algae blooms to form. These blooms can be identified as floating mats of decaying, bad-smelling and gelatinous scum. One type of algae, cyanobacteria (also referred to as blue-green algae), naturally occurs in all freshwater ecosystems. When algae blooms form and cyanobacteria degrade, many release algal toxins that can be harmful to aquatic and human life.

An algal bloom is defined as the rapid growth or accumulation of algae in aquatic ecosystems. Harmful algal blooms (HAB) are algal blooms composed of phytoplanktons known to naturally produce bio-toxins that are harmful to the resident aquatic population, as well as humans. The presence of harmful algal blooms leads to fish die-offs, fish sickness, and human sickness when affected organisms are consumed.

Algal blooms are caused by excessive amounts of nitrates, phosphates, and nutrients entering an aquatic ecosystem, often via discharges from sewage treatment plants and septic tanks, and storm water run-off from fertilized lawns and farms. Other factors that aid algal growth include sunlight and

slow-moving water.

These nutrients cause a type of pollution called eutrophication. Eutrophication entails excess nutrients stimulating an explosive growth of algae. As these algae grow, out-competed plants die off and become food for the bacteria that decompose them. With more food available now, the bacteria also experience an explosive growth, rapidly using up all the oxygen in the water until many fish and aquatic insects can no longer survive. The end result of an algal bloom is a dead zone.

The presence of algal blooms can induce a variety of damaging effects on the surrounding environment and its inhabitants. Toxins released from the algal bloom can cause anything from tissue deterioration and illness, to death and extirpation. How these toxins induce their effects on their victims vary by mechanism, but can include malnutrition, reduced appetite, suffocation, and respiratory failure. The results are devastating—not just for the resident aquatic populations, but also to many other plants and animals in the community, including people. In humans, direct exposure to toxins via drinking water can cause a series of health issues, such as rashes, stomach or liver illnesses, respiratory problems, and neurological effects.

Toxins secreted by Gymnodinium veneficum, G. brevis, Prodinium phonesus can kill many kind of fishes. It affect the nervous and muscular system of fishes. Species of Gonyaulex secrete endotoxins which accumulate in digestive system of shellfish feeding on them. when entered to human chain lead to paralysis and dealth.

Anabaena, Microcystis and Aphanizomenon form bloom under oxygen deficiency and secrete biotoxins. these planktonic enter in human body with drinking water, causes diseases. Anabaena, Microcystis cause gastric problems, Gymnodinium brevis respiratory disease, Lyngbya and Chlorella skin problem. Tetradontoxin by Gonyaulex catenella enter human body through fish, causes numbness, paralysis and dealth. Cephaleuros

(Chlorophyceae) causing red rust of Tea.