Unit-7: Food Contamination and Food Adulteration

7.1 FOOD CONTAMINATION

Food contamination is the presence of any substance which is not intentionally added to food, and is present in food as a result of the production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food or as a result of environmental contamination. The term does not include insect fragments, rodent hairs and other extraneous manner.

In some of the foods commonly consumed by man substances harmful to the human health occur and they are commonly referred to as contaminants of natural origin. In some they are present in minute quantities and may not present any health hazards in the quantities they are normally consumed. Some of these toxins get accumulated in the body or ingestion of small quantities for prolonged period may result in certain diseases. Some of the naturally occurring toxins which are of practical relevance in the Indian context are indicated below.

7.1.1 Seafood Toxins

There are number of causes of food poisoning originating from seafoods and shellfish. Seafood poisoning can be caused by Ciguatera poisoning, a toxin from microalgae, which has been accumulated in fish flesh. Another poisoning known as Scrombroid poisoning is believed to occur due to consumption of fish flesh containing high levels of histamine and possibly some biogenic amines. Shellfish poisoning is caused by a group of toxins produced by planktonic algae upon which the shellfish feed. All shellfish are potentially toxic.

7.1.2 Biogenic Amines

The biogenic amines are biologically active compounds synthesized from amino acids. Foodborne biogenic amines are most commonly synthesized by spoilage microorganisms and are usually considered to be potential toxins. A subgroup of the biogenic amines are the mammalian polyamines: putrescine and spermine. Biogenic amines should not always be considered as potential toxicants but can also be considered to be non-hormonal growth promoters.

7.1.3 Alkaloids

They are all nitrogeneous heterocyclic compound which occur mainly in plants as their salts of common carboxylic acids such as citric, lactic, oxalic, acetic, malic and tartaric acids as well as fumaric, benzoic, aconitic and veratric acids. Their amine character produce an alkaline solution in water and hence the origin of their name - alkaloids.

A toxic alkaloid called Sanguinarine causes a disease called Epidemic Dropsy. Epidemic Dropsy is caused by consuming mustard oil contaminated with argemone seed oil. Argemone mexicana is a weed and produces seeds that are very similar in appearance to mustard seed. PFA Rules under A.17.06 specify negative test for agremone oil.

7.1.4 Protease Inhibitors

PROTEASE INHIBITORS INTERFERE WITH THE ACTION OF TRYPSIN AND CHYMOSTRYPSIN, ENZYMES PRODUCED BY THE PANCREAS TO BREAK DOWN INGESTED PROTEINS. THEY ARE FOUND TO SOME EXTENT IN CEREAL GRAINS (OATS, BARLEY, AND MAIZE), BRUSSELS SPROUTS, ONION, BEETROOT, WHEAT, FINGER MILLET, AND PEANUTS.

Several plants specially belonging to the family Leguminoseae such as redgram, Bengal gram, cow pea, double bean, soybean, lathyrus contain protein inhibitors active against pancreatic proteolytic enzymes of vertebrates. These trypsin inhibitors cause growth retardation and hypertrophy of pancreas. The release of essential aminoacids like methionine is hampered by the presence of inhibitors. The trypsin inhibitors are generally heat labile and are destroyed in the normal process of cooking.

7.1.5 Lathyrogens

Lathyrogens, found in legumes such as chick peas are derivatives of amino acids that act as metabolic antagonists of glutamic acid, a neurotransmitter in the brain. When lathyrogens are ingested in large amounts by humans or animals, they cause a crippling paralysis of the lower limbs and may result in death. Lathyrism only occurs on a impoverished diet of sweet pea, or grass pea and is characterized by bone thinning and leg paralysis.

7.1.6 Goitrogens

Food plants species in the Cruciferae (Brassicaceae) family contain substances called goitrogens or glucosinolates, which probably play a role in the plant's defenses against predators and fungal attack. When eaten by animals or humans, glucosinolates can inhibit thyroid gland functioning, causing enlargement and atrophy of the thyroid, or goiter. Brassica species containing goitrogens include cabbage, broccoli, cauliflower, rutabaga, kohlrabi, and the oilseeds, rapeseed and canola. The enzymes required for production of goitrogens in the plant are destroyed by cooking. Goitrogens are also lost through leaching into cooking water.

7.1.7 Phytates

The phytates are present in cereal grains and some lentils. Phytates are usually present in a bound form with potassium, calcium or magnesium. Phytates have adverse effects on the availability of zinc, calcium, magnesium and iron, because they form insoluble complexes with these minerals.

Many individuals, especially Indians, do consume more than enough iron-rich foods, yet they tend to be anemic or iron-deficient. Our Indian diets consist of preponderant amounts of cereals and some lentils which do contain more than enough dietary iron. Unfortunately this dietary iron is bound as iron-phytate and cannot be absorbed into the blood stream. An easy way to cleave or break free the dietary iron from the phytate is by just soaking the cereal or lentil overnight in water. This will leach out the phytic acid to some extent.

7.1.8 Cyanogenic Glycosides

Cyanogenic glycosides are present in a number of food plants and seeds. These glycosides occur in edible parts of plants such as Cassava or tapioca and sorghum. Cases of poisoning after a heavy meal of cassava and unripe sorghum have been reported. Only fresh peeled cassava washed in running water should be consumed and the bitter, damaged ones should be discarded. In India, the glycoside Hydrocyanic acid should be maximum 5 ppm in any article of food.

7.2 FOOD ADULTERATION

Adulteration is defined as the process by which the quality or the nature of a given substance is reduced through (I) the addition of a foreign or an inferior substance and (ii) the removal of a vital element

A good example for the first one is addition of water to milk and that for the second is removal of fat from milk.

Adulteration of food may endanger health if the physiological functions of the consumer are affected due to either addition of a deleterious substance or the removal of a vital component.

7.2.1 TYPES OF ADULTERATION

Adulteration may be intentional or unintentional. The former is a willful act on the part of the adulterator intended to increase the margin of profit. Incidental contamination is usually due to ignorance, negligence or lack of proper facilities.

a. Intentional adulteration

Intentional adulterants are sand, chips, stones, mud, powder, water, mineral oil and coaltar, dyes. These adulteration cause harmful effects on the body.

Table 7.1 gives methods of identification of adulterants in different foods.

Name of the food article	***Adulterant***	**Simple method for detection of adulterant**
Ghee or Butter	Vanaspati	Take about one teaspoonful of melted ghee or butter with equal quantity concentrated Hydrochloric Acid in a test tube and add to it a pinch of cane sugar. Shake well for one minute and test after 5 minutes. Appearance of crimson colour in lower (acidic) layer shows the presence of 'vanaspathi'. This test is specific for seasame oil which is compulsorily added to vanaspathi. Some of coaltar dyes also gives a positive test
	Mashed potatoes, sweet potato and	Add a drop of tincture of iodine. Iodine which is brownish in colour turns to blue if mashed potatoes/sweet potatoes/other starches are

	other starches	present.
Milk	Water	The lactometer reading should not ordinarily be less than 1.026.
		The presence of water can be detected by putting a drop of milk on a polished vertical surface. The drop of milk either stops or flows slowly leaving a white trail behind it; whereas milk adulterated with water fill flow immediately without leaving a mark.
	Starch	Add tincture of iodine, indication of blue colour shows that the presence of starch This test is not valid if skimmed milk or other thickening material is added..
Khoa	Starch	Add a tincture of iodine. Iodine of blue colour shows the presence of starch.
Edible oils	Argemone oil	Add concentrated nitric acid to a sample and shake carefully. Red to reddish brown colour in acid layer would indicate the presence of argemone oil.
	Mineral oil	Take two ml of edible oil and add a quantity of N/2 alcoholic potash. Heat in boiling water both for 15 minutes and add 10 ml of water. Any turbidity within 5 minutes indicates the presence of mineral oil
	Castor oil	Dissolve some oil in petroleum either in a test tube and cool in a ice salt mixture. Presence of turbidity within 5 minutes indicates the presence of oil. (This test is not for minute traces.)
Sweet meat, Ice cream, Sherbet	Metanil yellow (a non permitted coal	Extract colour with luke warm water from food article. Add few drops of conc. Hydrochloric acid. If magenta red colour develops the presence of

	tar dye)	metanil yellow is indicated.
Dals	Kesari dal	Add 50ml of dilute Hydrochloric acid to dal and keep on simmering water for about 15 minutes. The pink colour if develops indicates the presence of kesari dhal.
	Clay, stones, gravels lead chromate	Visual examination will detect these adulterants. Shake five grams of dhal with five ml of water and add few drops (yellow) of Hydrochloric Acid. A pink colour shows the presence of colour.
Hing	Soap stone (pumice stone) or other earthly matter.	Shake with water, soap stone or other early matter will settle to the bottom.
	Starch	Same test as in the case of Milk
Tea leaves	Exhausted tea or black or bengal gram dal husk with colour	tea leaves sprinkled on wet filter would immediately release added colour.
		Spread a little slaked lime on white porcelain tile or glass plate. Sprinkle a little tea dust on the lime. Red orange or other shades of colour spreading on the lime will show the presence of coal tar dye. In the case of genuine tea, there will be only a slight greenish yellow colour due to chlorophyll which appears after sometime.
Saffron	Dyed tendrils of maize cob.	Genuine saffron will not break easily like artificial. Artificial saffron is prepared by soaking maize cob in sugar and colouring it with coal tar dye. The colour dissolves in water if artificially coloured. A bit of pure saffron when allowed to dissolve in water will continue to give its saffron colour so long as it lasts.

Wheat, bajra and other food grains	Ergot (fungus containing a poisonous substance)	Purple black longer size grains in bajra show the presence of ergots.
		Put some grains in a glass containing 20% salt solution. Ergot floats over the surface while sound grains settle down.
	Dhatura-seeds	Dhatura seeds resemble chillies seeds with blacklish brown colour which can be separated out by close examination.
Sugar	Chalk powder	Dissolve in a glass of water, chalk will settle down at the bottom.
Black pepper	Dried seeds of papaya fruit	Papaya seeds can be separated out from pepper as they are shrunken, oval in shape and greenish brown or brownish black in colour. The suspected papaya seed in black pepper sample is distinguishable by its characteristics repulsive flavour quite distinct from the bite of black pepper.
	Light berries	Light berries float on spirit
Silver leaves	Aluminium leaves	On ignition genuine silver leaves burn away completely, leaving glistening white spherical ball of the same mass whereas aluminium leaves are reduced to ashes of dark grey blackish colour. The silver foil is very thin and if crushed between two fingers, crumbles to powder. Aluminium foil is comparatively thicker and only breaks to small shreds when passed similarly.
Turmeric	Coloured saw dust metanil yellow	Take a teaspoon full of turmeric powder in a test tube. Add a few drops of conc. Hydrochloric Acid. Instant appearance of violet colour which disappears on dilution with water. If the colour

		persists metanil yellow (an artificial dye) non permitted coal tar dye is indicated.
		This test is only for metanil yellow
Chilli powder	Stones	Any grittiness that may be felt on tapping the sediment at the bottom of glass confirms the presence of brick powder or sand. Smooth white residue at the bottom indicates the presence of soapstone.
Jaggery Powder	Chalk powder	Add few drops of HCl. Effervescence indicates adulteration. Stir a spoonful sample of sugar in a glass of water. The chalk settles down.
Cloves	Volatile oil extracted cloves	Exhausted cloves can be identified by its small size and shrunken appearance. The characteristics pungent taste of genuine cloves is less pronounced in exhausted cloves.
Rawa	Iron filling	By moving a magnet through it,iron fillings can be separated.
Rice	Marble or other stones	A simple test is to place a small quantity of rice on the palm of the hand and gradually immerse the same in water. The stone chips will sink
Wheat flour (maida)	Atta from which maida suji has been extracted	When dough is prepared from resultant wheat flour, more water has to be used and chapaties prepared out of this blow out. The normal taste of chapaties prepared out of this blow out wheat is some what sweetish whereas those prepared out of adulterated wheat flour will taste insipid.
Common salt	White powdered stone, chalk	Stir a spoonful of simple salt in a glass of water. The presence of chalk will make the solution white and other insoluble impurities will settle down.

Mustard seeds	Argemone Seeds	Mustard seeds have smooth surface. The argemone seeds have grainy and rough surface and are blacker hence can be separated out by close examination.
Honey	Molasses (sugar and water)	A cotton wick dipped in pure honey when lighted with a match stick burns. If adulterated the presence of water will not allow the honey the honey to burn. If it does it will produce a cracking sound.
Supari	Colour and sachharin	Colour dissolves in water. Saccharin gives excessive and lingering sweet taste.
Pulses (green peas)	Colour dye stuffs and dals	Sample is kept immersed in water for about half an hour and stirred. Colour separation indicates adulteration.
Cinnamon	Cassia bark	Cinnamon barks are very thin. Cassia barks are thick and stiff, Cinnamon barks can be rolled
Coffee	Chicory	Gently sprinkle the coffee powder sample on the surface of water in a glass. The coffee floats over the water but chicory begins to sink down within a few seconds. The falling behind them a trail of colour due to large amount of caramel they contain.
	Tamarind or date-seed powder	Sprinkle the suspected coffee powder on white blotting paper and spray over 1% sodium carbonate solution. Tamarind and date-seed powder will, If present, stain blotting paper red.

b. Contamination of foods with harmful microorganisms

Raw foods such as meat, fish, milk and vegetables grown on sewage are likely to be contaminated with harmful microorganism. These are generally destroyed

during cooking or processing of food. Some of the microorganisms may survive due to inadequate heat processing. Further, some of the foods, if consumed in the raw state, may cause food poisoning. Recent studies have shown that food grains, legumes and oil seeds when stored in humid atmosphere are infected by pathogenic fungus which can cause serious illness. The pathogenic microorganisms commonly contaminating foods and responsible for causing serious illness are listed in the Table 7.2

Table7.2 : Food borne diseases caused by some pathogenic organism

Pathogenic organisms	**Food commonly involved**	**Ill effects and diseases**
BACTERIAL *Bacillus cereus*	Cereal products	Nausea, vomiting, abdominal pain
Clostridium botulinum toxins	Defectively processed meat and fish.	Botulism (muscular) paralysis, death due to respiratory failure.
Clostridium perfringens (welchii)	Defectively processed precooked meat.	Nausea, abdominal pain and diarrhoea.
Salmonella	Defectively processed meat, fish and egg products, raw vegetables grown on sewage	Salmonellosis (vomiting diarrhoea and fever)
Shigella sonnei	Foods kept exposed or sale in unhygienic surroundings.	Bacillary dysentery.
Staphylococcus aureus	Foods kept exposed or sale in unhygienic surroundings	Increased salivation, vomiting abdominal pain and diarrhoea.
Streptococcus pyogenes	Foods kept exposed or sale in unhygienic surroundings.	Scarlet fever, septic sore throat.
FUNGAL *Aspergillus flavus (aflatoxin)*	Corn and groundnut	Liver damage and cancer.
Claviceps purpurea (Ergot)	Rye and pearl millet infested	Ergotism (burning sensation

	with ergot.	in extremities peripheral gangrene.
Fusarium sporotrichlordies	Cereals and millets infected with fusarium	Alimentary toxic aleukia.
Penicillium islandicum	Rice	Liver damage
PARASITIC *Trichinella spiralis*	Pork and pork products	Nausea, vomiting, diarrhoea, colic and muscular pains (trichhionosis)
Ascaris lumbricoides	Raw vegetables grown on sewage farms	Ascariasis
Entamoeba histolytica	Raw vegetables grown on sewage farms	Amoebic dysentery.
Ancylostoma duodenale (hookworm)	Raw vegetables grown on sewage farms	Epigastric pain, loss of blood, anaemia.

C. METALLIC CONTAMINANTS

If metals like arsenic, lead or mercury get accumulated in the body they can be harmful. For e.g.

Lead is a toxic element and contamination of food with lead can cause toxic symptoms. Turmeric is coated by illiterate manufacture in India with lead chromate. Lead brings about pathological changes in the Kidneys, liver and arteries. The common signs of lead poisoning are nausea, abdominal pain, anaemia, insomnia, muscular paralysis and brain damage. Fish caught from water contaminated with mercuric salts contain large amounts of mercury. The organic mercury compound methyl or dimethyl is the most toxic. The toxic effects of methyl mercury are neurological. When the brain is affected, the subject becomes blind, deaf and paralysis of the various muscles make him cripple. The other elements which are toxic in small doses are cadmium, arsenic, antimony and cobalt.

Table 7.3 Toxic of some metals and chemicals

Name	**Food commonly involved**	**Toxic effects**
Arsenic	Fruits sprayed by lead arsenate, drinking water.	Dizziness, chills, cramps paralysis leading to death
Barium	Foods contaminated by rat poison (barium carbonate)	Violent peristalsis, muscular twitching and convulsions.
Cadmium	Fruit juices and soft drinks, that come in contact with cadium and plated vessels, crabs, oysters and kidneys	Excessive salivation, liver, kidney damage, prostrate cancer, multiple, fractures (painful ltai-ltai'disease reported from Japan due to cadium poisoning.)
Cobalt	Water, beer	Cardiac failure
Copper	Acid foods in contact with tarnished copper ware.	Vomiting, diarrhoea, abdominal pain.
Lead	Some processed foods. Lead water pipes.	Paralysis, brain damage
Mercury	Mercury fungicide treated seed grains or mercury contaminated fish particularly pike, tuna and shell fish	Paralysis, brain damage and blindness
Tin	Canned food	Colic, vomiting, photophobia
Zinc	Food stored in galvanised iron wire.	Dizziness, vomiting
Pesticides	All type of foods	Acute or chronic poisoning causing damage to liver, kidney brain and nerves leading to death.
Diethyl stilbestrol	Present in meat of stibestrol	Teratogenesis carcinogenesis

	fed animals and birds.	
Antiboitics	Meat from animals fed antibiotics	Drug resistance, hardening of arteries heart diseases.

d. Incidental Adulterants

Incidental adulterants are pesticides residue, tin from can, dropping of rodents, larvae in food. Metallic contamination with arsenic, lead, mercury can also occur incidentally.

The *Argemone mexicana* is frequently found growing in brassica fields and if proper care is not taken during cultivation its seeds get mixed with those of bacteria and the oil expressed contains argemone oil. Its presence in edible mustard oil is injurious and outbreaks dropsy are probably due to it.

Wood smoke which contains chlorodioxins is toxic and contaminate the food coming in contact with the smoke.

Pests such as rodents and insects introduce into the food high degree of filth in the form of excreta, bodily secretions and spoilage microorganisms. Effective means of food quality can be achieved by Good Hygienic Practices (GHP),and Good Manufacturing Practices (GMP).

The most common incidental adulterants are pesticides, DDT and malathion residue may be present on the plant product much more than what is considered as safe. The maximum permissible residue allowed for DDT, malathion is 3 ppm and for pyrethrum it is 10ppm.

Chemicals like DDT are absorbed by the small intenstine when ingested. These then adhere to the fatty tissues- the toxins usually pile up in the fatty tissues of such vital organs as the throid. Heart, kidney, liver, mammary gland and testes and damage these organs. They can be transferred from the umbilical cord blood to the growing foetus and through breast milk. They could affect the

health of young children adversely. This incidental poisoning can be prevented by :

- Regular market surveys to warn people of dangerous build-up of toxicans in food.
- Stepping up the integrated pest management programme to use pesticides judiciously.No spraying should be done before the harvest.
- Taking up on a war footing, the control of pests using their natural predators.
- Using safer pesticides like synthetic pyrethroids or malathion.
- By washing vegetables and fruits thoroughly before cooking.

e. Packaging hazards

Polythylene, polyvinyl chloride and allied compounds are used to produce flexible packaging material. While this method of packaging is very convenient, it must not contain any noxious thermal breakdown products which can be injurious to health. Further, temperatures used for heat sealing, or sterilisation should not result on formation of toxic residues. It has been observed sometimes that in foods like pickels the acid and oil could attack the plastic packaging material and create a health hazard. To avoid such incidences, it is essential that only food grade plastic packaging materials be used for packaging foods.

F. NEW ADULTERANTS

The newer adulterants include the legumes such as imported toxic lentils marketed as local lentils, local legume like Subabul (*Lencana leucocephala)* seeds, veterinary drug residues in milk, flours made from mouldy wheat, strychnos potatorum, a forest produce in arecanut, animal fat in bakery

products and industrial contaminants like orthonitro aniline in Vanaspati and synthetic milk.

The Lathyrus sativus, Lens culinaris (lentils) and Vicia sateva are three closely related species containing unusual amino acids.

Ginger is used widely in culinary practice in India in the fresh or dry states. Dry ginger is often coated with a blue coloured dye ultramine blue to prevent insect infestation. It is an inorganic pigment used as laundry whitener. In USA and Canada its use is restricted to addition in salt meant for animal consumption.