

Chapter 10: Food Safety Risk by Food Categories

- **Food categorization**
- **Dairy Products and Analogues**
- **Cereals, Pulses, Millets and their products**
- **Fruits and Vegetables**
- **Spices and Condiments**
- **Edible Oils and Fats**
- **Meat, Poultry, Fish and Eggs**
- **Other food products**
 - *Organic foods*
 - *Irradiated foods*

Chapter 10: Food Safety Risk by Food Categories

Food is essential for human existence. It provides energy and other resources for normal human physiological functions. Food availability at affordable prices is an important parameter of food security. Besides availability, food should also be free from potential health risks. It is therefore implied that to qualify as food, it should be safe and wholesome for human consumption. Thus, food security and food safety go hand in hand. As per the Food Safety and Standards Act, 2006 “Food” means any substance, whether processed, partially processed or unprocessed, which is intended for human consumption and includes primary food, or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum, and any substance, including water which is added to the food during its manufacture, preparation or treatment but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants prior to harvesting, drugs and medicinal products, cosmetics, narcotic or psychotropic substances. “Food safety” means assurance that food is acceptable for human consumption according to its intended use. Since there are a number of food commodities, foods have been categorized into food categories, and subcategories for easy identification and regulatory compliance.

Food categorisation

Foods have been categorized into 16 major categories by Codex. These categories have been further divided into subcategories comprising of similar products. This categorization allows easy implementation and enforcement of standards by regulatory bodies. For example, certain food additives and processing aids may be allowed to be used in some foods to achieve certain desired technological functions. Major food categories are listed below.

1. Dairy products and analogues: This category includes all types of dairy products that are derived from the milk of healthy milch animal(s).
2. Fats and oils, and fat emulsions: Includes all fat-based products that are derived from vegetable, animal or marine sources, or their mixtures.
3. Edible ices, including sherbet and sorbet: This category includes water-based frozen desserts, confections and novelties, such as fruit sorbet, and flavoured ice.
4. Fruits and vegetables (including mushrooms and fungi, roots and tubers, pulses and legumes, and aloe vera), seaweeds, and nuts and seeds.
5. Confectionery: Includes all cocoa and chocolate products, other confectionery products that may or may not contain cocoa, chewing gum, and decorations and icings, or foods produced solely with any combination of foods conforming to these sub-categories.
6. Cereals and cereal products derived from cereal grains, roots and tubers, pulses, legumes and pith or soft core of palm tree: Includes unprocessed and various processed forms of cereal and cereal-based products.
7. Bakery wares: Includes categories for bread and ordinary bakery wares and for sweet, salty and savoury fine bakery wares.

8. Meat and meat products, including poultry: This category includes all types of meat and poultry products, in pieces and cuts or comminutes fresh and processed.
9. Fish and fish products, including molluscs, crustaceans, and echinoderms: This broad category is divided into categories for fresh fish and various processed fish products. This category includes aquatic vertebrates (e.g. fish) and aquatic invertebrates (e.g. jellyfish), as well as molluscs (e.g. clams, snails), crustaceans (e.g. shrimp, crab, lobster), and echinoderms (e.g. sea urchins, sea cucumbers).
10. Eggs and egg products: Includes fresh in-shell eggs, products that may substitute for fresh eggs and other egg products.
11. Sweeteners, including honey: Includes all standardized sugars, non-standardized products, and natural sweeteners.
12. Salts, spices, soups, sauces, salads, protein products: This is a broad category that includes substances added to food to enhance its aroma and taste including salt and salt substitutes; herbs, spices, seasonings and condiments, certain prepared foods like soups and broths; sauces and like products; and salads and sandwich spreads, and products derived from soybeans.
13. Foodstuffs intended for particular nutritional uses: Includes Infant formulae, follow-up formulae, and formulae for special medical purposes for infants, complementary foods for infants and young children, dietetic foods and food supplements.
14. Beverages, excluding dairy products: Includes all types of non-alcoholic and alcoholic beverages.
15. Ready-to-eat savouries: Includes all types of savoury snack foods.
16. Prepared foods: These foods are not included in the other food categories (1-15) and shall be considered on a case-by case basis. Prepared foods are mixtures of multiple components (e.g. meat, sauce, grain, cheese, vegetables); the components are included in other food categories.

Each type of food is associated with different hazards according to the nature of the food, storage and processing conditions. Thus, it is important to understand what can be done to protect different kinds of foods from becoming unsafe. This chapter describes the hazards that may be found in some of the food categories, measures to keep the foods safe and pointers for selection of safe and quality food products.

Dairy products and analogues

Milk is an extensively consumed food product in the diet of humans of all age groups. Milk provides almost all the essential nutrients required by the body for its growth, development and maintenance of healthy bones especially for children, women and the elderly. These include protein, carbohydrate, fats, vitamins and minerals. India is the largest producer of milk in the world.

However, milk and milk products are perishable and hence tend to spoil fast if appropriate storage temperatures are not maintained. They are also at a high risk for adulteration being

expensive commodities which are in high demand. Let us learn how milk can become unsafe for consumption.

Spoilage and Contamination

Milk being an excellent growth medium for many microorganisms is regarded a high-risk food product and is a highly perishable commodity. Spoiled products may cause food poisoning and/or adverse health effects on unsuspecting consumers. The contamination may occur in milk at the farm level, during manufacture of products or during transit.

Milk contains few bacteria during secretion from the udder of the healthy animals. During milking, milk may get contaminated by the exterior of the udder. There are chances of contamination from the milk contact surfaces such as dairy utensils, milk pails and milking machines. Milk can also get contaminated by the hands of dairy workers and surrounding environment. Hence, immense care needs to be taken on farm while milking animals.

Approximately, 64 per cent of the milk is sold by the unorganized sector in loose form by local farmers or traditional milk suppliers who are unaware about the regulatory requirements and the ill-effects of adding chemicals in milk.

Lack of good agricultural and good veterinary practices may lead to higher levels of residues of pesticides, antibiotics, hormones, heavy metal contaminants and mycotoxins in milk. Poor handling and storage of milk also increase the risk of pathogens in milk. Milk has a long and complex supply chain which involves collection of milk from dairy farmers, collection in chilling centres and then transportation to milk cooperatives and dairy companies for further processing and final distribution. It is necessary to maintain the temperature of milk below 4°C to protect milk quality through the supply chain.

Adulteration of milk

A gap in demand and supply tempts vendors to adulterate milk. It may also be adulterated to increase its shelf-life. Previously, addition of water was the most common practice but now a plethora of chemical substances are being detected in milk, which have been added to increase shelf life (like formalin, hydrogen peroxide, neutralisers, etc.) or to mask the dilution (by adding starch, urea, etc. to increase density or melamine to increase nitrogen content). Addition of water to milk may seem to be just an economic offence. However, the dilution brings down the nutritional quality of the milk. Also, if unsafe water is used for dilution, it may introduce hazardous microbes. Apart from adulteration, other practices like mislabelling (wrongly labelled for instance, claiming on the label that the product is free of antibiotic residues whereas it is not), misleading (leading the people to believe that the product has certain attributes/health benefits which it actually doesn't have), counterfeiting (e.g. fat spread made with vegetable oil being sold as butter), are also prevalent.

Keeping it safe

Consumers have the right to expect that the milk they buy is safe and of the expected quality. Food Safety and Standards Authority of India (FSSAI) works to ensure that safe and good quality food products are available for consumers. FSSAI has the following approaches:

- FSSAI has established standards for the quality of milk and milk products. All food businesses need to comply with these standards in order to provide safe and quality products to the consumers.
- FSSAI has been conducting surveys based on sampling and quality analysis. A National Milk Safety and Quality Survey is conducted. Based on the survey report FSSAI takes necessary measures and identifies action areas to address the issues of quality and safety of milk in India.
- In order to cultivate and foster growth of compliance culture, FSSAI has notified Food Safety and Standards (Food Safety Auditing) Regulations, 2018, which also enables compliance of high-risk foods including milk, through private recognized auditing agencies.

Selection

- Milk and milk products (like curd, *paneer*, *khoa*, etc.) in loose or packaged form should be purchased from reliable and known sources.
- Since dairy products are stored at low temperature, milk and other dairy products should be bought at the end of grocery shopping. This will ensure that the products do not spoil, and consumers take them home in a fresh state. Dairy products stocked in stores at room temperature should not be purchased except otherwise indicated on the package label.
- Consumers should check the details on label properly such as FSSAI License, best before date/ manufacturing and packaging date, manufacturer's details etc.
- To address growing concern of micronutrient deficiencies, fortification of milk with Vitamin A and Vitamin D is encouraged. Consumers should look for +F logo on the label while purchasing milk.

Cereals, pulses, millets and their products

Cereals and pulses are important sources of carbohydrates and proteins, vitamins and minerals in the daily diet of people. Many commodities in this category are staple foods in Indian diets. Selecting good quality cereal grains, pulses, and their products in daily diet is therefore important. These foods are also susceptible to certain food hazards.

Spoilage and Contamination

The spoilage of grains mainly occurs due to moisture absorption during storage. This leads to fungal growth mainly under conditions of high temperature and humidity. Cereals are often contaminated before harvest by fungal spores which may germinate and produce mycotoxins. Signs of spoilage are:

- Musty odour and off flavour
- Presence of weevils, beetles, moths and worms
- Clumping and caking

In addition, poor agricultural practices may lead to grains being contaminated with pesticides and heavy metals. Excessive spraying of crops with pesticides or mixing pesticides with harvested grains to prevent pest damage may result in high residues which are harmful to health. Growing crops in contaminated soils close to industries or using contaminated water for irrigation could lead to build up of heavy metals in the crops.

Grain allergy

Food allergy is a condition in which certain foods trigger an abnormal immune response. The symptoms of the allergic reaction may range from mild to severe, and may include itchiness, swelling of the tongue, vomiting, diarrhea, hives, trouble breathing, or low blood pressure.

Gluten is the main protein found in wheat and certain other cereal grains including rye, barley, and triticale. Gluten causes damage to the intestines of people with celiac disease or gluten intolerant patients. Patients with celiac disease or wheat intolerance should buy foods that are labelled 'gluten- free'.

Soy allergy is one of the most common food allergies. Symptoms include stomach cramps, indigestion, diarrhea, etc. People allergic to soy should strictly avoid soy and soy products in their diet.

Keeping it safe

Grains should be stored in a cool and dry place. The drums or silos used for storage of grain and grain products should be airtight and insect proof. Grains and grain products are normally disinfested using permitted fumigants or using ionizing radiation. Before use, grains should be washed thoroughly to reduce pesticides residues and dirt and grime.

Selection

- Whole grains are healthier than the refined ones. In whole grain all three main parts bran, germ and endosperm are intact. Shelf life of some whole grains like brown rice may be less than white polished rice because of the higher fat content.

- The grain may be chewed to check the texture and flavour. Hollow, soft fibrous texture indicates poor quality.
- Sour taste or rancid flavour and odour indicate spoilage during storage.
- Grains should be free from colouring matter, molds, insects, obnoxious substances, discolouration, poisonous seeds, and foreign matter.
- Clumping in grains and grain products is an indication of insect infestation.

Fake news: Plastic Snacks

Media reported that some of the snacks made of cereals/ millets/pulses in the market were made of plastic. There were videos of snacks such as *namkeens* and potato chips being set aflame to prove the same. These are mainly made of cereals/millets/pulses (rich in starch), spices and oil. Starch and fats have a natural characteristic of burning when exposed to fire. The effect seen was not because they were made of plastic!

Fruits and Vegetables

Fruits and vegetables are called protective foods as they protect us from diseases. Therefore, it is important to consume fresh fruits and vegetables for good health. Fruits and vegetables also serve as vehicle for certain food borne contaminants and should be selected with great care.

Spoilage and Contamination

The spoilage of raw fruits and vegetables may result from physical injury, action of natural enzymes, microbial action, or a combination of factors. The presence of high humidity, and high temperature as extrinsic factors during storage of fruits and vegetables increase the chances of microbial growth and spoilage. Microbial spoilage results in significant economic loss throughout the distribution chain. Storage in contaminated containers, contact with decayed products, unhygienic handling, fruit fly infestation also aggravate spoilage. Fungal growth may be accompanied by formation of mycotoxins which cause serious health consequences. In addition, they may also be contaminated with pesticides and heavy metals due to poor agricultural practices.

Keeping it safe

Implementing Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) are important steps to reduce food safety risks:

- Fruits should be stored under low temperature and controlled humidity conditions. In large scale storage units, the storage atmosphere can be modified by decreasing

the oxygen and increasing the amount of carbon dioxide to prolong shelf life by decreasing the respiration rate.

- The outer leaves of leafy vegetables such as lettuce and cabbage should be discarded to minimize the hazards of pesticide residues as well as microbes.
- Cut fruits and vegetables should be consumed or cooked within 1-2 hours or they should be chilled or refrigerated for longer storage.
- Fruits and vegetables should be properly washed or scrubbed under running water.
- Contact surfaces such as cutting boards, dishes, utensils should also be washed with hot water and safe detergent
- Fruits and vegetables should be stored separate from raw meat, poultry, and seafood to prevent cross-contamination.
- Chopping boards and utensils used for cutting meat, poultry and seafood should not be used for cutting fruits and vegetables.
- Fruits and vegetables infected by molds should be discarded.

Selection

- For direct consumption the selected fruits and vegetables should be free of any physical damage, mold growth, necrosis or other abnormalities.
- Fruits ripened by ethylene gas should be used. Ethylene is a natural hormone produced within the fruits and does not pose any health hazard to consumers.
- Fruits and vegetables with artificial colours should be avoided. Artificial colours on fresh fruits and vegetables may be detected by rubbing water or cotton soaked in vegetable oil on the surface. If colour appears on cotton, it indicates coating of colour on produce.
- Juice of bitter bottle gourd or *lauki* contains a toxic compound called cucurbitacin. Hence it should be tasted for bitterness before juicing. Do not consume the gourd even if slightly bitter. This toxic compound is also found in bitter cucumbers.
- Fruits coated with natural waxes such as bees wax at safe levels are not harmful. Coating of fresh fruits with natural waxes is done to protect moisture loss from fruits and to increase their shelf life. However, coating with non-edible waxes can be a problem.
- Unhygienic openly stored pre-cut fruits and vegetables for direct consumption should be avoided. Choose only those which are properly stored under refrigerated or low temperature conditions.

Artificially Ripened Fruits

To avoid spoilage of fruit during transport and storage, traders generally harvest raw fruits and then artificially ripen them near the point of sale. Artificial ripening is the process by which ripening is controlled to achieve desired characteristics intended for better consumer acceptance and improving sales. It is generally done for climacteric fruits such as mango, papaya, banana, etc. to achieve faster and uniform ripening characteristics. There is no harm in consuming fruits artificially ripened with ethylene gas as it is also naturally produced by fruits during the process of ripening. However, use of calcium carbide is not permitted for ripening fruit as it can leave traces of arsenic on the fruit which can be very harmful if consumed. Its use is banned in India.

https://fssai.gov.in/upload/uploadfiles/files/Guidance_Note_Ver2_Artificial_Ripening_Fruits_03_01_2019.pdf

Spices and condiments

Spices and condiments are important components of our meals. These ingredients increase the palatability and appeal of the prepared food. Dry spices have longer shelf life than herbs and condiments. Even though these are consumed in small quantities they may carry potentially harmful contaminants.

Spoilage and Contamination

Buy spices in small quantities to prevent its spoilage due to insect infestation. Contaminants such as heavy metals, mycotoxins or pesticide residues are often detected in spices. High levels of microbial contamination in spices and herbs is also often reported. Studies suggest that poor conditions during postharvest handling, storage, and processing are responsible for this.

High value spices are common target for economic adulteration. Ground spices are often substituted with fillers, less expensive/low quality spices, flour, corn starch, sawdust etc. Sometimes toxic and potentially carcinogenic dyes are also added to older stocks to enhance their appearance and hide the presence of fillers. Some of the common adulterations in spices are:

- Addition of low-priced cassia in cinnamon
- Addition of papaya seeds in black pepper
- Use of sudan dye to enhance the appearance of low-quality chilli powder
- Addition of foreign resin in asafoetida.
- Addition of coloured gelatin fibres, maize cobs fibre and parts of flower other than the stigma and style in saffron.
- Exhausted spices mixed with fresh ones in small quantities to confuse the consumer.

Keeping it safe

Spices should be stored in cool and dry place preferably in airtight containers to prevent loss of aroma and microbial spoilage. Storing spices for long duration should be avoided at home. During long term storage, spices and condiments are prone to insect and microbial contamination. This may be controlled by using fumigants or physical processes such as irradiation on a large scale. The problem of microbial and chemical contaminants is best mitigated through the use of good agricultural practices in the field as well as post-harvest drying, processing and storage.

Selection

- While buying whole or ground spices from the market it is better to avoid spices with extra shine and bright colour as they are more likely to be adulterated.
- Do not buy spices having lump formation or unpleasant odor.
- Do not buy spices having visible mold growth or insects.
- Always read the best before date, manufacturing date, manufacturer details and other labelling claims before buying the spices.
- Always check FSSAI organic logo (Jaivik Bharat) before buying organic spices.
- Cumin seeds are sometimes adulterated with grass seeds coloured with charcoal dust by the fraudsters. Rub small amount of cumin seeds on palm and if palm turns black it indicates the adulteration with coloured grass seed.
- Cassia is often mislabelled and marketed as Cinnamon due to similarity in appearance and characteristics. Bark of cinnamon is thin and can be rolled up in multiple layers to form compact stick, whereas, cassia bark is thick and looks like hollow tube on rolling.
- Exhausted whole spices (volatile oil extracted) mainly cloves, cardamom etc. should be checked before buying. Exhausted spices are light in weight and if put in water will float while genuine spices tend to settle at the bottom.
- Do not buy powdered spices available in loose form. Sale of powdered spices in loose form is not permitted by FSSAI due to high possibility of adulteration.
- Always buy powdered spices in packaged condition from trusted brands only. Check the FSSAI license number and AGMARK logo on packed spices.

Edible Oils and Fats

Edible oils and fats are an essential part of a healthy diet and are a major source of energy. Edible oils and fats also add to the taste and palatability of the product. However, a high intake of fat is associated with increased incidence of non-communicable diseases such as obesity, diabetes, hypertension and cardiovascular diseases. It is important therefore to limit their intake and select the type of oils to be used in order to maintain good health.

Vegetable oils consist of fatty acids and other minor constituents like pigments, fat soluble vitamins, antioxidants, sterols, free fatty acids, etc. There are three types of fatty acids: saturated, monounsaturated and poly unsaturated. A fatty acid carbon chain that possesses one or more point of unsaturation is called as unsaturated fatty acid. With one point of unsaturation, it is called a monounsaturated fatty acid (MUFA). With two or more points of unsaturation, it is called a polyunsaturated fatty acid (PUFA) which can further be categorized as Omega 3 and Omega 6 fatty acids. It is called a saturated fatty acid (SFA) when there is no point of unsaturation.

Sources of oils or fats are both plant and animal based. Milk fats such as ghee and butter are rich in SFA, whereas, plant sources (vegetable oils) are predominantly rich in MUFA and PUFA, except coconut oil and palm oil. Of all the fatty acids, omega-3 and omega-6 are considered as essential fatty acids since these cannot be synthesized in the body.

Spoilage and Contamination

The oils and fats are mostly spoiled due to rancidity. Rancid oils have characteristic unpleasant odour and flavour. The oils may go rancid due to oxidation or hydrolysis when exposed to air, light, moisture, enzymes or by bacterial action. In refined oils, spoilage due to flavour reversion is generally observed i.e. the development of objectionable flavours before the onset of rancidity when exposed to UV light, visible light or heating.

Oils and fats like *ghee* being expensive are also susceptible to adulteration with cheaper oils and fats. Unrefined oils like groundnut oil may be contaminated with Aflatoxin if fungal infested groundnuts are used for oil extraction. Mustard oil may be contaminated with Argemone oil as the Argemone plant often grows wild next to the mustard crop and their seeds are similar in appearance.

Keeping it safe

- Store in an airtight container.
- Do not store in plastic container. Store in stainless steel or glass container.
- Do not store at warm places such as near the stove etc.
- Do not reuse frying oil to avoid the formation of polar compounds and other harmful breakdown products which have detrimental effects on health. Its best to use the oil left after frying for making other preparations provided it is clear, has not got discoloured or become viscous.

Selection

It is best to buy cooking oils and fats from reliable sources. Buy only packaged oils and check all the essential details on the label viz. FSSAI license number, best before/expiry date, type of oil, etc. The packaging should be opaque to prevent light from causing oxidative damage to the oil. Consume a variety of oils, rotating them every month or using different kinds of oils and fats for preparing different dishes. This is because no one oil is perfect. Having a variety will give you all the nutritional benefits. Avoid using fats which are rich in trans fats like *vanaspati*, margarine, partially hydrogenated fats or products made from these.

Safe Use of Cooking Oil

Repeated use of cooking oil for frying should be avoided as it leads to the production of polar compounds which are harmful for health. Fresh oil should never be mixed with old used oil and stored as it can also get spoilt. Used cooking oil should be filtered before storage and used within a day or two. It can be used for preparing some other dish also. You should discard the oil if it darkens, starts foaming or becomes viscous.

Meat, Poultry, Fish and Eggs

Meat and other flesh foods are considered a good source of protein and certain vitamins. Fish is a good source of essential fatty acids. However, these foods are highly perishable. Flesh foods are also a potential source of microbial pathogens, hence, require special attention while handling.

Spoilage and Contamination

Flesh foods and eggs may be contaminated with veterinary drug residues like hormones, antibiotics, etc which were administered to the animal or bird. Contaminated feed can also transfer chemical contaminants like pesticide residues to the meat and eggs. Meat is one of the highly perishable commodities owing to its composition and high moisture content. Spoilage of meat and meat products occur due to the contaminating microorganisms (bacteria or fungi) and enzymatic activity. **Meat** spoilage may show the following signs:

- Surface slime: Growth of bacteria on the surface of the meat leads to formation of slime.
- Changes in colour of meat pigments: The red colour of meat, called its "bloom," may be changed to shades of green, brown, or grey.
- Black spots or red spots or green patches on the surface: Due to fungal growth.
- Rancidity: The oxidation of unsaturated fats leads to rancidity (off-odours and off-flavours)

- Souring: It results due to lactic acid activity and enzymatic action.
- Phosphorescence (photoluminescence): This defect is caused by phosphorescent or luminous bacteria, e.g., *Photobacterium* spp., growing on the surface of the meat. Such meat will show luminous (shining) areas on its surface.

Fish is also highly perishable and source of microbial pathogens. It may also contain naturally occurring toxicants. Many people may be allergic to fish and other seafood. Fish are also likely to be contaminated with heavy metals like mercury.

The spoilage of fish begins as soon as fish dies, which results in the undesirable change in the colour, texture, flavour, odour, and appearance. Spoilage of fish is also referred to as “putrefaction”. In raw fish, spoilage takes place mainly due to three reasons mentioned below:

- Enzymatic (autolytic) action: This results in flavor changes in fish, belly bursting and color changes in the fish (Black /blue discoloration, yellowing of fish flesh, brown discoloration),
- Microbial action: Bacteria are present on the skin, gills and intestine of fish. In dead fish bacteria begin to invade the tissues causing spoilage and production of undesirable compounds. This may result in the foul smell due to the formation of ammonia, trimethylamine and indole production. Microbial spoilage of fish also produces the toxin, histamine in certain fishes.
- Chemical action (oxidation of fats): Fat oxidation (breakdown of fat) gives rise to rancidity such as rancid flavour and odor as well as discoloration.

Specific fish hazards

- Biotoxins: Biotoxins get accumulated in fish/shellfish which include brevetoxins, okadaic acid, saxitoxins, ciguatera toxin and domoic acid.
- Allergens: Hypersensitivity to an allergen present in fish can happen, which may result in an overreaction of the immune system and lead to severe physical symptoms.
- Mercury and other toxic metals: Fish products have been shown to contain varying amounts of toxic metals. Organometallic forms such as dimethyl mercury and tetraethyl lead can be extremely toxic.

Persistent organic pollutants: **If fish and shellfish inhabit polluted waters, they can accumulate toxic chemicals, particularly fat-soluble pollutants containing chlorine or bromine, dioxins.**

Parasites: Parasites in fish are a natural occurrence and common. Though not a health concern in thoroughly cooked fish, parasites are a concern when consumers eat raw or lightly preserved fish.

Formalin: Formaldehyde is naturally present in fishes. Formalin (formaldehyde in water) is also a common adulterant used in fish by the traders and suppliers to extend the storage life of fresh or chilled fish and artificially improve the sensory attributes. Ingesting large amounts of formaldehyde can cause health problems like abdominal pain, vomiting, coma, and renal injury.

Freshly laid **eggs** are sterile. Shells soon become contaminated by faecal matter of hen, cage or nest, water used for cleaning and washing of eggs, handling and packaging materials. In general, more spoilage is caused by bacteria than molds. Three main types of spoilage are green rot, colourless rot and black rot. The other two types of spoilage are pink rot and red rot.

Types of Bacterial Spoilage in Eggs

- Green rot is caused by *Pseudomonas fluorescens*
- Colourless rot is caused by *Pseudomonas*, *Acinetobacter* and *Alcaligenes*.
- Black rot is most commonly caused by *Proteus sp.* *Pseudomonas* and *Aeromonas* can also cause black rot.
- Pink rot is caused less often by strains of *Pseudomonas*.
- Red rot caused by *Serratia* occurs quite rarely

Molds that cause spoilage of eggs include species of *Penicillium*, *Cladosporium*, *Sporotrichum*, *Mucor*, *Alternaria* and *Botrytis*.

Development of off-flavours or mustiness may be caused in eggs by bacteria. The growth of *Streptomyces* near the egg may produce earthy or musty flavours that are absorbed by the egg. A hay odour is caused by *Enterobacter cloacae*. Fishy flavours are produced by certain strains of *E. coli*.

Keeping it safe

Following steps should be adopted while handling flesh foods and their products to keep them safe:

- Wash hands and surfaces often.
- Fish should be thoroughly washed with running tap water to remove the formaldehyde present in the fish, especially marine fish.
- Don't cross-contaminate. Keep raw and cooked meat separately. Store meat in sealed, moisture proof carry bags to avoid any contamination or dripping into other foods. Wrap the cooked meat tightly while storing.

- Cook to the right temperature. In general, all flesh foods should be cooked to achieve minimum core temperature of 75 °C or higher.
- Store at right temperature. Meat must be stored in a chiller (4 °C) for short term storage (up to 4 days) or in the freezer (-18 °C or lower) if it needs to be stored longer. To avoid any health risk, the chilled meat shall be consumed within 2 to 4 days and the frozen meat shall be consumed within 10 -12 months.
- Fish may be chilled in refrigerator (4 °C) or may be covered with layers of ice for short term storage or in the freezer (-18 °C or lower) if it needs to be stored longer.
- Wet or dry salting can be done to increase its shelf life.
- The fish or fish product can be dehydrated to improve its storage life.
- Frozen products should be thawed slowly, in the refrigerator.
- Always wash hands thoroughly with soap and water after handling flesh foods and even eggs.
- Take out only as many eggs as needed for immediate use. Do not stack egg (trays) near the grill or stove.
- Use only clean, uncracked eggs.
- Avoid washing eggs. However, in case of dirty/soiled eggs, it is advised to clean it using a piece of sandpaper.
- Never mix the shell with internal contents of the egg.
- Do not reuse a container (blender, bowl and mixer) after using raw egg in it. Clean and sanitize the container thoroughly before using again.
- Never leave egg dishes at room temperature for more than one hour (including preparation and service time).
- Refrigeration keeps eggs fresh for longer duration as compared to room temperature, and also minimises the risk of any bacterial growth.
- Store eggs away from foods with strong odours (such as fish, cabbage or onions).
- Rotate egg use – Follow the First in/First out (FIFO) principle.
- Good veterinary practices will prevent contamination of flesh foods and eggs with drug residues.
- Control of quality of feed given to animals will help in ensuring that other contaminants like residues of pesticides are not transferred to the flesh foods and eggs.

Selection

The following points should be taken into consideration while selecting any **meat or poultry products** for consumption:

- Meat should have a uniform colour throughout the cut and should have no slime formation on the surface. Avoid meat that has discolouration
- Meat should have a normal smell. Any rancid or strange smelling meat should be avoided
- Always make sure the meat is firm to the touch. It can be tested by poking it. Meat that doesn't come back to the original shape or is too tight to poke should be avoided.
- Do not procure meat from places having unhygienic conditions
- Avoid buying meat from retail shops who hang the carcasses in open. Prefer to buy packaged and chilled/ frozen meat
- Never buy meat that is wrapped in newspaper or coloured plastic bags
- For packaged meat or poultry products, always closely examine the labelling with respect to its ingredients, use by date or expiry date
- Do not select meat or poultry in packaging that is torn or leaking

Following parameters of **fish** should be examined while selecting it for human consumption:

- Clear eyes: The eyes of the fish should be crystal-clear, plump, wet, and shiny, with no sunken features. Once the fish begins to deteriorate, the eyes dry out, become cloudy, and sink in or shrivel away.
- Healthy tail and fins: The tail and dorsal fins of the fish should be healthy-looking, wet, and intact. A fish that has been mishandled will have torn or ragged fins, while an older fish's fins will be dry and brittle.
- Firmness: It can be done by poking the fish. Fish that has lost its firm shape is no longer fresh.
- Colour of gills: The brighter the colour, the fresher the fish. When first caught, a fish's gills appear bright red, and slowly darken over time becoming dark brown or even black in colour. The gills will become slimy and sticky if spoiled.
- Touch the scales: The scales should be shiny and firm. Less-fresh/spoiled fish will often shed scales when touched, and they may appear dry and flaky.

- Look for cracks and breaks in fillets: Look for cracks in the fillet that run between the muscles and collagen sheath (the white lines running through the fish). Breaks in the muscle itself tend to indicate mishandling. Natural separation of the muscles along the collagen sheaths indicates that the fish is not very fresh.
- Fish flesh: For white fish, such as cod or halibut, the meat should look fairly translucent. If it is very opaque and extremely white, it's a sign that the flesh is not fresh. For darker meat, like tuna or salmon, the flesh should be bright and very saturated in color. For all fish, make sure the flesh is wet and glossy. Fish that is sticky, dry, or chalky has likely been handled improperly (held at warm temperatures), frozen and thawed several times, or is old.
- Packaged fish or fish products: Always closely examine the labelling with respect to its ingredients, use by date or expiry date (whichever is mentioned) and the quality of packaging material.

The following points should be considered while selecting the **eggs**:

- Visual inspection (exterior): While the egg is in shell, check that the shell is not cracked, slimy or powdery. Sliminess or cracks can indicate the presence of bacteria, while a powdery appearance on the shell may indicate mold.
- Visual inspection (interior): Fresh eggs will have milky or clear whites and a bright yellow or orange yolk. If the egg is rotten, the whites will be thin and watery or may look pink and the yolk will flatten out.
- Smell: Uncooked fresh eggs should have a neutral odour and should not smell sulphuric or sour. If the egg smells bad before or after you crack it, it is rotten.
- Read the use-by date on the carton. Eggs can usually last up to 3 weeks if stored in the refrigerator. The use by date on the carton is usually a good indication of whether the eggs are still fresh.
- Perform float test: If the egg sinks to the bottom, it is still fresh. If the egg sinks but stands upright on the bottom of the container, the egg is slightly old. If the egg floats in water, it should be avoided as such eggs might be stale or rotten.

Myth Buster: Plastic Eggs

Plastic eggs or artificial eggs are a myth mainly because there is no technology available to manufacture an egg which perfectly resembles the natural egg. Eggs stored at high storage temperatures tend to spoil faster with the whites becoming watery and the membrane around the yolk rupturing resulting in mixing of the egg yolk and white. Depending on the variety of hen and also freshness of the egg, the egg membrane may sometimes be thick also. It is best to store eggs in a refrigerator and consume within a few days.

<https://fssai.gov.in/upload/uploadfiles/files/Guidance Note Plastic Eggs 08 08 2018.pdf>

Other Products

Organic Foods

Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for organic foods. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM).

Consumers are interested in buying foods which are free from pesticides and other contaminants. The country's organic food market is transforming into the world's fastest growing segment. Consumer's decision to buy organic foods is typically affected by the variables such as price, health consciousness, certification and labeling, availability, and environmental concerns.

Organic foods are produced from various crops in accordance with the organic production standards where the commodities are grown under a system of agriculture without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach and processed as per the prescribed standards.

Selection of organic products and regulatory mechanism

To ensure consumer's trust, there is need of establishing genuineness and authenticity of foods claimed as 'Organic'. To ensure this, a regulatory mechanism backed by a robust certification system is required.

Section 22 of the Food Safety and Standards Act, 2006 (FSS Act, 2006) gives mandate to Food Safety and Standards Authority of India to regulate manufacture, distribute, sell or import organic foods. Food Safety and Standards (Organic Foods) Regulations, 2017 have been notified.

The organic foods should comply with provisions of any one of the following certification system:

- National Programme for Organic Production (NPOP) notified by Directorate General of Foreign Trade (DGFT) under the Foreign Trade (Development & Regulations) Act, 1992. It is a quality assurance initiative by the Government of India under the Ministry of Commerce and Industry. The NPOP not only provides the institutional framework for accreditation of certification agencies and operationalization of certification programme through its accredited certification agencies but also ensures that the system effectively works and is monitored on regular basis.
- Participatory Guarantee System for India (PGS-India) implemented by Department of Agriculture, Cooperation and Farmer's Welfare through National Centre of Organic Farming (NCOF)- PGS-India certify producers based on active

participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange. People in similar situations (small holder producers) assess, inspect and verify the production practices of each other and take decision on organic certification. National Advisory Committee is the apex policy making body for PGS India Programme and National Centre of Organic Farming is the Secretariat of the PGS programme.

Organic food needs to comply with the requirements of Food Safety and Standards (Labelling) regulations in addition to that of NPOP or PGS-India. Additionally, organic food products shall carry Food Safety and Standard Authority of India's organic logo and may carry certification or quality assurance mark of NPOP/PGS-India.

Traceability should be established through one of the above mentioned systems. Both NPOP and PGS-India have well established traceability system for products.

Sales by small original producer or producer organisation directly to the end consumer are exempted from provisions of any of the above mentioned two systems.

All organic food need to comply with the requirements of product standards as provided in the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011 Regulations and contaminants, toxins as provided in the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011 except for residues of insecticides for which the maximum limits shall be 5% of the maximum limits prescribed or Level of Quantification (LoQ) whichever is higher.

Organic food imports under bilateral or multilateral agreements on the basis of equivalence of standards between NPOP and the organic standards of the respective exporting countries shall not be required to be re-certified on import to India. India had equivalence agreements with EU, Switzerland and with USA for conformity assessment (as per information available till December 2019).



Consumers are reluctant to buy organic food from the market because they are not sure about its genuineness. FSSAI's 'Jaivik Bharat Logo' enables consumers to distinguish organic foods as authentic organic foods available on the shelves. Additionally, FSSAI has also developed "Indian Organic Integrity Database Portal" which is a repository of Organic Food Business Operators certified under NPOP and PGS-India. This would help consumers verify the authenticity of organic foods. Through this portal, consumers can access all information with respect to the producer, the certification system and the availability of certified organic products in specific markets.

Irradiated Foods

Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for irradiated foods. Radiation processing of food or food irradiation is a physical process in which food commodities, bulk or pre-packaged are exposed to controlled doses of energy of ionizing radiation such as gamma rays or X-rays to achieve different technological objectives. These technological objectives include extension of shelf life, destruction of storage and quarantine insect pests, and killing of parasites, pathogens and spoilage microorganism. Radiation processing can thus be used for enhancing food safety, food security and international trade.

Salient features of the technology

Radiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation.

- Ionizing radiations are short wavelength radiations of the electromagnetic spectrum. X-rays and gamma rays are examples of ionizing radiations.
- Radiation processing of food is carried out inside a radiation shielded chamber. Food either pre-packed or in bulk placed in suitable containers is sent into it with the help of an automatic conveyor.
- The absorbed dose is determined by the residence time of the carrier or tote box in irradiation position. Absorbed dose is checked by placing dosimeters at various positions in a tote box or carrier.
- Advantage of radiation processing of food is that it does not leave any harmful toxic residues in food and is more effective.
- The irradiation process does not make the food radioactive, the food itself never comes in contact with the radioactive material.
- Extensive scientific studies have shown that irradiation has a very little effect on the main nutrients in food. Very little change in vitamin content is observed in food exposed to low doses.

Safety and wholesomeness of irradiated foods

Foods processed by radiation have been subjected to a thorough assessment of safety in national and international laboratories. These studies show that food irradiation presented no toxicological, nutritional or microbiological problems. The food products that can be irradiated are:

- Fresh fruits and vegetables including bulbs, stem and root tubers and rhizomes
- Cereals and their milled products, pulses and their milled products, nuts, oil seeds, dried fruits and their products
- Fish, aquaculture, seafood and their products (fresh or frozen) and crustaceans
- Meat and meat products including poultry (fresh and frozen) and eggs
- Dry vegetables, seasonings, spices, condiments, dry herbs and their products, tea, coffee, cocoa and plant products
- Dried foods of animal origin and their products
- Ethnic foods, military rations, space foods, ready to eat, ready to cook/minimally processed foods
- Food additives
- Health foods, dietary supplements and nutraceuticals

How safe are Irradiated Foods?

Food irradiation is a physical process in which food is exposed to controlled doses of ionizing radiation (gamma rays or X rays) to extend the shelf life of food. The radiation destroys pests and microbes without harming the food constituents. No harmful effects on human health have been reported.

https://fssai.gov.in/upload/uploadfiles/files/Guidance_Note_Irradiated_Food_Safe_24_12_201

Regulatory framework

Regulations on radiation processing have been notified under the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011, as per these Regulations, all packages of radiation processed food shall bear the Radura logo in green colour and following declaration, namely:

PROCESSED BY RADIATION



Name of the Product:

Purpose of Radiation Processing:

Operating License No.:

Batch Identification No. (BIN) (as provided by facility):

Date of Processing:

Table 10. 1: Some hazards associated with different food categories

Food	Physical hazard	Chemical hazards	Biological/Microbiological hazards
Dairy products	Glass, chipped pieces from equipment, metal shavings from cans and foils, plastic pieces, lint and threads, hair, finger nails	Detergents, sanitizers and disinfectants, urea, hydrogen peroxide, other preservatives, neutralizers, pesticides, antibiotic and veterinary drug residue, hormones, metal contaminants, residues from packaging materials	Mycotoxins (Aflatoxin), <i>Salmonella</i> , <i>Escherichia coli</i> , <i>Listeria monocytogenes</i> , <i>Staphylococcus aureus</i> , <i>Yersinia enterocolitica</i> , <i>Bacillus cereus</i> , <i>Clostridium botulinum</i> , <i>Mycobacterium bovis</i> , <i>Brucella abortus</i> , <i>Brucella melitensis</i>
Cereals and pulses	glass, nail chipping, hair, stones, grit, dirt, pest droppings, metal pieces plant parts, debris, weeds, seeds	Pesticide residues, metal contaminants, naturally occurring toxic substances (<i>Lathyrus</i> or Khesari dal with neurotoxin BOAA -beta-oxalyl aminoalanine; Trypsin inhibitors, Haemagglutinins, Cyanogenic glycosides), metal contaminants	Mycotoxins (Aflatoxin) <i>Bacillus cereus</i>
Fruits & Vegetables	Dirt, weeds	Pesticide residues, heavy metals, naturally occurring toxic substances (cucurbitacins, goitrogens, solanine, etc.)	Insect larvae, mycotoxins <i>Escherichia coli</i> O157:H7, <i>Salmonella</i> spp., <i>Listeria monocytogenes</i> .
Spices and condiments	Dirt, weeds, foreign seeds, straw	Pesticide residues, heavy metals, artificial colors	Mycotoxins, <i>Salmonella</i> spp.

Food	Physical hazard	Chemical hazards	Biological/Microbiological hazards
Meat	Dirt, shards of bone	Pesticide residues, heavy metals, naturally occurring toxic substances, veterinary drug residues	<i>Salmonella, Campylobacter, Listeria, E. Coli, Pseudomonas spp.</i>
Fish and seafoods	Dirt, microplastics, pieces of bone	heavy metals, naturally occurring toxic substances (Biotoxins: brevetoxins, okadaic acid, saxitoxins, ciguatoxin, domoic acid), veterinary drug residues	<i>Salmonella, Shigella, E. coli, S. aureus, Clostridium botulinum, Vibrio sp., Aeromonas sp.</i>
Eggs	Dirt, bird droppings	Pesticide residues, heavy metals, veterinary drug residues	<i>Salmonella, Pseudomonas, Streptococcus, Alcaligenes, Staphylococcus, Bacillus, Flavobacterium, Proteus, Serratia, Arthobacter and Micrococcus spp</i>
Fats and oils	-	Polar Compounds, adulterants like mineral oils, paraffin, argemone oil	Mycotoxins

Summary

- Foods have been categorized into 16 major categories. These categories have been further divided into subcategories comprising of similar products.
- Milk and milk products are regarded as high risk foods, highly perishable and susceptible to adulteration. In addition, they may be contaminated with pesticide residues, heavy metals and mycotoxins the source of which might be the contaminated feed given to milch animals. They may also have residues of veterinary drugs administered to the animals.
- FSSAI has established standards for the quality of milk and milk products. All food businesses need to comply with these standards in order to provide safe and quality products to the consumers.
- Cereals, pulses, millets and their products are prone to fungal and pest infestation. In addition, poor agricultural practices may lead to grains being contaminated with pesticides and heavy metals. A few people may be allergic to the wheat protein – gluten and to soyabean.

- Fruits and vegetables are highly perishable foods and spoil on keeping due to natural enzyme action or microbial action. They may also be contaminated with mycotoxins, pesticides and heavy metals due to poor agricultural practices.
- Appropriate selection, processing and cooking methods can be used to decrease the exposure to contaminants.
- Spices and condiments are susceptible to insect infestation. Contaminants such as heavy metals, microbes, mycotoxins or pesticide residues are often detected in spices. High value spices are common target for economic adulteration.
- The oils and fats are mostly spoiled due to rancidity. The oils may go rancid due to oxidation or hydrolysis when exposed to air, light, moisture, enzymes or by bacterial action. Oils and fats like *ghee* being expensive are also susceptible to adulteration with cheaper oils and fats.
- Meat, poultry, fish and eggs have a high microbial load and be contaminated with disease causing germs. They need to be handled very carefully. These may also be contaminated with veterinary drug residues or pesticide residues.
- It is important to select these foods with great care.
- Organic foods are produced without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach. Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for organic foods.
- The organic foods should comply with provisions of either National Programme for Organic Production (NPOP) or Participatory Guarantee System for India (PGS-India).
- FSSAI's 'Jaivik Bharat Logo' enables consumers to distinguish organic foods as authentic organic foods available on the shelves. Additionally, FSSAI has also developed "Indian Organic Integrity Database Portal" which is a repository of Organic Food Business Operators certified under NPOP and PGS-India.
- Radiation processing of food or food irradiation is a physical process in which food commodities, bulk or pre-packaged are exposed to controlled doses of energy of ionizing radiation such as gamma rays or X-rays to achieve different technological objectives.
- Regulations on radiation processing are notified under Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011. As per these Regulations, all packages of radiation processed food shall bear the Radura logo in green colour along with a declaration.

Key Words

Jaivik Bharat Logo – symbol to identify authentic organic foods

Irradiated food - involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation.

Organic food – foods produced without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach

Radura logo – symbol to identify food processed by radiation

Exercises

1. Briefly explain the purpose of classifying food into different categories.
2. List the different types of contaminants and adulterants which may be found in milk and milk products.
3. What points should be kept in mind while selecting the following foods:
 - a. Grains
 - b. Vegetables
 - c. Fish
 - d. Eggs
 - e. Spices
4. Describe the kinds of spoilage seen in:
 - a. Meat
 - b. Grains
 - c. Fruits
 - d. Oils
5. What are the kinds of adulterants that have been seen in spices?
6. What are the special types of hazards found in fish?
7. What are organic foods? How is their sale regulated in India?
8. Explain the technology of food irradiation in simple terms. Give examples of foods which are irradiated in India.

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