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Chapter 6: Understanding Food Hazards

‘If it is not safe, it is not food!’ Food nourishes our body and is vital for survival. If food becomes contaminated with substances that are harmful for our health, then it becomes unfit for human consumption. Such food can lead to debility, illness and even death. The public health impact of contaminated food is borne out by the facts that 1 in 10 people worldwide fell ill after consuming contaminated food in 2010 (WHO 2015). An understanding of the different types of food hazards, how they enter the food chain and how food can turn from being a source of sustenance to a health hazard is important for all. Equally important is to learn about how we can reduce our exposure to these hazards. Food allergens are another type of hazard present in foods. Severe reactions to certain ingredients in food can be fatal and hence one must be aware of foods which contain these allergens and understand how to avoid consuming them. One of the major sources of foodborne illness is contaminated water. Ensuring potable water for all is a challenge in a big country like India with a diverse geography. Sanitation has also been linked with the health status of the population as poor hygiene breeds infections and dilutes efforts being put in for providing safe and wholesome food for all.

Foodborne illness

Intake of food contaminated with microbes or chemicals can lead to illness and even death. Lack of adequate hygiene and sanitation is primarily responsible for food becoming contaminated with microbes. Chemicals may either be added intentionally to foods or may enter unintentionally because of poor agricultural or manufacturing practices. Food can become contaminated at any point during slaughtering or harvesting, processing, storage, distribution, transportation, preparation and consumption.

Extent of problem

In a report, WHO has provided the first-ever estimates of the global burden of foodborne diseases. The report presented the burden of foodborne diseases caused by 31 foodborne agents (bacteria, viruses, parasites, toxins and chemicals) at the global and regional levels. An estimated 600 million, almost 1 in 10 people in the world fell ill after eating contaminated food and 4,20,000 died in 2010. Children under 5 years of age carry 40% of the foodborne disease burden, with 1,25,000 deaths every year. Diarrhoeal disease agents were the leading cause of foodborne disease burden in most sub-regions, causing 550 million people to fall ill and 2,30,000 deaths every year (WHO, 2015). In India most foodborne illnesses go unreported. Media reports outbreaks only if a large number of people are affected and usually these reports are only from urban areas. The analysis of Integrated Disease Surveillance Programme (IDSP) data from 2011-16 shows food-borne outbreaks constituted nearly half of all reported outbreaks in India (NCDC, 2017).

Effect on health

Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, young children, elderly and the sick. Illness can result from consumption of food
which is contaminated with chemicals or microbes. Repeated episodes of illness can adversely affect the nutritional status resulting in a state of malnutrition. Malnourishment further brings down the immunity level making individuals susceptible to infections!

Food borne diseases can be of two types – food poisonings or food infections. **Food poisoning** is caused by the ingestion of toxins produced by a microbe, plant or animal or ingestion of a toxic chemical. **Food infection** is caused by the entry of a microbe into the body through ingestion of contaminated foods and the reaction of the body to them or to their metabolites. Infections are usually transmitted from person to person through the faecal-oral route. Poor personal hygiene, cross contamination from raw foods to cooked foods, touching food with bare hands, all facilitate transmission of microbes. Intoxications are more a result of inadequate cooking of foods and cooked foods being stored at room temperatures, allowing microbes to multiply and produce toxins. Intoxications can't be transmitted from person to person.

Most foodborne illnesses reported have been due to biological hazards. Microbes like bacteria, fungi, virus and protozoa have been implicated in different food borne disease outbreaks. Some are mild episodes with gastro-intestinal symptoms while others can be fatal.

A large number of chemical hazards in food could lead to illness and even death. People can be exposed to low levels of these chemicals over an extended period of time (chronic exposure) resulting in diseases like cancer, neurological disorders, etc. Acute outbreaks of chemical poisoning only occur when a large dose of the toxin has been consumed at a single time point or for a short while.

Foodborne illness outbreaks have been reported from several parts of the country for instance, when pesticides have been inadvertently used as a food ingredient during cooking. Symptoms have ranged from gastrointestinal (abdominal cramps, vomiting) to neurological resulting in death. Shellfish poisoning is another example of acute poisoning. Paralytic shellfish poisoning causes the most severe symptoms of all the shellfish poisonings. This is due to the presence of a toxin known as Saxitoxin. Within half an hour of consumption the initial symptoms of numbness and tingling in the extremities appear which soon spread to the whole body causing loss of co-ordination and inability to move, speech defects, nausea and vomiting. If the respiratory system is affected, it may lead to death. Pufferfish poisoning or blowfish poisoning is caused by Tetrodotoxin, a neurotoxin which is one of the most poisonous substances found in nature. Its consumption can result in death in as few as 20 minutes of ingestion. Mushrooms are also referred to as toadstools coming from the German word *Todesstuhl*, meaning death's stool. Symptoms of mushroom poisoning can include hallucinations, sweating and shortness of breath. Some varieties of wild mushrooms are highly poisonous and can lead to death.

**Economic cost**

Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade. The economic consequences of a food borne illness are also massive involving money spent on medical treatment, decrease in work capacity due to weakness after a food poisoning episode and loss of man hours spent away from work. Foodborne diseases resulted in a burden of 33 million DALYs (Disability Adjusted Life Years) in 2010 (WHO, 2015). According to the World
Bank (2018), food borne diseases cost India about $28 billion (Rs1,78,100 crore) or around 0.5% of the country’s gross domestic product (GDP) every year.

Food supply chains now cross multiple national borders. Rejection of food exports as a result of contamination can lead to a huge loss of business. In 2010, there were 240 rejections of agrifood products exported from India by the European Union (EU) and 1023 rejections by the US. The fish and fishery products losses were estimated at 2 million US dollars and herbs and spices losses at 1.4 million US dollars in 2010 due to rejection by the EU (UNIDO, 2015).

Thus, to reduce the economic burden, India needs to invest in ensuring robust food safety systems.

**Food hazards**

A food-borne hazard is a substance or organism which can increase the risk of illness or adverse health effects when present in a food item. These hazards can be of different types.

**Types of hazards**

Food hazards can be classified as:

- Physical
- Chemical
- Biological

**Physical hazards** include items like straw, husk, chips of stones, bone, shards of glass, iron filings, etc. anything physically present in food which can cause damage to our teeth when we bite the hard substance or irritate/damage the gastrointestinal tract in case it is a sharp object.

Some foods like tea leaves and semolina (suji) are processed in between iron rollers. As a result, small iron filings scrape off the rollers and may get mixed with these foods. Unintentionally several harmful things may find their way into our food and drink like shards of glass from the mouth of a bottle or cup/glass, bits of plastic/porcelain from chipped cutlery, bits of straw or tiny stones in grains, etc.

**Chemical hazards** as the name suggest is chemical substances which may enter food via different routes and are harmful for our health. These include residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, toxic chemicals naturally present in plants and animals, chemicals which leach out of packaging material or food contact surfaces and chemicals which get formed during cooking or processing.

If a crop has recently been sprayed with a *pesticide*, a suitable time gap should be given before the crop is harvested depending on how long it takes for the residues of the pesticides to dissipate. Pesticides even in small quantities can prove to be hazardous as our body finds it difficult to excrete them. These tend to accumulate in our bodies and have
been known to cause cancer, birth defects, liver damage, reduced sperm count, sterility, miscarriage and nerve damage.

A variety of veterinary drugs are used to raise and maintain livestock like antimicrobials to treat infections, hormones to stimulate growth or increase milk production etc. When treating livestock with any veterinary drug it is important to wait for a specified period of time till the drug residues are out of the animal’s system before milking or slaughtering the animal. Residue laden milk, meat and eggs especially antibiotic residues may result in the development of resistance to the antibiotic. Allergic reactions in sensitive people have also been reported. The food industry is also adversely affected as these residues interfere with the bacterial cultures used to make cheese, curd and other fermented products.

Metals like arsenic, antimony, aluminium, cadmium, chromium, copper, lead, mercury, nickel and tin released as untreated effluent by several industries, mines, or by volcanic eruptions, etc. into the seas and rivers or simply buried in soil can enter the food chain and lead to serious harm. Plants take up these metals from the polluted soil and water. Sea and river fish may get contaminated with the metals. Metals may also enter food from metallic cans and containers in which the food is packaged, stored or cooked. Acidic conditions in the food products may cause the surface layer of the containers to dissolve. Some of these metals, especially the heavy metals like mercury and lead can be very toxic. They can damage our vital organs like brain, liver, kidneys, etc. and seriously affect the nervous system.

A wide range of other chemical hazards can find their way into our food. Plastics are widely used in food processing equipment, utensils, and as packaging material. In their manufacture, numerous additives like plasticizers are used. In addition, the polymerization process may leave trace quantities of residual monomer or low-molecular-mass polymer in the plastic. Bisphenol A (BPA), phthalates and polychlorinated biphenyls (PCBs), used for making plastic equipment or plasticisers, coatings or lubricants, can leach out into food and water. They are very harmful for our body, affecting the action of natural hormones in the body (endocrine disruptors). They are also potentially carcinogenic (cancer causing). Dioxins are a group of chemicals which are persistent organic pollutants being formed as a by-product of industrial processes and can have a broad series of toxic effects. The production of toxic chemicals in foodstuffs through processing is a recently discovered phenomenon, for instance, formation of acrylamide, polycyclic aromatic hydrocarbons (PAH), advanced glycation end products (AGEs), heterocyclic amines, nitrosamines, etc. in food by traditional cooking methods at high temperatures such as baking, frying, grilling and roasting.

Foods also contain a wide range of natural chemical compounds which may act as toxicants or anti-nutritional factors which interfere with the way our body utilizes nutrients. The harmful effects of consuming these range from mild symptoms of gastric distress to even death. Some examples of naturally occurring toxicants are seafood toxins, biogenic amines, alkaloids and toxic amino acids. Shellfish poisoning, epidemic dropsy and lathyrism are some of the disease conditions arising out of consuming foods containing these natural toxins. Some of the chemicals which act as anti-nutritional factors are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides. They interfere with the absorption or utilization of nutrients by our body. Sometimes chemicals are intentionally added to foods for a technological purpose like to impart colour and flavour to the food, to increase the shelf life of the food or to impart desirable texture to the finished food product. These chemicals are known as food additives and these can turn
problematic when they are consumed in large quantities as some additives like preservatives and colouring agents have been associated with allergic reactions in sensitive people. The malpractice of adding inferior quality ingredients and masking their use with the help of additives is also widely prevalent in India. These inferior quality ingredients are called **adulterants**, and at times can be very toxic mostly because of the use of inedible substances.

**Biological hazards** include microbes like bacteria, viruses, fungi, protozoa and helminths which can lead to several food borne illnesses (Figure 1).

![Biological hazards present in food](https://commons.wikimedia.org/wiki/File:Ameba_002.jpg)

**Figure 6.1: Biological hazards present in food**

**Sources of images:**
http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Trichinellosis_il.htm
https://commons.wikimedia.org/wiki/File:Ameba_002.jpg
https://commons.wikimedia.org/wiki/File:Coli3.jpg
https://commons.wikimedia.org/wiki/File:Norovirus_virions_white_background_NIH_21348.jpg
https://commons.wikimedia.org/wiki/File:Schimmelmandarijn.jpg
**Bacteria** are single-celled organisms present all around us in the soil, water, dust and air as well as present in our body. Some bacteria are useful to man helping us digest food, synthesize vitamins, preventing the growth of bad microbes, and also helping in preparation of fermented products like *idli-dosa*, *dhokla*, etc. and beverages (wine, apple cider, etc.). Other bacteria however can be harmful. Consumption of food contaminated with bacteria and their toxins makes us ill. Some diseases caused by bacteria include typhoid, cholera, diphtheria, dysentery, etc.

**Mold** or **Fungi** are typically multicellular and filamentous. The mass of intertwined filaments growing on the surface of food is visible to the naked eye. Sometimes this may be coloured - green, blue-green, yellow, orange, pink, lavender, brown, gray, black, etc., the colour being used to identify the type of mold. Molds can be problematic for man and animals as some of them produce toxic substances known as **mycotoxins**. Aflatoxin, a mycotoxin, has been implicated as a cause of liver damage and cancer. Ergot alkaloids cause Ergotism, a disease with symptoms of nausea, vomiting, giddiness and sleepiness. Fumonisins have resulted in a fatal disease in horses and in humans it has been linked to cancer of the oesophagus.

**Yeast**, which are unicellular fungi, can cause spoilage of food products for instance various species of the genus *Candida* lead to spoilage of butter, margarine and foods high in acid and salt. *Torulopsis* spp. ferments lactose and may spoil milk products.

**Viruses** can only be seen with the help of powerful microscopes like electron microscopes because of their minute size. They require living cells to grow and reproduce and hence sometimes are referred to as **obligate intracellular parasites**. Viruses cause diseases not just in humans but also plants, animals and other microorganisms. When not inside a cell, viruses exist as independent particles known as virions.

Several viruses have been known to cause diseases in humans. Viruses that infect our intestinal tract are shed in extremely high numbers in the faeces of infected individuals and current sewage water treatment practices fail to ensure the complete removal of these pathogens. We are exposed to enteric viruses through various routes: shellfish grown in contaminated waters, food crops grown in land irrigated with wastewater and/or fertilized with sewage, sewage-polluted recreational waters (like swimming pools, water rides in parks) and contaminated drinking water. These viruses cause a wide variety of illnesses in man like hepatitis A, gastroenteritis and poliomyelitis.

**Worms or helminths** live like parasites in their host which can be an animal or man. Some examples of worms which can cause serious illnesses in man are round worms, tapeworms, hookworms and threadworms. Several worms can get entangled and cause intestinal obstruction, which may need to be surgically removed. Proper cooking of food can destroy the eggs of the worm. Other preventive measures involve maintaining a high standard of hygiene especially when handling food.

**Protozoa** are single-celled organisms. The most important disease-causing protozoan is an amoeba called *Entamoeba histolytica* which causes amoebic dysentery. Faecal contamination of food (especially raw vegetables) and water aids in spreading infection.

Prevention of enteric infections lies in safe disposal of human excreta and simple hygienic practices of washing hands before eating or handling food and after a visit to the toilet. Food handlers whether at home or in the commercial setting like hotels and restaurants,
should be periodically examined for enteric infections and should also be educated about basic practices of personal hygiene.

**Sources of food hazards**

Waste from our homes, offices and industries (detergents, soaps, pesticides, discarded batteries, effluent of factories, heavy metals, etc.) is disposed daily either into our rivers and seas or buried on land. Smoke from industries as well as exhaust fumes from vehicles and machinery pollute the atmosphere. These toxic chemicals present in the soil, water and air are taken in by the plants and by land and marine animals. Animals feeding on these plants accumulate these harmful chemicals and hence the meat, milk or eggs we get from these animals gets contaminated. Man being on top of the food chain consumes both contaminated plants as well as animals (Figure 2).

![Figure 6.2: How the contaminants enter the food chain](image)

**Adverse health effects**

Symptoms are usually restricted to the gastrointestinal tract – nausea, vomiting, diarrhoea and abdominal cramps, but may also become systemic if the infection/toxin travels to other parts of the body, sometimes resulting in death (Table 1). Dehydration is a cause of concern especially in small children leading to a lot of deaths.
Table 6.1: Microbes associated with different symptoms of foodborne diseases

<table>
<thead>
<tr>
<th>Symptoms/ Toxic effects</th>
<th>Microbes implicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td>Vibrio cholerae, Campylobacter spp., Bacillus cereus, Cryptosporidium spp., Entamoeba histolytica, E. coli, Giardia spp., Norovirus, Shigella spp., Salmonella spp. (non-typhoidal), Staphylococcus aureus</td>
</tr>
<tr>
<td>Enteric fever</td>
<td>Salmonella enterica Typhi and Paratyphi A</td>
</tr>
<tr>
<td>Septicemia/ sepsis</td>
<td>Listeria monocytogenes, E.coli, Staphylococcus aureus, Vibrio parahaemolyticus, Campylobacter</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Listeria monocytogenes, Salmonella spp, Enterobacter spp.</td>
</tr>
<tr>
<td>Neurological symptoms</td>
<td>Brucella spp., Toxoplasma gondi, Taenia solium</td>
</tr>
<tr>
<td>Hepatitis (inflammation in liver)</td>
<td>Hepatitis A virus</td>
</tr>
</tbody>
</table>

A large number of chemical hazards in food could lead to illness and even death. Table 2 lists some of these chemicals and the possible toxic effects that they could produce. Although short term exposure to a large dose of these chemicals could lead to severe reactions and even death, the larger public health problem lies in effects of chronic toxicity. People are exposed to low levels of these chemicals over an extended period of time resulting in diseases like cancer, neurological disorders, etc.

Table 6.2: Toxic effects of chemical hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide residues</td>
<td>Cancer, birth defects, liver damage, reduced sperm count, sterility, miscarriage and nerve damage</td>
</tr>
<tr>
<td>Veterinary drug residues</td>
<td>Resistance to the antibiotic, allergic reactions, interference with the bacterial cultures which are used to make fermented foods</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Damage vital organs like brain, liver, kidneys, etc. and seriously affect the nervous system</td>
</tr>
<tr>
<td>Chemicals leaching from containers, equipment (BPA, phthalates, PCBs)</td>
<td>Hormonal disturbances (endocrine-disruption), potentially can cause cancer, reduced mental development and suppressed immune reactions</td>
</tr>
<tr>
<td>Chemicals produced during cooking/processing (AGEs, nitrosamines, acrylamide, etc.)</td>
<td>Increased oxidative stress and inflammation, potentially carcinogenic</td>
</tr>
<tr>
<td>Dioxins</td>
<td>Some of them are known to cause cancer in humans, have also been linked to severe effects on the brain, reproductive and immune systems</td>
</tr>
<tr>
<td>Naturally occurring chemicals</td>
<td>Konzo (paralytic disease from eating cassava), Lathyris (paralytic disease from eating khesari dal), Shellfish poisoning</td>
</tr>
</tbody>
</table>
Measures to reduce exposure

Food needs monitoring right from the level of the primary producer up to the end consumer to ensure safety. This approach is referred to as the ‘farm to fork approach’. Most of the diseases are transmitted person to person by the faecal-oral route. Humans are a reservoir of infectious microbes and may be excreting millions of disease-causing bacteria and viruses. Due to improper personal hygiene practices, like not washing hands before handling food, or poor environmental sanitation like open defecation, these microbes excreted by carriers may reach others through food and water.

The principal means of prevention of outbreaks of food poisoning include prevention of contamination of the food. This is achieved by general methods of maintaining hygiene and sanitation.

At the farm level the farmer needs to follow good agricultural practices (GAP) so that food does not become contaminated with pesticides, mycotoxins and heavy metals. The dairy farmer or the animal rearer similarly needs to maintain his livestock/fish/poultry and adopt good veterinary practices (GVP) to avoid residues of drugs and other contaminants in his produce. Good manufacturing practices (GMP) at the secondary level of processing foods in the industry, go a long way in ensuring that food is free from physical, chemical and microbial contaminants. Tamper proof packaging, storage at appropriate temperatures and appropriate handling practices are important.

At the consumer level, personal hygiene plays a major role in the transmission of germs and perhaps is responsible for most of the food poisoning outbreaks. Dirty hands especially have been recognised as one of the most important sources of contamination. Sanitation of not just the kitchen and food storage areas but also surrounding areas is important. This is because pests from these areas can easily enter the kitchen bringing disease causing germs.

Keeping the environment clean is vital. This starts by choosing an appropriate location for the kitchen or food service establishment. The surrounding areas have to be clean with no garbage dumps, open drains or other sources of pollution in close proximity. The kitchen should be constructed in such a way that pests cannot gain entry through the walls, floor, windows or doors. Screens on doors and windows and traps in drains help to keep pests like rodents and insects out. There shouldn’t be any places which can harbour pests inside or outside the kitchen.

Special precautions need to be taken to reduce the exposure to chemical contaminants which will be dealt with in detail in the next chapter. In general purchasing food from trusted sources, thoroughly washing all foods like grains, fruits and vegetables before cooking and consumption, using appropriate utensils, containers for cooking and storing food and using appropriate cooking methods can help reduce different types of physical and chemical contaminants in our food.
Consumer Guidance: Formalin in Fish

Formaldehyde is not permitted to be added to preserve fish. Consuming fish adulterated with formaldehyde can be harmful for health as it may cause abdominal discomfort, vomiting, renal injury etc. Formaldehyde is water soluble and washing the fish thoroughly in water will reduce the content of the chemical. Cooking thoroughly at temperatures above 75°C also decreases the formaldehyde content as it is volatile. Consumers can also test for adulteration with formalin using the rapid detection kit 'CIFTest' developed by ICAR-CIFT. It is advisable to purchase the fish from reliable sources.


Food allergies

Some people show abnormal responses to certain foods ranging from breaking into a rash to breathing difficulties and even death. Let us understand how the same food which others can safely eat, can become a hazard for these individuals.

What is food allergy?

When the body's immune system overreacts to some specific foods it is termed as a food allergy. The substance to which the body reacts is referred to as an allergen. When an allergen is consumed, the body's immune system identifies it as a threat and counters it with release of antibodies. In most cases the allergen is a protein found in the offensive food.

Food allergies affect both adults and children. Prevalence of food allergy in preschool children in developed countries was reported as 10% and that in developing nations like India as 7% in a global survey (Prescott et al., 2013). With a population of more than a billion, such high prevalence rates would mean millions of people being affected and food allergy becoming a huge public health problem. Some estimates suggest up to 3% of Indians (mostly those under the age of 40) may already have food allergies. Around 30,000 emergency hospital treatments and 100 to 200 deaths per year could be attributed to food allergies. Up to 3 million Indians may have peanut allergy alone (Gazzola, 2010).

The allergic reactions can be triggered by ingestion of even minute quantities of allergenic food. The symptoms which may appear can be from mild to severe. Symptoms of food allergy include:

- Itching or swelling in your mouth
- Vomiting, diarrhoea, or abdominal cramps and pain
- Running nose, sneezing and watery eyes
- Hives or eczema
- Tightening of the throat and trouble breathing
- Chest tightness as in severe asthma
• Hypotension
• Loss of consciousness, confusion, coma

Anaphylaxis - Anaphylaxis is a severe allergic reaction that is rapid in onset and may cause even death. Not all allergic reactions will develop into anaphylaxis. However, early signs of anaphylaxis can resemble a mild allergic reaction. These can quickly progress to life threatening symptoms such as-

• breathing difficulties
• trouble swallowing or speaking
• dizziness or fainting

Food intolerance happens when unpleasant symptoms (usually gastrointestinal) occur after eating a substance, which the body cannot handle because the digestive system does not produce sufficient quantities of an enzyme/chemical, which is needed to break down the food and aid digestion. A common example is that of lactose intolerance in which an individual’s digestive system lacks the enzyme lactase. Symptoms include bloating, diarrhoea and abdominal cramps. Lactose intolerance is distinct from allergy to milk proteins in which individual’s immune system may react to bovine milk proteins. Gluten is a protein found in cereal grains like wheat, rye and barley. People may develop an allergy to gluten and hence wheat.

Common food allergens

The foods that most often trigger allergic reactions include fish, shellfish, peanuts, tree nuts, eggs, milk, soy, and wheat. In infants the cow’s milk may cause allergic symptoms like bloating, diarrhoea etc. Early introduction of other foods in infancy may also be responsible for development of allergic reactions especially if there has been family history of some food allergy.

Lactose Intolerance

Lactose intolerance is common digestive problem where body is unable to digest lactose, or milk sugar found in milk and dairy products. Individuals suffering from lactose intolerance may experience symptoms like diarrhoea, flatulence, abdominal pain and/or abdominal distension. Lactose intolerance can be diagnosed with a breath or blood test. Lactose breath test is the preferred method as it is a non-invasive and simple method. It measures amount of hydrogen and/or methane in end expiratory breath. Patient is asked to breathe into balloon-type container. Then, asked to drink 25g lactose dissolved in 250 ml of water. Samples of breath are collected at set time intervals, hydrogen and methane levels are checked. Normally, very little hydrogen and methane are there in breath. Raised hydrogen and/or methane in breath indicates lactose intolerance. Limiting intake of lactose is the main treatment for lactose intolerance. Curd is usually better tolerated than milk. This is because the bacteria which ferment milk convert the lactose into lactic acid, performing the function of the missing enzyme lactase.
Managing allergies

Near about 40% of food allergies in children subside by the age of five years. As soon as a food allergy is identified foods having the particular allergen should be excluded from diet (elimination diet). Re-challenge (i.e. introducing the allergenic food again into the diet) after one year can be done as most of the allergies abate with time. Nuts, peanuts and seafood allergies are particularly persistent and can be re-challenged at 4 to 8 years interval.

Some allergies like from peanut and sea foods may cause anaphylaxis even on consumption of very small quantities leading to death. Individuals with a history of such allergies should observe caution while eating out and having packaged food. They should carefully check the food labels and ingredient information on the food products to avoid ingestion of food they are allergic to. According to the new regulations it will be mandatory for packaged food products to declare on their labels the presence of any ingredient which can cause food allergies.

Most Indian dishes are a combination of several ingredients. It is very important for people with allergies to be aware of the composition of dishes and avoid foods which contain allergens. They should also inform and alert the staff in restaurants so that the correct selection of dishes can be made. They should keep a note about their allergic condition on their person for medical help during emergencies resulting from inadvertent consumption of the allergenic food. In India many people are not aware about their allergies or food sensitivities. They need to be aware of these as an adverse reaction can be fatal.

Exposure to food antigens in early infancy is likely to lead to hypersensitivity. The risk of food allergy can be reduced by delaying the introduction of solid foods to an infant until after 6 months of age. Up till six months exclusive breastfeeding should be encouraged as mother’s milk is easy to digest and is tailor-made for the infant. Cow’s milk can however cause allergic reactions in sensitive infants.

Food allergy awareness among public, health officials and individuals involved in food processing is an important step towards prevention of adverse reactions. In order to manage allergen risks, manufacturers need to have a thorough knowledge of the allergenic ingredients and possible contaminants in a food product. Proper cleaning of equipment after using potential allergy causing foods should be done as to avoid unintentional contamination of other foods.

In schools, offices and colleges the canteens should clearly mention the ingredients of the dishes prepared. Anti-allergy medication should be kept in medical kits in these institutions to give first aid to individuals who accidently consume an allergen.
**Gluten Sensitivity and Celiac Disease**

Gluten is a protein found in wheat, rye and barley. Some individuals may show a heightened immune response to gluten. Celiac disease is a chronic inflammatory disorder of the small intestine triggered by consumption of gluten in genetically predisposed individuals. Symptoms include chronic diarrhoea, poor weight gain, growth retardation, irritability and damage to the lining of the small intestine because of which absorption of nutrients is adversely affected. People having this condition need to eat a gluten-free diet. They should read labels carefully and look for products labelled ‘gluten-free’. For any product to be declared gluten-free, it should have less than 20mg of gluten per kg. Hence the ingredient list should be checked before purchase to make sure there are no gluten containing foods. They should also avoid buying flour from local mills as these may have processed wheat at some point in time and there is a high risk of cross-contamination.

**Source:**

**Water and sanitation**

As already discussed in the previous sections, contaminated water is one of the most common sources of hazards and foodborne illness. Unclean environments are major contributors to physical, chemical and biological hazards. Inadequate water, sanitation and hygiene cause about 829,000 preventable deaths from diarrhoeal disease per year. Globally, 23% of all deaths could be prevented through healthier environments (WHO, 2019).

Drinking water includes water used for drinking, cooking and personal hygiene. People around the world drink water from a variety of sources. Health of the consumer is at a significant risk of getting affected by intake of water contaminated with microbes and toxic chemicals. Unsafe water is responsible for a large part of the burden of foodborne diseases. Poor sanitary conditions contribute to spread of diseases and add to the overall burden. Sustainable Development Goal 6 (SDG 6) aims to ensure availability and sustainable management of water and sanitation for all, and to eradicate open defaecation by 2030. Achievement of a number of other Sustainable Development Goals is dependent on the state of sanitation in the country and accessibility to safe drinking water.

As per the joint UNICEF-WHO Report (2019), 7 out of 10 people used safely managed drinking water services, 4 out of 10 used safely managed sanitation services and 3 out of 5 had basic handwashing facilities in 2017. There has been a 47% points reduction in open defaecation in India between 2000-2017 and 43% points increase in use of basic sanitation services.

Globally, billions of people live without access to even the most basic sanitation services. Inadequate management of sanitation systems puts billions of people at risk of infections and infestations. Diarrhoea is one of the leading causes of disease and death in the developing world. Part of the reason there is a lot of undernutrition in these countries is also because of communicable diseases which spread because lack of adequate sanitation facilities.
Potable water

Water is a scarce resource and an important basic necessity for human survival. The quantity of potable water on earth is limited and its availability per person is reducing day by day due to increase in global population and damage to the environment. In 2017, 90% of the World’s population used at least basic drinking water services, rising from 82% in 2000 (UNICEF/WHO, 2017). However, according to 2016 data, at least 2 billion people in the world drank faecally contaminated water. (WHO, 2019).

Access to safe drinking water was declared as a human right by the United Nations but remains a challenge for India. Depleting ground water, lack of proper rainwater harvesting and rising contamination in the ground water due to sewage and industrial effluent discharge is posing fresh challenges for the Indian cities, especially in low-income or resettlement colonies. While 5% of the total Indian population who are affluent depend on purified water and packaged or bottled water, over 95% of Indians still depend on free sources of water, some of which are unreliable. Lack of safe drinking water poses many health hazards such as diarrhoea, cholera, and typhoid, etc.

Adequate drinking water, sanitation, and hygiene are all essential ingredients to ensure good health. Proper wastewater management is also a basic prerequisite for environmental welfare and protection. Improving upon these services will bring long term economic gains by reducing the prevalence of infections and foodborne illnesses. These issues received attention in 2014 with Prime Minister Narendra Modi focussing on drinking water and sanitation in India and later launching the Swachh Bharat Mission that added further momentum and strength to the implementation of WASH (Water, Sanitation and Hygiene) facilities in the country. There is a move to strengthen implementation of regulations for drinking water, monitoring and surveillance of water quality and minimizing microbial and chemical contamination of drinking water by protecting water resources.

Open defecation

Sanitation is defined as ‘access to and use of facilities and services for safe disposal of human urine and faeces.’ However, the problem of open defecation is quite widespread in India. Open defecation refers to the practice whereby people go out in fields, bushes, forests, open bodies of water, or other open spaces rather than using a toilet to defecate.

Open defecation poses a serious threat to health. The lack of safe sanitation systems increases the risk of vector-borne diseases and helminthic infections and their consequences (Table 3). Diarrhoea is a major public health concern and a leading cause of disease and death among children under 5 years of age in low- and middle-income countries. More than 500 children under the age of five die each day from diarrhoea in India alone. Unsanitary conditions have been linked with stunting which affects almost one quarter of children under-5 globally (UNICEF/World Bank. 2018).

Under the Swachh Bharat Mission there has been a massive drive to build toilets in rural and urban areas and to encourage people to use these. However, there are several reasons why people prefer to defecate in the open rather than use toilets. These include lack of facilities, or poor quality or unclean facilities, convenience, habit, lack of familiarity with toilets, limited awareness of health consequences, lack of water and the belief that a toilet inside the home makes the home impure (WHO, 2018).
The Swachh Bharat Mission (SBM) was launched to accelerate the efforts to achieve universal sanitation coverage and to put focus on sanitation by the Prime Minister of India on 2nd October, 2014. The Mission Coordinator for SBM is Secretary, Department of Drinking Water and Sanitation (DDWS), Ministry of Jalshakti with two Sub-Missions, the Swachh Bharat Mission (Gramin) and the Swachh Bharat Mission (Urban). The basic objective is to bring about an improvement in the general quality of life by ensuring cleanliness and sanitation.

Know more about: [https://swachhbharatmission.gov.in/SBMCMS/about-us.htm#content](https://swachhbharatmission.gov.in/SBMCMS/about-us.htm#content)

[https://swachhbharat.mygov.in/](https://swachhbharat.mygov.in/)

### Table 6.3: Health Impact of Unsafe Sanitation

<table>
<thead>
<tr>
<th>Direct Impact (Infections)</th>
<th>Indirect Impact (Consequences of infection)</th>
<th>Broader Well-being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td>Stunting/Growth faltering</td>
<td>Poor pregnancy outcome</td>
</tr>
<tr>
<td>Dysentery</td>
<td>Impaired cognitive function</td>
<td>Absence from school due to repeated infections</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>Anaemia</td>
<td>Antimicrobial resistance</td>
</tr>
<tr>
<td>Typhoid</td>
<td>Nutritional deficiencies</td>
<td>Decreased economic productivity and consequently poverty</td>
</tr>
<tr>
<td>Helminth infections</td>
<td></td>
<td>Need for privacy and security not met for women</td>
</tr>
<tr>
<td>Insect vector diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vectors breeding in faecally-contaminated waters) e.g. filariasis, Trachoma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Good Practices**

Water treatment before distribution is vital to ensure that only safe drinking water reaches households. Pathogenic bacteria, viruses, protozoa and helminths may be present in drinking water and hence disinfection is essential. Water sources also need protection from chemical contamination and hence regulation of industrial effluents being released into water bodies and wastewater management are important.

Good sanitation is associated with improvements in health, including positive impacts on infectious diseases, nutrition and well-being. Key actions for improving sanitation begin
with preventing open defecation. This can be achieved not only by provision of safe and clean toilets for every household but also by creating a demand for these toilets. A social behavioural change needs to be brought in the community to motivate people to prefer and use toilets over open defecation. A monitoring and evaluation plan should always be a part of the program. Behaviour change programs are most effective when they target the determinants of behaviour. Safe toilets with adequate hand washing facilities also need to be provided in public places, schools and places of work. A safe sanitation system, designed and used to separate human excreta from human contact at all stages of the sanitation service chain from the toilet to final disposal, is needed in communities. In addition, wherever wastewater and excreta are used in agriculture and aquaculture, safe practices need to be ensured. Sanitation and hygiene need to be integrated in all health and nutrition related programs. SDG indicators related to WASH need to be monitored. WHO Guidelines (2018) talk about ensuring universal access to toilets and encouraging the use of toilets. Toilets should safely contain excreta at home, workplaces, schools, health care facilities and public places. Ensuring a safe sanitation service chain is crucial for safe disposal (Figure 3). Either the faeces is treated at source or sent to treatment plants from where it is safely disposed or the end product used in agriculture, etc.

![Sanitation Service Chain](https://ejalshakti.gov.in/JSA/JSA/Home.aspx)

**Figure 6.3: Sanitation Service Chain**

**Source:** WHO, 2018

Safe sanitation is associated with improvements in health of a community. Positive impacts on incidence of infectious diseases, nutrition and wellbeing are the likely benefits of maintaining good sanitation. There is an urgent need to focus on the vulnerable age-groups and those left behind in order to achieve targets of universal access to drinking-water, sanitation and hygiene services. Efforts should be directed towards creating an enabling environment taking care of social, political and economic factors alongside infrastructure and governance.

**The Jal Shakti Abhiyan (JSA)** was a timebound, mission-mode water conservation campaign. The JSA ran in two Phases: Phase 1 from 1st July to 15th September 2019 for all States and Union Territories; and Phase 2 from 1st October to 30th November 2019 for States and UTs receiving the retreating monsoon (Andhra Pradesh, Karnataka, Puducherry and Tamil Nadu). During the campaign, officers, groundwater experts and scientists from the Government of India worked together with state and district officials in India’s most water-stressed districts for water conservation and water resource management by focusing on accelerated implementation of five target interventions. The JSA aimed at making water conservation a Jan Andolan through asset creation and extensive communication.

Know more about: [https://ejalshakti.gov.in/JSA/JSA/Home.aspx](https://ejalshakti.gov.in/JSA/JSA/Home.aspx)
Summary

• Eating safe food is important for good health.

• Foodborne diseases have a major impact on health. Repeated episodes of illness can adversely affect the nutritional status resulting in a state of malnutrition. Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade.

• A food-borne hazard is a substance or organism which can increase the risk of illness or adverse health effects when present in a food item. These hazards can be classified as physical, chemical or biological.

• Physical hazards include items like straw, husk, chips of stones, bone, shards of glass, iron filings, etc. anything physically present in food which can cause damage.

• Chemical hazards include a wide variety of chemicals which are either naturally present in plant and animal foods, or produced during processing of food, leaching into food from equipment and storage containers or entering as residues of pesticides, veterinary drugs or heavy metals.

• Biological hazards are microbes (bacteria, fungi, yeasts, protozoa and viruses) and their toxins as well as helminths.

• Food needs monitoring right from the level of the primary producer up to the end consumer to ensure safety. This approach is referred to as the ‘farm to fork approach’.

• Safety of food can be assured by proper handling, preparation, storage and consumption. Importance of personal hygiene and environmental sanitation cannot be overemphasized.

• Food allergens are also hazards which can lead to adverse reactions by the body like itching or swelling in the mouth, vomiting, diarrhoea, abdominal cramps, running nose, sneezing and watery eyes, hives or eczema, tightening of the throat and trouble breathing, drop in blood pressure, collapse, coma and even death (anaphylaxis).

• The foods that most often trigger allergic reactions include fish, shellfish, peanuts, tree nuts, eggs, milk, soy, and wheat.

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Did you know?

According to UNICEF, One GRAM of faeces contains:

• 10,000,000 viruses
• 1,000,000 bacteria
• 1,000 parasite cysts

Child faeces contain more germs than adults’
• Lactose intolerance is a common digestive problem where the body is unable to
digest lactose, or milk sugar found in milk and dairy products.

• Food allergies can be managed by affected individuals by avoiding foods likely to
have the offending allergen.

• Globally, 23% of all deaths could be prevented through healthier environments. 
Unsafe water is responsible for a large part of the burden of foodborne diseases. 
Poor sanitary conditions contribute to spread of diseases and add to the overall 
burden.

• Open defecation poses a serious threat to health. The lack of safe sanitation 
systems increases the risk of vector-borne diseases and helminth infections and 
their consequences. A social behavioural change needs to be brought in the 
community to motivate people to prefer and use toilets over open defecation.

• A safe sanitation system, designed and used to separate human excreta from 
human contact at all stages of the sanitation service chain from the toilet to final 
disposal, is needed in communities.

Key Terms

Anaphylaxis – a serious allergic reaction which is rapid in onset and can cause death

Food allergy – abnormal response to food triggered by the body’s immune response

Food hazard - a substance or organism which can increase the risk of illness or adverse 
health effects when present in a food item

Food Intolerance – hypersensitive reaction to food primarily due to difficulty in digesting 
the food

Open defecation - the practice whereby people go out in fields, bushes, forests, open 
odies of water, or other open spaces rather than using the toilet to defecate

Potable Water – water that is safe to drink

Sanitation - access to and use of facilities and services for safe disposal of human urine 
and faeces

Sanitation service chain - includes the capture, storage, transport, treatment and 
disposal or reuse of human excreta and wastewater

SDG - Sustainable Development Goals are global goals adopted by Member States of the 
United Nations in 2015 with the aim to end poverty, protect the planet and ensure that all 
people enjoy peace and prosperity by 2030.

WASH - Water, Sanitation and Hygiene
Exercises

1. List the types of hazards which can be present in foods.
2. What are the different types of biological hazards which cause foodborne disease in humans?
3. Discuss briefly how foodborne diseases affect the economy of a country.
4. Comment on the sources of different chemical contaminants explaining how they enter the food chain.
5. Which foods are considered to be the most allergenic? How should people who are allergic or intolerant to certain foods, manage their diets?
6. Describe measures which can help reduce our exposure to food hazards.
7. What are some of the adverse health effects of consuming chemical contaminants?
8. Why is ensuring good water quality important for preventing food borne diseases?
9. Why is open defecation a problem?
10. What do you understand by ‘Sanitation service chain’. Outline some good practices which will help improve sanitation.

References


Chapter 7: Safe Food at Primary Production Stage

- Pesticide residues
  - Good Agricultural Practices
  - Integrated pest management

- Veterinary drug residues
  - Good veterinary practices
  - Monitoring

- Heavy metals
  - Bioaccumulation and Biomagnification
  - Ensuring safe waste disposal

- Mycotoxins
  - Types of mycotoxins and crops affected
  - Adverse effects
  - Control and prevention

- Feed control
  - Sources of contamination
  - Quality control

- Other hazards
  - Naturally occurring toxicants
  - Produced during processing
  - Packaging and Storage conditions

- Food adulteration
  - Foods commonly adulterated
  - Health effects of adulterants
  - Prevention and Control
Chapter 7: Safe Food at Primary Production Stage

In the last chapter you learnt about the different physical, biological and chemical contaminants which may enter the food chain. Primary production of food includes harvesting, slaughtering and milking of animals. Physical contaminants like dust, stones, metal/glass shards, seeds, straw, husk, etc. could enter the food during these processes. Bacteria, viruses, helminths, fungi and mycotoxins could contaminate the food when adequate sanitation is not maintained during the production process or if the growing conditions of food crops favoured microbial contamination. Good hygiene practices are essential for the handling of animals and animal products otherwise it can lead to serious food borne illnesses. Residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, and toxic chemicals naturally present in plants and animals are likely to contaminate food at the primary production stage. Contamination can also occur at later stages of production, storage and transport of foods. Contaminant chemicals can leach out of utensils or packaging material in which food has been kept. Some chemicals may get formed during the process of cooking or processing. This chapter describes in detail how these contaminants enter our food, how severe the problem of contamination is, and the good practices needed to keep level of contaminants in check at the production level.

Pesticide residues

Pesticides are chemicals used to protect food from pests, such as insects, rodents, weeds, mold, and bacteria. The use of pesticides has increased several-fold in India over the years. Residues of these pesticides persist in the environment as well as in food. Runoff water from fields can contaminate the water bodies in which it falls or the soil and ground water if it penetrates the surface. Residues of pesticides detected in different foods like cereals, pulses, fruits, vegetables and in drinking water are a result of poor agricultural practices at the farm level.

Use of pesticides which do not dissipate very easily creates further problems. The most persistent pesticides are termed “persistent organic pollutants” (POPs). These tend to accumulate in the food-chain. They can biomagnify (concentrate) in marine and land animals, as well as humans building up chiefly in the adipose tissue, leading to toxic effects in the body. Examples of POPs include mainly organochlorine pesticides, namely, aldrin, endrin, dieldrin, chlordane, DDT, endosulfan, lindane, hexachlorobenzene, etc.

Examples of chronic poisoning effects due to build-up of pesticide residues in the body may include- carcinogenicity (ability to produce cancer), mutagenicity (ability to cause genetic changes), teratogenicity (ability to cause birth defects), oncogenicity (ability to induce tumour growth), liver damage, endocrine disruption resulting in hormonal disorders, reproductive disorders such as reduced sperm count, sterility, and miscarriage, neurotoxicity (nerve damage) or development of allergies to pesticides or chemicals used in formulation of pesticides.
Exposure of either parent to pesticides before conception, or of the mother during pregnancy, has been associated with increased risk of foetal death, spontaneous abortion and early childhood cancers. Exposure within the womb is also associated with increased risk of growth retardation, low birth weight and congenital anomalies.

**Good Agricultural Practices (GAP)**

People applying the pesticide in the field are not aware about concentrations to use, frequency with which to apply, sometimes applying more than needed amounts in the belief that their crops will be better protected. They also lack the knowledge about the safest pesticide to use, and land up purchasing substandard pesticides which they may need to apply more of to get the desired effect. Or, they may purchase the more toxic varieties even though safer and more effective substitutes are readily available. Another reason for high residue levels in foods is the post-harvest treatment of grains, fruits and vegetables, before they are marketed. This is mainly done to prevent spoilage due to insects and microbes. Thus, to ensure good agricultural practices, the farmers and other users of pesticides need to be trained and sensitized to adverse effects of misuse. Every packet of pesticide should carry the relevant information in the local language. In addition, efforts must be made to reduce the use of these chemicals in agriculture.

**Integrated pest management**

Pesticides even in small quantities can prove to be hazardous for us as our body finds it difficult to excrete them. Thus, even if these are judiciously used by the farmers, small amounts tend to accumulate in our bodies and have been known to cause adverse health effects. Research focus is thus on other forms of pest-control. Non-pesticide dependent agriculture and integrated pest management (IPM) is increasingly gaining popularity. The UN’s Food and Agriculture Organisation (FAO) defines IPM as “the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.”

There are eight principles of integrated pest management according to the European Union (Figure 1). The first and foremost is to prevent or suppress pests by various techniques like crop rotation, balanced fertilizer use, adequate drainage and observing hygiene measures. The second principle is to monitor harmful pests using scientific tools. The monitoring data should be able to predict when food becomes vulnerable to pests. The system should have an inbuilt system to warn against pest infestations. The third principle is decision making which the professional needs to do about plant protection measures to apply when he receives a warning from the monitoring system. The fourth principle talks about using biological or physical methods of pest control where possible. The fifth principle states that if pesticides are to be used then the one selected should be the least harmful for the environment, humans and other animals. The sixth principle says that the quantity/frequency of pesticide used should be the minimal required to control the pest
problem. The seventh principle states that appropriate strategies are needed to ensure that resistance to a pesticide does not develop in the pest. This could be done by using a variety of pesticides with different modes of action. The eighth principle is that the success of plant protection measures should be regularly evaluated. This can be done by monitoring the pests and relating this to the pest control measure used.

**Figure 7.1: Principles of integrated pest management**

1. Prevention  
2. Monitoring  
3. Decision making  
4. Non-chemical methods  
5. Pesticide selection  
6. Reduced pesticide use  
7. Antiresistance strategies  
8. Evaluation

Biopesticides are living things or natural materials like animals, plants, bacteria and certain minerals or biochemicals which can be used for pest management. Biopesticides are less toxic than conventional pesticides. They don’t affect the environment adversely as they don’t persist in the environment and don’t affect other organisms. Microbes like fungi have been used to control weeds and insects. Strains of *Bacillus thuringiensis* (Bt) have been used to control insect larvae. Certain genetically modified plants may have the ability to produce proteins which are pesticidal. Beneficial nematodes have also been used to control insect and slug pests. Animals can also be used as predators to control the population of pests. Such measures can contribute towards reducing contamination of foods and the environment.
National Pesticide Monitoring System

The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare had started a central sector scheme, "Monitoring of Pesticide Residues at National Level" (MPRNL) in food commodities and environmental samples during 2005-06 with the participation of various laboratories representing Ministry of Agriculture, Indian Council of Agriculture Research, Ministry of Health and Family Welfare, Ministry of Environment and Forest, Council of Scientific and Industrial Research, Ministry of Chemical and Fertilizer, Ministry of Commerce and State Agricultural Universities across the country. The objectives of the scheme include:

- To identify crops and regions having preponderance of pesticide residues in order to focus extension efforts
- To strengthen infrastructure at Quarantine stations to prevent entry of foods which have pesticide residues above maximum residue limit (MRL)
- Testing / Certification of pesticide residues in export / import consignments
- To test pesticide residues and other contaminants in food commodities and environmental samples like soil and water.

Source: [http://agricoop.nic.in/sites/default/files/MPRNL%20Guidelines_0.pdf](http://agricoop.nic.in/sites/default/files/MPRNL%20Guidelines_0.pdf)

Veterinary drug residues

Various types of drugs are used while breeding animals, fowl and insects like bees which provide us with food. Some are injected into the animal while some others are given orally-mixed in the feed. Some chemicals may be sprayed or applied on the animals. Residues of these drugs show up in the food derived from these animals like meat, milk, eggs and honey. Acute poisoning outbreaks attributed to veterinary drug residues have been reported in several cases. Those who ate veal liver contaminated with a steroid like drug called clenbuterol developed symptoms of tremor, headaches, abnormally rapid heart rate and dizziness in Lyons, France (Pulce et al, 1991). Similar acute outbreaks were seen in 1996 in Caserta, Italy and in 1992 in Catalonia, Spain which affected 113 people. Hormones have been used by the beef and meat industry for several years to improve growth or milk yield. There have been serious concerns about environmental contamination, particularly of drinking water, from faecal and urinary excretion of hormones by millions of cattle. Hormones in food and water have been linked to endocrine disruption in humans with increased risk of breast cancer and early puberty in girls. Diethyl stilbesterol (DES) which was earlier used to promote growth of cattle, is now banned as it was found to be a potent carcinogen.

Antibiotic residues can be problematic for persons allergic to certain antibiotics. These may also cause a potential build-up of antibiotic resistant organisms in humans. Chloramphenicol has been shown to induce aplastic anaemia in sensitive individuals. Nitrofurans and some sulpha drugs have shown the potential to cause cancer in experiments conducted on laboratory animals. These drugs have been mostly banned for use in food producing animals. When the microflora of our gut is exposed to low doses of antibiotics in the form of residues in the food that we eat (viz. meat, milk and eggs of...
contaminated animals), it starts changing. This alteration of gut microflora may lead to
diseases and the development of resistant strains which cause failure of antibiotic therapy
in case of an infection. Anthelmintics (which get rid of worms e.g. tapeworms) and
antifungal medicines also cause a serious ecological problem with their residues being
detected in the soil, besides the meat and milk.

**Good veterinary practices**

Numerous scientific bodies and regulatory agencies have looked at the issue of residues of
hormones coming into the milk and meat meant for human consumption. Most of them
have concluded that if good veterinary practices are followed, then drug residues wouldn’t
pose a significant risk to health. It is important therefore to consult a veterinarian before any
drug is administered to livestock. This ensures that the appropriate drug is prescribed in
the right dosage. The veterinarian can also advise about the appropriate time gap to be
given between administering the drug and milking or slaughtering the animal to avoid high
residue levels in the food products. This time gap is referred to as the withdrawal time or
period during which the drug gets metabolized in the animal’s body and the residues are
excreted from the body so that these do not linger in the meat, milk or eggs of the animal
when slaughtered for consumption. Due to mass production of milk, meat and eggs, use of
drugs has become a necessity. Maintaining good hygiene and sanitary conditions in farms
is of primary importance to reduce the use of these drugs to a minimum.

**Monitoring**

In India, the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations,
which came into force on 5th August, 2011, deals with compliance to standards set for
various contaminants, toxins (microbial and naturally occurring) and residues (of
pesticides, veterinary drugs and other pharmacologically active substances) in food.
FSSAI specifies the tolerance limits for antibiotic residues in sea foods like shrimps,
prawns, fish and fishery products. The responsibility for residue control is not solely that of
the government. The responsibility should be shared by producers, marketing co-
operatives, veterinarians, scientists and all those involved in the industry. Drug
manufacturers are required to provide tissue residue and depletion rate data for all new
drugs. They also need to provide a method to detect the residues in tissues so that
monitoring can be done effectively.

Concerns over drug residues in food are not limited to public health. They can have serious
economic consequences as well. Antibiotic residues present in milk intended to produce
cheese or other fermented milk products, may interfere with the fermentation process by
adversely affecting the bacterial or yeast cultures. This would result in subsequent
economic losses to the food industry. Every year several consignments of seafood, honey,
meat and meat products, etc. are rejected due to detection of veterinary drug residues by
USA and the European Union. Hence it is in everyone’s interest to address this problem and
work towards a solution.
Heavy metals

Metals contaminate our foods when factories throw their waste products into the seas and rivers or bury their wastes before appropriately treating them. Smoke from industries as well as exhaust fumes from vehicles and machinery pollute the atmosphere with the particulate matter ultimately settling down on plants and soil not only in the vicinity but places further away as well due to widespread dispersion by wind. Food grown in contaminated soil or using contaminated water (especially raw sewage water/sludge), or even in the vicinity of polluting industries tends to be high in heavy metal content. Similarly, fish and other seafood from contaminated water bodies have heavy metals in them. The heavy metals in soil tend to contaminate the ground water as well.

Lead emissions are from road transport, cadmium emissions are mainly from tobacco smoke, fuel combustion and metallurgical operations, and mercury emissions are related to coal consumption. Metals may also enter food from metallic cans and other containers in which the food is cooked, stored or packaged, especially if the food is acidic in nature. Poor quality tin coating or improper tinning of brass vessels can result in tin and copper leaching into the food cooked or stored in the vessel.

Heavy metals like lead, cadmium, mercury and arsenic can cause a lot of damage to human health. Other heavy metals noted for their potential toxicity, include nickel, copper, zinc, silver, tin, and antimony. These metals are not readily excreted from our bodies and so keep getting deposited in different tissues and organs of the body. Concentrations of these heavy metals in blood, hair, nails and urine have been used as biomarkers of exposure. Contamination of drinking water with inorganic arsenic is a major problem in some parts of India especially States like West Bengal. Several surveys in India have detected high levels of lead in different foodstuffs, in drinking water and in seafood. The gastrointestinal uptake of lead from food is high. Also lead can easily cross the blood-brain barrier in children thus leading to neurotoxic effects. There may be a link between heavy metals (like lead, mercury, zinc, copper, arsenic) and autism, and aluminium and Alzheimer’s disease as these heavy metals can be neurotoxic.

Bioaccumulation and Biomagnification

As it is difficult for the body to excrete heavy metals, these tend to over time, accumulate in the body tissues of not just humans but also animals (bioaccumulation). Contamination of fish with methyl mercury is a big problem due to industrial effluents being dumped into rivers, seas and oceans. In fact, fish consumption strongly predicts mercury levels in the body. Large old predators like sharks and pike, or scavengers like halibut, hold the greatest concentrations of mercury as they have fed on several contaminated fish which have in turn fed on contaminated plankton, krill etc. The higher the fish in the food chain, the more mercury it tends to have and this process is referred to as biomagnification (Figure 2). In plants, green leafy vegetables with large leaves tend to accumulate more heavy metals than the ones with smaller leaves. Certain plants tend to bio-accumulate heavy metals from the soil or water more than the others.


Figure 7.2: Bioaccumulation and Biomagnification of Toxins

**Ensuring safe waste disposal**

Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge. Extensive research has shown that certain plants or microorganisms can be used to remove some heavy metals such as mercury. These plants can hyper-accumulate the heavy metals from soils by concentrating them in their bio matter.

Use of lead in petrol has decreased over the last few decades, phasing out of the remaining uses of lead additives in motor fuels should be encouraged. Similarly use of lead in paints, food containers, glazing should be banned to reduce exposure to this toxic heavy metal.

Exposure to arsenic is mainly via intake of food and drinking water. According to a study, folic acid (a type of B vitamin) supplementation may reduce the risk of arsenic-related
adverse health outcomes (Gamble et al., 2006). Folic acid helped in the methylation of arsenic and decreased excretion of the inorganic form which has been linked to skin and bladder cancers and peripheral vascular disease. A study in Bangladesh (Freeman, 2009) has indicated that improved nutritional status could constitute a key strategy for reducing the risk of arsenic-related diseases especially in children. Itai Itai disease in which cadmium accumulates in the bones is also seen more in people who in addition to being exposed to excessive cadmium, consume a diet low in calcium and have poor vitamin D status. Thus, having a nutritious diet can protect us from the toxic effects of heavy metals.

Avoiding farm produce grown in contaminated soil, choosing smaller fish to consume and green leafy vegetables with small leaves can also help to reduce our exposure. Utensils made of only good quality alloys should be used. Cheap alloys may leach out more metals when in contact with food materials being stored or cooked in it. Other measures of reducing exposure would include a crackdown on polluting industries, treatment of sewage/sludge to decrease the load of heavy metals, safe and responsible disposal of electronics and batteries, etc. which have heavy metal components and vigilance in monitoring heavy metal levels in the food and water of the population. Contaminated ground water should be treated before consumption. Scientists have been working on low cost technologies to decontaminate water at the household level, especially in rural areas.

FSSAI, the regulatory authority, specifies the maximum amount of heavy metals permissible in food. It is the work of the State Food Safety Departments to monitor levels in foods. For instance, lead in milk should be below 0.02 ppm, whereas in turmeric up to 10 ppm is permissible. Methyl mercury in any food should not be more than 0.25 ppm.

**Mycotoxins**

Fungi growing on food may produce toxins which are harmful to health. These are called mycotoxins. Diseases caused by the growth of fungus on a host are termed as mycoses (like athlete's foot, ringworm, etc.) while diseases caused due to exposure to toxic fungal metabolites or mycotoxins is called mycotoxicoses.

**Types of mycotoxins and crops affected**

Mold growth is supported by a number of foods and hence mycotoxins have been detected in a variety of foods for human consumption, particularly cereals and nuts. Consumption of mycotoxin contaminated feed by animals can result in tainting of meat, eggs and milk. Some examples of mycotoxins are aflatoxins produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, ergot alkaloids produced by the *Claviceps sp.*, Trichotheecenes, Fumonisin and Zearalenone produced by the *Fusaria sp.* and *Ochratoxin* by *Aspergillus ochraceus* and *Penicillium* species. The crops may get contaminated with the fungus while still in the field or after harvest during the storage period. For instance, *Claviceps* affects cereals during the pre-harvest stages; *Fusaria* contamination generally occurs under the field conditions and persists during early storage; and, *Aspergillus* and *Penicillium* are typical storage fungi, infecting agricultural commodities due to improper storage. Infection with *A. flavus* can also occur in the field. Currently there are more than 300 known types of mycotoxins but the attention is usually focussed on the ones which are very toxic to us or those that are carcinogenic.
**Adverse effects**

Aflatoxin is one of the most commonly detected mycotoxins in peanuts and products made from peanuts as well as a variety of cereal grains. It is toxic to the liver and has been recognised as a hepatocarcinogen (causing liver cancer). Consumption of cereal grains containing ergot alkaloids leads to symptoms of gangrene and convulsions. Deoxynivalenol and other trichothecenes found in cereal grains and some vegetables and other crops have been shown to inhibit protein synthesis in the body, haemorrhaging in the digestive tract and decreased bone marrow and immune function. In case of skin contact they have also caused dermatitis. Zearalenone has been toxic to the reproductive tract of animals, causing oestrogenic effects in farm animals. Ochratoxin A found in cereals, coffee, spices and dried fruits is a possible carcinogen. It has been shown to be toxic to kidneys. Patulin, found in apples, apple juice, cider, and other fruits, is an irritant to the stomach, causing nausea, vomiting and even ulceration in severe cases. It is genotoxic, neurotoxic, and known to cause reproductive toxicity. These are only some examples of the adverse health effects of mycotoxins.

**Aflatoxin M1 detected in Milk in India**

The National Milk Safety and Quality Survey 2018 conducted by FSSAI revealed Aflatoxin M1 residues beyond permissible limits in 368 (out of 6,432) samples, that is 5.7% of the samples. Aflatoxin M1 comes in the milk through feed and fodder. Amongst the top three States with highest levels of Aflatoxin M1 residues are Tamil Nadu, Delhi and Kerala.

**Control and prevention**

The world over, mycotoxin contamination of foods and feeds has led to significant health and economic impacts - loss of human life, cost of health care and in addition the losses incurred when farm animals or livestock are affected. This is especially a problem in India where farmers can lose their source of livelihood if their cattle or other livestock succumb to the toxic effects of mycotoxin contaminated feeds. High levels of contamination have been seen in certain food crops as well as feed due to poor agricultural and storage practices. In addition, the country has had to deal with huge financial losses due to rejection of shipments of foods by importing nations, due to unacceptable levels of mycotoxins.

As it is not always economically feasible to reject mycotoxin contaminated foods, maximum permissible levels are declared by regulatory authorities of countries. Levels of mycotoxins falling below these are unlikely to cause harm even if consumed for a long period of time. These levels however need to be monitored regularly to ensure that they do not exceed safe levels. Spread of awareness regarding harmful effects of mycotoxins as well as ways to prevent and reduce levels in food and feed is very important. FSSAI in India puts the limit for aflatoxin in different foods for human consumption between 10-15 ppb. For Ochratoxin A the limit is 20 ppb in wheat, rye and barley, 50 ppb for Patulin in apple juice and a 1000 ppb for DON in wheat. The European Union has the strictest maximum acceptable limit in the world (of 4 ppb) for aflatoxins in food for human consumption.

For reducing the amount of the mycotoxin in our food, simple measures like separating visibly mouldy grains, seeds and fruits from healthy ones, as well as washing before
consuming or processing them into food products, can go a long way. Processing and cooking of food seem to lower the level of mycotoxins in food for example, milling and cooking reduces aflatoxin levels in foods. However, processing and pasteurisation of milk does not completely destroy aflatoxin. Filtering unrefined oils also reduces mycotoxin levels especially if passed through adsorbents which bind toxins like aflatoxin. Binding agents like bentonite and aluminosilicate clays are also added to feeds to bind aflatoxin so that it is not available for absorption.

**Good nutrition tackles adverse effects of mycotoxins**

Some nutrients and phytochemicals have shown the potential to reduce the toxic effects of mycotoxins. These include - antioxidants like selenium, vitamins A, E and C, and fructose, phenolic compounds, chlorophyll and coumarins.

However, preventing the growth of the fungi by good agricultural practices and proper storage seems to be the more logical way of reducing the mycotoxin content of foods. Harvesting the crop early is known to protect crop from fungus which is known to attack standing ready crop especially if the weather is unpredictable. Deep ploughing of fields after harvesting and then planting a different crop not susceptible to the same fungus also helps in getting rid of infestations. Sorting, winnowing, washing, crushing combined with de-hulling of grains is effective in reducing mycotoxin levels.

Maintaining absolute cleanliness and sanitation of the storage area and controlling storage conditions go a long way in reducing contamination levels. Maintaining moisture levels below 10%, keeping temperatures low and or maintaining an inert gas environment helps as it discourages fungal growth. Mycotoxin levels could also be kept low by use of chemicals to control growth of fungi and insect infestation. A number of fungicides are used by the agricultural sector, although, there are several concerns with regard to pesticide residues in feeds and food as well as damage to the environment.

**Feed control**

From the discussion above it can be seen that several contaminants may enter the food chain through feed given to animals. Feed contaminants have been detected in the animal products like meat, milk, eggs, etc. Thus, it is important to look at the quality of feed that is given to livestock.

**Sources of contamination**

Environmental, agricultural, industrial, or other sources can contaminate animal feed and feed ingredients, causing serious adverse effects to animal and human health. Contamination can happen at any stage of the animal feed production system – harvest, manufacture, storage, or transportation. Mycotoxins, naturally occurring chemical hazards, heavy metals, pesticides and veterinary drug residues are the different types of contaminants detected in feeds. These may enter as a result of feed of animals being
treated with pesticides, low doses of veterinary drugs being mixed with feed to support growth of animals, feed grown on soil or using water contaminated with heavy metals and, other additives being mixed in feeds. Feed additives are products used in animal nutrition for purposes of improving the quality of feed and the quality of food from animal origin, or to improve the animals’ health. Feed if improperly stored can develop fungal and pest infestation.

Transmissible Spongiform Encephalopathies (TSEs) are a group of progressive degenerative conditions that affect the brain and nervous system of some animals and humans. TSEs are also referred to as prion diseases. Scrapie is a degenerative disease afflicting the nervous system of sheep and goats. In 1986, scientists first learnt that the disease was transmissible to another species. Cattle were being fed offal (intestine and internal organs), meat and bone meal from sheep and goats to increase the amount of protein in their diet. This probably resulted in the transfer of the infective agent causing cattle to develop Bovine spongiform encephalopathy (BSE) or ‘mad cow disease’. The disease was first reported in United Kingdom, and by 2006 the disease spread across international boundaries to more than 24 countries. The export of animal feed products made in UK to other countries had apparently resulted in the spread of the disease.

Quality control

The Feed Hygiene Regulation of the European Commission ensures that feed safety is considered at all stages. This has an impact on feed and food safety, including primary production. The registration of all feed business operators by the competent authority is compulsory. The Regulation tries to ensure that all feed businesses operate in accordance with harmonised hygiene requirements and apply good hygiene practices at all levels of agriculture production and use of feed. Hazard Analysis and Critical Control Point (HACCP) principles are used by feed business operators other than at the level of primary production. There are community and national guidelines for good practices in feed production.

In India, a new Regulation for Animal feed, Feed Additives and Pre-mixtures under FSS Act, 2006, has been formulated. It covers feed standards and hygiene requirements for feed ingredients, medicated feed, feed additives and pre-mixtures as well as specifies sampling and testing methods. Training content under FoSTaC has also been developed for training of feed safety supervisors working in processing establishments and for feed safety officers. Also, there is a module for third party audit of feed business operators.

Other hazards

Some toxins occur naturally in food stuffs. Several may be formed because of the way we process and package the foods during secondary and tertiary processing. Cooking normally destroys or decreases the amount of toxicants in foods. However, in some cases it may introduce new chemicals which are harmful for our health. Some of these have been discussed here highlighting the need to reduce human exposure to these toxic chemicals which can be carcinogenic.
**Naturally occurring toxicants**

Foods also contain a wide range of natural chemical compounds which may act as toxicants or anti-nutritional factors which interfere with the way our body utilizes nutrients. The harmful effects of consuming these range from mild symptoms of gastric distress to even death. Some examples of naturally occurring toxicants are seafood toxins, biogenic amines, alkaloids and toxic amino acids. Shellfish poisoning (due to toxins present in shellfish), epidemic dropsy (due to consumption of Argemone seeds or oil) and Lathyrism (due to a toxic amino acid in *Khesari dal*) are some of the disease conditions arising out of consuming foods containing these natural toxins. Some of the chemicals which act as anti-nutritional factors are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides. They interfere with the absorption or utilization of nutrients by our body.

**Produced during processing**

A number of toxic chemicals are produced during cooking and processing of foods. Advanced Glycation End Products (AGEs) are produced when animal fats are cooked at high temperatures. They are also produced when plant foods are cooked to the point of browning or crisping. Animal-derived foods that are high in fat and protein are generally AGE-rich. These have been implicated in atherosclerosis as they increase oxidative stress and inflammation, and in aging of the skin (formation of wrinkles). Acrylamide is formed whenever foods that contain the amino acid asparagine and any reactive carbohydrate are heated at temperatures greater than 120 °C. Starch based foods like potato, bread, bakery products and breakfast cereals, cocoa based products and coffee are especially likely to contain acrylamide. Acrylamide causes DNA damage, neurological and reproductive damage, and is a probable carcinogen.

Heterocyclic Amines are formed from pyrolysis of amino acids and proteins at high temperature or when creatine and amino acids present in muscle tissues of animals are heated to high temperatures like during cooking of meat. They may also be formed during the Maillard reaction in which amino acids react with carbohydrates. These are mutagenic and carcinogenic. These may also be formed in plant-based foods when they are browned or charred. Nitrosamines are formed when nitrates or nitrites (preservatives added to processed meat/ fertilizers added to vegetables) combine with amino acids on exposure to high temperatures during cooking (e.g. grilling or frying). These preservatives are used a lot in processed meat products like sausages, bacon, ham, salami, etc. and hence it is undesirable to eat these foods as a part of the regular diet. Nitrosamines have also been detected in alcoholic beverages like beer, cheese, soyabean oil and canned fruit. Drying, kilning, salting, smoking or curing of food also promotes formation of nitrosamines. Nitrosamines have been shown to produce cancer in experimental animals. Polycyclic Aromatic Hydrocarbons (PAHs), are formed during grilling or charring of food especially meats. Food exposed to fumes of cooking oil or to smoke from the fossil fuels (wood, coal and oil) used for cooking may also contain these toxins. Cooking directly in contact with the flame also increases the PAH content.
Packaging and Storage conditions

Toxic chemicals may also migrate from the packaging/holding container to the food. Hence it is very important that the best quality materials be used for cooking, storing and packaging food. Several studies show that storing water and food in plastic results in migration of chemicals. Additives like plasticizers, antioxidants, catalysts, suspension and emulsifying agents, stabilizers and polymerization inhibitors, pigments, fillers, etc. are regularly used in the manufacturer of different types of plastics. These may leach into food and water stored in plastic containers. Bisphenol A (BPA) a component of polycarbonate used to make plastic bottles and also the epoxy-resin lining of metal cans, is a chemical which has been detected even in plain water stored in plastic bottles. BPA is an endocrine disruptor and its use has been banned in many countries especially in baby bottles and cups for children. Phthalates which make plastics more supple and bendable have also been known to leach out into food and beverages in contact with plastics. Food packaging material, tubing and other parts of processing equipment may all have phthalates which can leach out into the food products. Phthalates have also been identified as potential carcinogens and endocrine disruptors.

Tin, aluminium, iron/steel cans and containers may also leach metals into foods stored in them. Acidic foods generally react with metals. Inks used on the packaging for branding, printing the label information and barcoding may also leach out into the food product. Sterilization while food is there in the packaging using gamma radiation, steam, or ethylene oxide treatments, can cause leaching. Gamma radiation can break the carbon-chlorine bonds found in PVC plastics and some additives, forming breakdown products that can then percolate into food. Highly processed foods are likely to contain higher amounts of most of these chemicals. NHANES data from USA indicates that higher the consumption of fast foods by participants, the higher is the concentration of phthalate metabolites in their urine.

Some chemicals are also intentionally added to foods for a technological purpose like to impart colour and flavour to the food, to increase the shelf life of the food or to impart desirable texture to the finished food product. These chemicals are known as food additives and these can turn problematic when they are consumed in large quantities as some additives like preservatives and colouring agents have been associated with allergic reactions in sensitive people. These chemicals may become further problematic and produce other symptoms if misused like adding more than permitted. When additives are added in excess or to foods in which they aren’t permitted, it becomes a case of food adulteration.

Safe Cooking Practices Lower Levels of Contaminants

It is better to reduce consumption of foods cooked at high temperatures (e.g. by frying, grilling, and baking). One should refrain from eating foods that are cooked to a crisp, smoked, charred, or blackened, to reduce exposure to harmful chemical products like AGEs, acrylamide, heterocyclic amines, nitrosamines, and polycyclic aromatic hydrocarbons.

Cooking foods at lower temperatures (boiling, steaming temperatures) or eating some vegetables in the raw form will reduce exposure to most of these chemicals formed at high cooking temperatures.
Food adulteration

Buying food from reliable sources is also an important step towards ensuring that we consume safe food. This reduces the chances of the food being adulterated. Unscrupulous vendors may add inferior quality material or extract valuable ingredients from a food for economic gains. This not only decreases the quality of the food but can lead to serious health consequences if non-edible harmful ingredients are added to food.

According to the Food Safety and Standards Act, 2006 an adulterant is defined as “any material which is or could be employed for making the food unsafe or sub-standard or mis-branded or containing extraneous matter”

Foods commonly adulterated

Adulterants have been detected in almost all kinds of foods - food grains and pulses, edible oils and fats, spices, milk and milk products, meat and meat products, beverages (both alcoholic and non-alcoholic), tea, coffee, sweetening agents like sugar, honey, jaggery and items made from these like mithai. Foods which are more likely to be adulterated include:

- Foods which are expensive - like edible oils, spices, etc.
- Foods which sell more like wheat flour, oil, milk etc. are foods consumed daily
- Foods which are perishable like milk and milk products
- Foods sold loose like milk, spices, etc.
- Foods in which it is easy to mix an adulterant like those in the form of powder, paste or mince.

Foods which are in a powder, minced or paste form are also more likely to be adulterated, as it is more difficult for the naked eye to detect adulteration in these foodstuffs. For instance, when buying minced mutton, it is difficult to tell which animal meat is being sold as goat meat, or similarly whether starch dyed yellow has been added to turmeric powder. Adulteration of foods sold loose by the retailer is also more common as compared to packaged foods as labels carry the name and address of the manufacturer or distributor and they can be caught by the regulatory authority if their food stuff is found sub-standard. Consumers should avoid buying foodstuffs sold loose even though these are cheaper.

Selecting Pure Spices

Ground spices are at a high risk of adulteration with coloured starch, straw, chalk powder etc. It is important to keep certain points in mind while purchasing these spices- Do not purchase loosely sold powdered spices as they are at a higher risk of being adulterated. Packets should be sealed properly and carry FSSAI license number and preferably AGMARK logo. Check the best before date. Do not purchase if the spices are too brightly coloured or have an extra shine.

Health effects of adulterants

Adulteration not only lowers the quality but may also lead to adverse health effects. There have been instances of death due to toxic substances added as adulterants to food. Chemicals like urea, sodium carbonate (washing soda, soda), sodium hydroxide (caustic soda), formaldehyde and hydrogen peroxide added to increase the shelf-life of milk, can damage the intestinal lining by irritating it. Use of the Lathyrus pulse to adulterate lentils (masoor) or toor dal or besan, can prove to be harmful. This pulse has a toxic factor, which is a neurotoxin leading to the crippling disease lathyrism. Mustard oil has been found to be adulterated with argemone oil which leads to symptoms of oedema, gastrointestinal disturbances, increased permeability of blood vessels, glaucoma, respiratory symptoms and congestive heart failure. Mineral oil (liquid paraffin) and castor oil, cheap inedible oils used as adulterants, may have a laxative effect with nausea, vomiting and possible damage to the lining of the intestine if consumed in excessive amounts or for a long period of time. Similarly, industrial dyes (like metanil yellow, sudan dyes, auramine, etc.) being used to colour food products have led to food poisoning outbreaks.

Prevention and Control

The Food Safety and Standards Authority of India (FSSAI) has been established for laying down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. FSSAI has also developed a simple, illustrated manual to detect common adulterants at home called DART - Detect Adulterants with Rapid Tests. This manual can be accessed from the weblink provided in the references. The simple tests include physical inspection of food as well as chemical reactions. For instance, artificially coloured pulse grains will leave a colour trail when immersed in a glass of water. Pure silver leaves will crumble to a powder when crushed between fingers whereas aluminium used as an adulterant on mithai (sweetmeats) is not that delicate and will leave shreds. If powdered spices are sprinkled on the water surface, pure spices will not leave any saw dust/powdered bran on the surface of water. In case one finds that any food item is adulterated, one must stop using the food product and report this to the authorities. State Food Authorities in addition regularly pick up samples and analyse them for quality and presence of adulterants. Food vendors selling adulterated food items are prosecuted as per the provisions of the FSS Act.

An efficient monitoring and surveillance system can help in ensuring that all food produced and sold for human consumption is safe from contamination and willful adulteration. Methods for reducing contamination of foods at the primary production stage should be actively used. It is also important to prevent contamination and production of hazardous chemicals in food during secondary and tertiary stages of production.
Summary

- Residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, mycotoxins and toxic chemicals naturally present in plants and animals are likely to contaminate food at the primary production stage.

- Residues of pesticides detected in different foods like cereals, pulses, fruits, vegetables and in drinking water are a result of poor agricultural practices at the farm level.

- Pesticides even in small quantities can prove to be hazardous for us as our body finds it difficult to excrete them. Non-pesticide dependent agriculture and integrated pest management (IPM) is thus increasingly gaining popularity. Biopesticides i.e. natural materials like animals, plants, bacteria and certain minerals or biochemicals are being used for pest management.

- Various types of drugs are used for animals, fowl and insects like bees which provide us with food like meat, milk, eggs and honey. Residues of these drugs show up in the food leading to acute food poisoning outbreaks, increased risk of antimicrobial resistance and economic loss to the food industry which uses live cultures for production of fermented products. Hormones in food and water have been linked to endocrine disruption in humans with increased risk of breast cancer and early puberty in girls.

- Good veterinary practices need to be followed and appropriate withdrawal time period given before milking or slaughtering animals for consumption.

- Food grown in contaminated soil or using contaminated water (especially raw sewage water/sludge), or even in the vicinity of polluting industries tends to be high in heavy metal content. Similarly, fish and other seafood from contaminated water bodies have heavy metals in them. Metals may also enter food from metallic cans and other containers in which the food is cooked, stored or packaged, especially if the food is acidic in nature.

- Heavy metals like lead, cadmium, mercury and arsenic can cause a lot of damage to human health as it is difficult for the body to excrete them. Bioaccumulation and biomagnification are a serious issue. Higher the animal in the food chain, greater the heavy metal concentration in body and higher the risk of adverse effects. Safe waste disposal is the key to reducing contamination of air, soil and water.

- Fungi growing on food may produce toxins (mycotoxins) which are harmful to health. Some of these are potential carcinogens. Some examples of mycotoxins are aflatoxins, ergot alkaloids, trichothecenes, fumonisins, zearalenone, patulin and ochratoxin.

- Proper hygienic and controlled storage conditions and certain processing activities can reduce mycotoxin levels in food and feed.
• Environmental, agricultural, industrial, or other sources can contaminate animal feed and feed ingredients, causing serious adverse effects to animal and human health. Contamination can happen at any stage of the animal feed production system – harvest, manufacture, storage, or transportation.

• Transmissible Spongiform Encephalopathies (TSEs) are a group of progressive degenerative conditions that affect the brain and nervous system of some animals and humans. The spread of TSEs has been linked to offal from affected animals being used as feed for other animals. Quality and safety of animal feed hence needs to be monitored.

• Some toxins and anti-nutritional factors occur naturally in food stuffs while others may be formed because of the way we process and package the foods.

• Shellfish poisoning, epidemic dropsy and lathyrism are some conditions which develop as a result of naturally occurring toxic substances in foods. Some of the chemicals which act as anti-nutritional factors interfering with the utilization of nutrients by our body are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides.

• Advanced Glycation End Products (AGEs), acrylamide, heterocyclic amines, polycyclic aromatic hydrocarbons and nitrosamines are formed when certain foods are cooked at high temperatures. One should refrain from eating foods that are cooked to a crisp, smoked, charred, or blackened, to reduce exposure to harmful chemical products.

• Toxic chemicals (like BPA, phthalates, inks, etc.) and metals may also migrate from the packaging/holding container to the food. Hence it is very important that the best quality materials be used for cooking, storing and packaging food.

• Unscrupulous vendors may add inferior quality material or extract valuable ingredients from a food for economic gains thus not only decreasing the quality of the food but also leading to adverse health consequences especially if non-edible harmful ingredients are used as adulterants.

• Foods which are expensive, have high sale value, are perishable, sold loose or sold in powdered, minced or paste form are more likely to be adulterated. One needs to be vigilant about the quality of food that is procured for consumption.

• The Food Safety and Standards Authority of India (FSSAI) has been established for laying down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.
Key Terms

**Bioaccumulation** – is the gradual accumulation of a substance in the body over time resulting from faster absorption in comparison to the rate of excretion.

**Biomagnification** – also known as bioamplification is the concentration of toxins (like pesticides, heavy metals, etc.) in an organism at successively higher levels in the food chain.

**Biopesticides** - are natural materials like animals, plants, bacteria and certain minerals or biochemicals which can be used for pest management.

**Carcinogenicity** - ability to produce cancer.

**Endocrine disruptors** – are chemicals which interfere with the normal functioning of the hormones of the body producing adverse health effects consequently.

**Mutagenicity** - ability to cause genetic changes.

**Oncogenicity** - ability to induce tumour growth.

**Persistent Organic Pollutants** – are chemicals which are organic in nature and tend to persist in the environment as they do not dissipate easily. They have adverse health consequences.

**Teratogenicity** - ability to cause birth defects.

Exercises

1. Discuss why pesticide residues in food and feed are health hazards.

2. How do veterinary drug residues in food affect us? How will good veterinary practices help to reduce our exposure?

3. What do you understand by bioaccumulation and biomagnification? Discuss with reference to mercury levels in fish.

4. What are mycotoxins? Explain how we can reduce our exposure to mycotoxins.

5. Why is it important to monitor the quality of feed given to animals used for production of food for humans?

6. List some toxic chemicals which are produced during cooking/processing. How can exposure to these be reduced?

7. How can packaging introduce contaminants in our food?

8. What is food adulteration? Which foods are more likely to be adulterated?
Activity

Visit your local market or use the food stuffs in your kitchen for this activity. Download the DART book for testing adulterants in food. Select some basic spices like pepper corns, turmeric and red chilli powder, as well as milk and cooking oil. Perform the simple tests described in the manual to check the purity of the food items.

References

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Chapter 8: Food Safety Law: Safe Food from Farm Gate to Plate

Overview of food safety law and regulations

The Food Safety and Standards Authority of India (FSSAI) is an autonomous body established under the Ministry of Health and Family Welfare. The FSSAI has been established under the Food Safety and Standards (FSS) Act, 2006 which is a consolidating statute related to food safety and regulation in India.

Brief historical perspective -from PFA to FSS Act.

Till 1954, several food laws were in force in different States of the country. There was considerable variance in the standards and rules for food and its trade under these laws leading to interference in the inter-provincial trade. In 1950, the Constitution of India empowered the Central Government for making legislation on food adulteration, as the subject was included in the concurrent list of the Indian Constitution. Thereafter, a Central legislation called the Prevention of Food Adulteration (PFA) Act was enacted by Government of India in 1954 which came into effect in 1955. The Act repealed all laws existing at that time in States concerning food adulteration.

Subsequently, to control the manufacture, sale and distribution of a number of food products including enforcement of sanitary and hygienic practices of the establishments where these products were manufactured, the Government of India promulgated various orders under the Essential Commodities Act, 1955, which included:

- The Vegetable Oil Products (Control) Order, 1947
- The Fruit Products Order, 1955
- The Solvent Extracted Oil, De oiled Meal, and Edible Flour (Control) Order, 1967
- The Meat Food Products Order, 1973
- The Milk and Milk Products Order, 1992
- The Edible Oils Packaging (Regulation) Order, 1998

These orders were administered by different Ministries of Government of India and over a period of time, this led to a state of multiplicity of food standards (often overlapping and sometimes contradictory to one another) and enforcement agencies. This created confusion among food businesses, consumers, traders, manufacturers and investors and hampered the growth of a modern food processing sector in the country as well as fixation of safety standards. Realizing how inadequate these Acts and Orders were proving, the Prime Minister’s Council of Trade and Industry in 1998 recommended enactment of a comprehensive legislation of food subsuming all the present food laws to modernize the food sector and ensure safety of food. In 2004, the Joint Parliamentary Committee (JPC) emphasized that all the present food laws should be converged and there should be just one regulatory body for the whole of India. The Food Standards and Safety Bill, 2005 was passed by both the Houses of Parliament after extensive discussions, consultations with stakeholders and forging a consensus on contentious issues and received assent of the
President of India on 23rd August 2006. It was thereafter published in the Gazette of India (Extraordinary) Part I, Section 1 dated 24th August, 2006. The Food Safety and Standards (FSS) Act, 2006 repealed the PFA Act and all the six Orders stated above.

**Objectives, Mandate and Scope of FSS Act and Authority**

The objective of the FSS Act, 2006 is to make available safe and wholesome food to the public, in keeping with changing needs and requirements. The Act also aimed to establish Food Safety and Standards Authority of India (FSSAI), as the single reference point for all matters relating to FSS Act, Regulations and enforcement, by moving from multi-level, multi-departmental control to a single line of command.

The major areas of departure of FSS Act from PFA act are:

- **a.** Food safety is the primary responsibility of the Food Business Operator (FBO) as he knows best how the food is manufactured and how safety can be compromised.

- **b.** Risk assessment must form the basis of standard setting. The regulator needs to monitor the latest scientific development in the food sector, emerging safety issues across the world and anticipate safety risks before they actually hit.

- **c.** FBOs at various stages in the food chain need to adhere to applicable safety and hygienic practices as contamination can occur at any point in the food chain. Certification of food safety processes or safety audits become important to ensure food safety

- **d.** Transparency in setting standards wherein stakeholders are provided with reasonable time to give suggestions on proposed regulations as well as sufficient time to FBOs to make necessary changes in their processes to adopt the new regulations.

- **e.** FBOs have a clear means of contesting the findings of government food laboratories by appealing to accredited referral laboratories.

Two years later, FSSAI was established under the administrative control of Ministry of Health and Family. The mandate assigned to FSSAI is a) to develop science based standards for food and b) to regulate and monitor the manufacture, processing, storage, distribution, sale and import of food, so as to ensure the availability of safe and wholesome food for human consumption. The Food Safety and Standards Rules, 2011 were notified vide Gazette Notifications dated 5th May, 2011. Six principal regulations were notified and came into force on 1st August 2011 - Food product standards and food additives, Contaminants, toxins & residues, Packaging and labelling, Licensing and registration of FBOs, Prohibition and restriction on sales, Laboratory and sample analysis.

All kinds of food whether unprocessed/semi-processed/processed foods are covered under the scope of the FSS Act. It also includes all kinds of substances and water that is used in the preparation of food. It is important to mention that, the Act considers live animals or products of agriculture, horticulture or animal husbandry as food only when it has already passed on from the hands of a farmer. Thus, all activities throughout the food value chain, after primary production through distribution to retail and catering are under
the ambit of the Act. The Act does not discriminate between a small hawker or a huge FBO and makes it mandatory for everyone handling food to keep it safe and fit for human consumption. Therefore, this Act is applicable to every person who is in the food business.

**Organizational structure with Roles and Responsibilities**

Food Authority is the apex body under FSS Act, and a single reference point related to food safety and standards in the country. It comprises of a Chairperson and 22 members, of which at least one-third are women representing various relevant Ministries and Departments such as Agriculture, Commerce, Consumer Affairs, Food Processing, Health, Legislative Affairs and other stakeholders representing farmers, scientists & technologists, small scale enterprises and consumer bodies. The Food Authority is assisted by Scientific Committee and various Scientific Panels in setting standards of food products and by the Central Advisory Committee (CAC) in coordinating with enforcement agencies. State/District level steering committees assist, aid or advise on any matter concerning food safety in a State/UT.

The Chairperson and Chief Executive Officer of FSSAI are appointed by the Central Government. The CEO is responsible for the day to day administration of the Food Authority and draws up work programme of the Authority in consultation with CAC and is responsible for implementing the work programme and decisions of the food authority. The CEO exercises the power of Commissioner of Food safety while dealing with matters relating to food safety of such articles.

The governing structure of FSSAI is depicted in Figure 1.

![Figure 8.1: Governing Structure of FSSAI](image-url)
The role of the Food Authority as prescribed under FSS Act is as under:

a. To specify food quality and safety standards and guidelines for food articles

b. To specify food labelling standards including claims on health, nutrition, special dietary uses and food category systems

c. To specify appropriate system of enforcement

d. To lay down methods of sampling, analysis and exchange of information among enforcement bodies

e. To lay down mechanisms and guidelines for recognition of accredited certification bodies engaged in FSMS auditing/certification.

f. To ensure quality control of imported food.

g. To provide scientific advice and technical support to central / state governments in matters of framing the policy and rules in areas relating to food safety and nutrition, in implementation of food safety crises management procedures, for improving cooperation with international organisations

h. To create an information network across the country to disseminate reliable and objective information on food safety and issues of concern including introduction of rapid alert system to all its stakeholders

i. To provide training programs in food safety and standards for persons who intend to become involved in businesses

j. Contribute and promote co-ordination of work on food standards undertaken by international governmental and non-governmental organisations.

**Decentralized regulatory delivery (Centre vs State role)**

India is a vast country with a population of over 1.3 billion and the sheer magnitude of food safety enforcement is a challenging task. The Food Authority and the State Food Authorities jointly share this responsibility. While the Food Authority provides policy intervention through notification of various food safety regulations and direction and coordination at National level, States/UTs conduct enforcement at the field level to verify compliance by FBOs to food standards. FSSAI provides support in the form of imparting training and capacity building of the enforcement staff of States/UTs. The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, Rules and Regulations made thereunder. All Commissioners of Food Safety are members of CAC. The CAC ensures close cooperation between Food Authority and State enforcement agencies. The CAC advises the Food Authority on its work programme, prioritization of work, identifying potential risks and pooling of knowledge. The organisational structure at the State level is described in Figure 2. Details about the testing labs and offices at the regional levels is given in Figure 3.
Figure 8.2: Organizational Structure at the State Level

Figure 8.3: Regional Laboratories and Offices
Other regulatory bodies dealing with food

**Bureau of Indian Standards (BIS)** is the National Standards Body of India, functioning under the aegis of Ministry of Consumer Affairs, Government of India for harmonious development of the activities of standardization, conformity assessment and quality assurance of goods, articles, processes, systems and services.

BIS has its Headquarters at New Delhi and 5 Regional Offices (ROs) which are at Kolkata (Eastern), Chennai (Southern), Mumbai (Western), Chandigarh (Northern) and Delhi (Central). There are 22 branch offices under the Regional Offices which offer certification services to the industry and serve as effective link between State Governments, industries, technical institutions, consumer organizations etc. of the respective region.

BIS is engaged in formulating Indian Standards in various technology areas and service sectors under the Bureau of Indian Standards Act, 2016 by a process of consultation involving Government and regulatory bodies, consumers, manufacturers, technologists, scientists and testing laboratories, through duly constituted technical committees comprising of Sectional Committees, Subcommittees and Panels which deal with specific group of subjects. In the Food and Agriculture sector, BIS has formulated over 2150 Indian standards covering food product and equipment specifications, test methods and hygiene codes covering the entire feed and food chain from farm to fork.

BIS does not make Technical Regulations. However, there are technical regulations which make compliance to BIS standards mandatory. Technical regulations are issued by various Departments/Ministries of Government of India.

BIS also operates a product certification scheme by which it grants licenses to manufacturers covering practically every industrial discipline. Though the BIS product certification scheme is essentially voluntary in nature, Government of India, in public interest (for example public health and safety, security, infrastructure requirements, mass consumption) has enforced mandatory BIS certification on various products through various Quality Control Orders or under Regulations issued from time to time under various Acts. In the food sector, FSSAI through the FSS (Prohibition and Restriction of Sales) Regulations, 2011, has made BIS certification mandatory for manufacture, sale and distribution of twelve food products for human consumption covering packaged waters, infant foods, milk powders and condensed milk.

The **Export Inspection Council (EIC)** is the official export–certification body of India which ensures quality and safety of products exported from India. The Export Inspection Council (EIC) functions under the Ministry of Commerce and has a mandate to ensure that products notified under the Export (Quality Control and Inspection) Act, 1963 meet the requirements of the importing countries in respect of their quality and safety.

This assurance is provided through certification of export commodities either by a consignment-wise inspection or quality assurance systems (in process quality control and self-certification) in the exporting units or through installation of food safety management in the food processing units. EIC has its 5 field offices ‘Export Inspection Agencies (EIAs)’ and a network of 30 sub offices backed by NABL accredited laboratories at various places. EIC provides mandatory certification for various food items namely fish and fishery products, dairy product, honey, egg products, meat and meat products, poultry meat
products and meat by-products, feed additives and pre-mixtures, while other food and non-food products are certified on voluntary basis.

Agricultural and Processed Food Products Export Development Authority (APEDA) and Marine Products Export Development Authority (MPEDA) also function under Ministry of Commerce, Government of India. The main work of these Authorities is to promote the export, assure the quality of the product as per international standards, formulate the standards for export, etc.

APEDA is mandated with the responsibility of export promotion and market development of agricultural commodities and processed foods. The products under the purview of APEDA includes fresh fruits and vegetables, floriculture, processed foods, meat, poultry, milk and other livestock products, food grain, cereals, seeds and allied products. In addition, it has the responsibility to monitor the import of sugar.

APEDA has its Headquarters at New Delhi and 5 Regional Offices and 13 virtual offices which perform the functions of APEDA, make registration and financial assistance schemes etc. available to entrepreneurs / prospective exporters.

MPEDA regulates exports and market promotion of marine products outside India. It is mandated to take all measures required for ensuring sustained, quality seafood exports from the country including carrying out inspection of marine products, implementation of financial assistance schemes for infrastructure development for better preservation and modernized processing, fixing standards, specifications, and imparting trainings to fishermen, fish processing workers, aquaculture farmers and other stake holders in the respective fields related to fisheries. MPEDA has its Headquarters at Kochi, Kerala and has 11 Regional Offices and 14 sub-regional divisions.

The Directorate of Marketing and Inspection (DMI) is an attached Office of the Department of Agriculture, Cooperation and Farmers Welfare under Ministry of Agriculture & Farmers Welfare. It was set up in 1935 to implement the agricultural marketing policies and programmes in the country with a view to safeguard the interests of farmers as well as the consumers. It implements the provisions of the Agricultural Produce (Grading & Marking) Act, 1937. Standards notified as per the provisions of the Act are popularly called AGMARK Standards. These standards differentiate between quality and 2-3 grades are prescribed for each commodity. Grades help farmers to get prices for agricultural commodities as per the quality produced by them and consumers get the desired quality. The DMI is implementing the scheme of certification of agricultural commodities for domestic trade and export. The Scheme is voluntary. For blended edible vegetable oils and fat spreads, certification under AGMARK is mandatory as per provisions in The Food Safety and Standards Act and regulations, 2006.
Risk Analysis

Risk Analysis is an internationally accepted and systematic approach to examine and assess public health and safety risks associated with food and to formulate, implement and communicate risk management decisions. Risk analysis is comprised of three interrelated components—risk assessment, risk management and risk communication.

It is widely recognized that risk analysis must form the basis for a food regulator in developing new food standards, evaluating proposed changes to existing food standards, for monitoring and surveillance activities, assessing new food processing practices, considering emerging food safety issues and ultimately help in taking necessary action.

Risk Assessment

Risk assessment – is the scientific evaluation of known or potential adverse health effects resulting from human exposure to food-borne hazards. The evaluation must be based on data which is of high quality, is credible and objective (e.g. toxicological studies, relevant human studies, laboratory-based studies, exposure studies, surveillance studies etc.). The process consists of the following steps:

**Step 1 - Hazard identification:** “Could this food or anything in it be harmful?” Risk assessors collect and review scientific data and identify biological or chemical hazards in food.

**Step 2 - Hazard characterization:** “What effects do the hazards cause?” Risk assessors evaluate scientific data to determine whether evidence is strong enough to demonstrate that a substance has the potential to cause harm and the nature of the harm.

**Step 3 - Exposure assessment:** “Who may be harmed and what level of exposure may be harmful?” Experts estimate how much of the food or ingredient consumers in general, population groups (e.g. infants, children, adults) or sub-populations (e.g. vegetarians, vegans) are likely to be exposed to under real-life conditions, where both dose and duration are considered. The exposure must be evaluated to determine if a hazard presents an actual risk (step 4). With increased exposure, the risk also increases.

**Step 4 - Risk characterization:** “How likely is it that people will be exposed at a level that can cause harm in real life?” The level of exposure that can cause harm is compared to the actual level of exposure that someone would experience in real life. If the exposure level is higher than that which causes harm, there may be a safety concern for consumers in general or for specific groups.

Risk Management

Risk management – is the process of weighing policy alternatives in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers, and, if needed, selecting appropriate prevention and control measures.
A range of risk management options are available to FSSAI as risk managers for preventing or reducing health risks associated with food. These options can be regulatory i.e. those specified in the Regulations, such as end product standards or outcome-based standards or non-regulatory, such as industry codes of practice, guidelines or information campaigns. While taking such measures, the social and economic aspects are also considered in addition to the scientific risk assessment.

Risk Communication

Risk communication – FSSAI is responsible for risk communication, which is a two-way process and involves sharing the information internally with risk analysis team and with external stakeholders including general public in an open and transparent way including the explanation of risk assessment findings and the basis of risk management decisions. Risk communication is also important to help bridge the gap which sometimes exists between the scientific assessment and consumers’ perceptions of risk.

As per the Food Safety and Standards (Food Recall Procedure) Regulations, 2017, the Food Authority may publicise the recall when it is of the opinion that the public needs to be alerted about a health hazard or that clarification of the situation needs to be made to allay public worries. In cases of public health emergencies, the Food Authority may, depending on the available evidence, alert the public before a decision on recall has been reached.

The Food Authority is planning to establish a web-based facility titled ‘Food Recall portal’ on its website with a unique identification number assigned to each recall for monitoring and to provide information to the consumers about such recall.

FSSAI established a **Food Safety Knowledge Assimilation Network (FSKAN)** portal in 2017 for building a scientific community for collation of knowledge and expertise at one place and to provide an electronic forum for scientific consultation as well as exchange of scientific information and coordination of research activities across the country. These serve as a resource for FSSAI when required to be consulted for particular purpose related to food safety.

FSKAN has provided a platform for wider exposure of identified concern areas/ issues across various food sectors leading to a more synchronized and targeted research in the country, avoided duplication in research and also in formulation and execution of joint projects in areas where gaps or uncertainty in risk assessment for food safety exist. FSKAN has helped FSSAI in strengthening its capacity to manage food safety risks and ensuring rapid access to information during food safety events.

Food standards – Ingredients and Additives

The basic purpose of establishing food standards is protection of public health and risk, promoting fair trade in food, prevent misleading or deceptive products and enable
consumers to make informed choices by providing adequate information. It is important that such standards should be uniform nationally so that FBOs in all parts of the country have only one set of requirements to be complied with and hence a level playing field.

**Standard setting process**

The entire process of standard setting is carried out in a transparent manner involving all stakeholders. FSSAI has constituted scientific bodies, namely the Scientific Committee and subject specific Scientific Panels comprising of eminent independent subject experts/scientists. The Scientific Committee comprises of Chairpersons of all Scientific Panels and six independent experts, responsible for providing consistent opinion to Food Authority while harmonizing working methods of Scientific Panels. The Committee provides opinions on cross industry and sectoral issues and covers areas that are unique and not covered under the competence of the Scientific Panels.

The scientific risk assessment and setting of standards is carried out on the basis of latest developments in food science along with various factors like emergence of new additives, changes in processing technology, identification of new risks associated with metallic contaminants, residues of veterinary drugs, microbiological contaminants, nutritional aspects, advances in analytical methods etc.

Formulation of standards of any article of food involves several stages (Figure 4). After recommendation by the Scientific Panel and validation by the Scientific Committee, a standard is approved by the Food Authority and by Ministry of Health and Family Welfare. Thereafter, a draft notification is issued for inviting public comments for a period of 60 days. The comments received are then considered by the relevant Scientific Panel and after approvals of the Scientific Committee, Food Authority and the Ministry, the standard is finally notified as either an amendment to an existing regulation or a new/revised regulation.

![Figure 8. 4: Stages for Formulation of Food Standards](image-url)
Types of Standards

Food Standards can be broadly categorized into –

**Horizontal Standards**- Horizontal Standards cut across food categories and primarily relate to food safety covering limits for various contaminants (chemical and biological), toxins in food and also requirements for packaging, labelling and claims. These are covered under FSS (Contaminants, Toxins and Residues) Regulations, 2011, under Appendix B of FSS (Food Product Standards and Food Additives) Regulations, 2011 and FSS (Packaging and Labelling) Regulations, 2011.

**Vertical Standards**- Vertical Standards mainly include identity and compositional standards of specific food products and are covered under FSS (Food Product Standards and Food Additives) Regulations, 2011 and under FSS (Health Supplements, Nutraceuticals, Foods for Special Dietary Use, Foods for Special Medical Purpose, Functional food and Novel food) Regulations, 2016.

Harmonization

Harmonization of Indian food standards with global standards is one of the principles mandated under the FSS Act. Standards set by FSSAI are based on international best practices and all efforts are made to harmonize with Codex to promote international trade and higher levels of food safety. Wherever, suitable and appropriate, codex standards are considered for adoption with or without modifications provided they are in line with domestic industry and consumer practices.

Food Safety by Kind of Business

FSSAI recognizes that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain - by all involved with the production, processing, trade and consumption of food, as food can be contaminated at any step in the food chain unless effective controls are not put in place. This approach encompasses the whole food chain from primary production to final consumption and the stakeholders include farmers, food processors, transport operators, distributors (wholesale and retail) and consumers. One weak link can make the whole food chain collapse. This necessitates the adoption of practices in food production, post-harvest treatment, processing and handling that reduce the risk of microbiological, chemical and physical hazards from entering the food chain (or controlling at source, if feasible). There are some cases in which the hazard simply cannot be removed from foodstuffs, for example, those hazards involving chemical contaminants. The adoption of sound practices along the food chain – based on the principles defined in Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) – are the keys to discharging this responsibility along the food chain.

Keeping this in view, FSSAI has laid down detailed sanitary and hygienic practices that should be followed by FBOs irrespective of their position in the food chain in order to ensure food safety. These practices are commonly called as Schedule 4 requirements (provided under Schedule 4 of FSS (Licensing and Registration of Food Business) Regulations, 2011). Compliance to these practices must be ensured by FBOs in the same way as compliance to standards of end product.
Schedule IV requirements and its significance

To provide assurance of food safety, FBOs should strive to implement an effective Food Safety Management System (FSMS) based on Hazard Analysis and Critical Control Point (HACCP) and suitable pre-requisite programmes by actively controlling hazards throughout the food chain starting from food production till final consumption.

Every licensed FBO must have a documented Food Safety Management System (FSMS) plan and is required to comply with Schedule 4 of FSS (Licensing and Registration of Food Business) Regulation, 2011. Schedule 4 introduces the concept of FSMS based on implementation of Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) by food businesses and is divided into five parts as given in Table 1.

<table>
<thead>
<tr>
<th>Schedule 4</th>
<th>General Requirements</th>
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<tbody>
<tr>
<td>Part 1</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for registration - Petty food operators and Street food vendors</td>
</tr>
<tr>
<td>Part 2</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license- Manufacturing/ processing/ packaging/ storage/distribution</td>
</tr>
<tr>
<td>Part 3</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license- Milk and milk products</td>
</tr>
<tr>
<td>Part 4</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license- Slaughter house and meat processing</td>
</tr>
<tr>
<td>Part 5</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license- Catering</td>
</tr>
</tbody>
</table>

Recently, FSSAI has introduced a web-based real time inspection platform for FSOs called **Food Safety Compliance through Regular Inspection & Sampling (FoSCoRIS)**. Based on the risk score of the food business the frequency of inspections is decided, and the inspections are allotted to FSOs by Designated Officers (DOs) through this application, making the application transparent and efficient. This platform enables verification of physical inspection taking place with features like geotagging, time-stamping and real time data collection. It can be used via hand-held devices and FSOs can upload the findings of the inspection of FBOs on the application which in turn helps to digitize inspection reports. This system is envisaged to ease sample collection and forwarding, traceability and, control the quality of compliances.

FSMS Guidance Documents

A series of sector specific Food Safety Management System (FSMS) Guidance Documents have been developed with the help of domain experts with the intent to provide implementation guidance to food businesses (especially the small and medium
businesses) involved in manufacturing, packing, storage and transportation to ensure that critical food safety related aspects are addressed throughout the supply chain.

These documents are primarily based on Schedule 4 of FSSs (Licensing & Registration of Food Businesses) Regulation, 2011. The documents are recommendatory in nature and provide the basic knowledge and criteria for implementation of Hazard Analysis and Critical Control Point (HACCP) system by the food businesses. Inspection checklists for FBOs to audit their facility and operations are also included in these documents. The FBOs can evaluate themselves based on the indicative scoring. Also, these documents provide important templates and forms to facilitate the FBOs to maintain the records. These include mandatory forms as prescribed by FSSAI and templates for maintaining records of processes critical for food safety.

**Third party auditing**

To strengthen the food safety surveillance system, FSSAI has developed a framework for conduct of food safety audits of FBOs to ensure compliance to sanitary and hygienic requirements, through Recognized Auditing Agencies as per FSS (Food Safety Auditing) Regulations, 2018. It is envisaged to use food safety audits as an alternate to regulatory inspections by Central or State FSOs thereby leading to less frequent regulatory inspections except for regulatory sampling. This will strengthen food safety surveillance system and encourage self-compliance while at the same time assuring safe food to the consumers.

**Hygiene rating and Right Place to Eat Scheme**

Hygiene Rating and Right Place to Eat Scheme has been initiated by FSSAI recently under Project Serve Safe, with the intent of ensuring that consumers make informed choices while eating out and encouraging food businesses to showcase and improve their food hygiene standards.

Hygiene Rating reflects the standards of food hygiene found on the date of inspection by the local authority or recognized third party audit agency. This is a voluntary scheme applicable to food businesses supplying food directly to consumers either on or off the premises and food businesses are rated based on food hygiene and safety conditions found at the time of inspection.

Right Place to Eat is a distinguishing mark granted to Food Businesses with hygiene rating of 4 or more, to encourage FBOs in promoting nutrition, and to bring about behavioral change in consumers by making them aware of healthy choices and giving them access to such options.
**FoSTaC**

Food Safety Training & Certification (FoSTaC) is a large scale training and capacity development programme initiated by FSSAI for training of food handlers working in the food businesses at supervisor level, to ensure that the establishments in which food is being handled, processed, manufactured, stored, distributed, conform to the food safety requirements. Once trained the food handlers are certified as “Food Safety Supervisor”. There are 16 FOSTAC courses in three levels, Basic, Advanced and Special covering all sectors of the food business. This initiative was started with the aim to enhance the availability of skilled manpower in order to ensure better implementation and self-compliance to FSS Regulations.

The training is imparted through empanelled training partners and master trainers. FoSTaC began in 2017 and has turned into a nationwide training ecosystem for food business operators. FSSAI has been successful in empanelling several institutes as training partners. FSSAI has mandated that all food businesses having Central Licences or State Licences should have at least one trained and certified food safety supervisor for every 25 food-handlers on all their premises.

**Domestic compliance**

**Licensing and Registration**

As per FSS Act, every FBO in the country is required to be licensed/ registered under FSSAI. The licensing and registration procedure and requirements are regulated by FSS (Licensing and Registration of Food Business) Regulations, 2011. Food Licensing and Registration system (FLRS) is an online system to facilitate FBOs in India to apply for License/ Registration certificate and for tracking their applications during processing.

**Registration** is meant for petty food manufacturers that includes petty retailer, hawker, itinerant vendor or a temporary stall holder or small or cottage scale industry having annual turnover up to 12 lacs. All food businesses having income more than this limit are required to take a license. The process of registration has been outlined in figure 5.
The eligibility criteria for Licensing is according to whether one wants a State or Central License:

**State License**-

- Food Businesses with Annual Turnover between 12 lakhs and 20 crores.
- All grain, cereal and pulses milling units irrespective of turnover.

**Central License**-

- Food Businesses with Annual Turnover more than 20 crores.
- Operating business in two or more States.
- Food business covered under Schedule 1 of FSS (Licensing and Registration of Food Businesses) Regulations, 2011.
The process of licensing is outlined in figure 6.

**State level regulatory structure**

The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, rules and regulations made thereunder. The framework for food safety enforcement machinery in the State as provided under the FSS Act primarily comprises of Designated Officer, Food Safety Officer, Adjudicating officer and Food Analyst (Figure 7).
Commissioners of Food Safety are responsible for ensuring an effective implementation of standards and other requirements under the FSS Act, conduct surveys of industrial units to ascertain compliance of such units to standards under the Act, sanction prosecution for offences, prohibit in the interest of public health, the manufacture, storage, distribution and sale of any article of food and also organize training for officials under the State Food Authority.

Designated Officers (DO) are appointed by Commissioner of Food Safety for every district of a State and are in-charge of food safety administration for that district. Designated Officer is the Licensing Authority who can issue or cancel the License of Food Business Operator (FBO). They have the power to prohibit the sale of any article of food, recommend to the Commissioner of Food Safety for sanction to launch prosecutions, maintain record of all inspections made by FSO and action taken by them in the performance of their duties and to investigate any complaint.

Food Safety Officers (FSO) are the representatives of the Food Authority at the ground level and interact directly with the FBOs and thus are the backbone of the entire food safety compliance structure. They are required to inspect all licensed units as frequently as may be prescribed by the DO, to verify/satisfy that conditions of licenses are being complied, report to the DO, procure sample, send for analysis in case of contravention, surveillance, investigate any complaint and to recommend issue of improvement notices to FBOs based on the results of inspections.

Adjudicating officer (AO) plays a crucial role in enforcement of the Food Law. They have the powers of a civil court for the purposes of the Act and all the proceedings before him are deemed to be judicial proceedings. The AO can issue direction to person found guilty of an offence, for taking corrective action to rectify the mistake or destruction of such article of food. He can also direct the offender to pay compensation to victim or representative of victim in case of injury or death of consumer. He can order for cancellation of license, re-call of food from market as well as forfeiture of establishment and property.
Active and Passive Surveillance

Food Safety Surveillance is a system that collects data regarding all types of contaminants with the purpose of timely identification of food safety hazards that are significant. It can provide relevant data for risk assessment and standards setting. The objective of food safety surveillance is to ensure that the food supplied in the market is safe. Without an effective surveillance system, the consumer can be exposed to a variety of hazards including contaminants, toxins and residues in food. In absence of data, it is not possible to assess the present state and magnitude of the problem. The reports received from surveillance activities are compiled and if any surveillance sample fails due to non-conformity then enforcement sampling may be executed and action for prosecution may be initiated.

Two types of surveillance activities are carried out by FSSAI – Active Surveillance and Passive Surveillance. **Active surveillance** comprises of food safety surveys conducted by FSSAI or the State Food Authorities. It provides the most accurate and timely data on food safety parameters. Such type of surveillance includes National level surveillance, State specific surveillance, Seasonal surveillance, Special surveillance during festivals, Commodity specific surveillance etc.

**Passive surveillance** is a system by which FSSAI receives reports from FBOs or other sources (hospitals, medical care practitioners, research institutions) on contaminants in food products. It is a relatively inexpensive strategy to cover large areas and provides critical information for monitoring community health.

Food imports regulations

FSSAI has the mandate to regulate import of food into the country and ensure that it is safe and wholesome for human consumption. The import procedure and requirements are governed primarily by the FSS (Import) Regulations, 2017. No imports of food article are permitted in India without a valid import license from the Central Licensing Authority of FSSAI.

The major food commodities being imported in India are oil and fats, pulses, fruits and nuts, vegetables, cereals, sugars and sugar confectionery, coffee, tea, spices and beverages. Top exporting countries exporting food commodities to India are Australia, Indonesia, Ukraine, USA, Canada, Brazil and Myanmar.

Import clearance process

FSSAI has its presence at six locations through its own Authorised Officers at Chennai, Kolkata, Mumbai, Delhi, Cochin and Tuticorin covering 20 points of entry. Further, at other Point of Entries throughout the country, FSSAI has notified Customs officials as Authorised Officers for the purpose of regulating food imports. FSSAI has in place an online Food Import Clearance System (FICS), integrated with the customs ICE-GATE (Indian Customs Electronic Commerce/Electronic Data interchange Gateway) under SWIFT (Single Window Interface for Facilitating Trade). The consignment of food articles is referred to FSSAI for clearance by Customs Authorities through FICS.
Thereafter, the food consignments are subject to scrutiny of documents, visual inspection, sampling and testing in FSSAI notified laboratories in order to determine whether they conform to the safety and quality standards laid down under various FSS Regulations.

To expedite the clearance process of imports, Risk Management System (RMS) has been introduced under SWIFT which scrutinizes the application and if the sampling is required; the BOE is referred to FSSAI through FICS or else cleared through green channel. FSSAI has mapped a total of 1470 ITC-HS Codes pertaining to articles of food or food additives with the Customs-ICEGATE. These HS Codes have been subdivided into High Risk or Low-Risk food items based on safety. Further, dual use items have also been identified and if end use is food then the dual use items are referred to FSSAI for clearance.

**Testing facilities**

A laboratory is required under Import regulations to complete the analysis and upload the test report in FICS within five days of receipt of the sample with conclusive opinion about the product tested as conforming or non-conforming. For testing of food import consignments through a transparent and expeditious process, NABL accredited laboratories have been notified by FSSAI throughout the country.

If the samples are found conforming, then a No Objection Certificate (NOC) is generated and if not conforming then Non-Conforming Report (NCR) is generated rejecting the clearance of food consignments. The same is communicated to Customs-ICEGATE through FICS. A system of sending the sample to referral labs exists as in the case of domestic compliance when the sample fails in the notified laboratory. FSSAI has also notified Referral labs for re-testing of appeal samples of the Importers. Animal Quarantine and Plant Quarantine Departments under the Ministry of Agriculture also take samples separately in case of certain food items marked by Customs for their NOC.

Special dispensation for rectification of labels is provided for imported packaged food consignments under Import Regulations, 2017. The Import Regulations also provides for issuance of Provisional NOC in respect of consignments of fresh fruits and vegetables which are perishable in nature with shelf life of less than 7 days or consignments of food which require special storage conditions (refrigerated conditions like frozen or chilled food products) or consignment of pre-packaged retail food products, subject to satisfactory visual inspection and without waiting for the result of testing from the notified laboratory. The consignment can thereafter be moved to the warehouse of the importer. However, the products cannot be released into the domestic market without issuance of NOC which is based on the analysis report. In the event of a non-conformance report, the importer is responsible for moving the consignment back to customs jurisdiction and comply with the requirement of re-export or destruction as decided by AO.
Food traceability

Meaning of Food recall

Food Recall means an action to remove food products from market at any stage of the food chain, including that possessed by consumer, which may pose a threat to the public health or food that violates the FSS Act. Recall of food product is in the common interest of the industry, the government and the consumer. A food recall may be initiated as a result of a report or complaint from a variety of sources – manufacturers, wholesalers, retailers, government agencies and consumers.

Food recall regulations and implementation

The FBOs are strictly liable for any article of food which is unsafe under the FSS Act. The FSS (Food Recall) Regulations provides guidance to the FBOs for food recall procedures whereby an FBO is required to immediately inform the competent authorities and co-operate with them, if the food which he has placed in the market is unsafe for the consumers. The regulations also mandate the FBO to establish an effective and efficient follow-up action/ post-recall report system.

A traceability system is an effective tool with which FBOs can trace food throughout the food chain. The FBO is required to have as a minimum a documented one-step-back/one-step forward traceability approach. Small FBOs with limited distribution may not be required to have a fully documented traceability system in place and may rely solely on their purchasing and sale records to act as their traceability record. In the context of a food recall, the objectives of traceability are to:

a. Identify uniquely a lot/batch/consignment of food in a way that allows tracing of the physical flow of the food forwards through the food chain to the immediate customer and tracing of the physical flow of raw materials backwards to the immediate supplier.

b. Create and maintain accurate traceability records that can be provided within a short time period when needed for recall or at the request of the competent authorities.

Summary

- The Food Safety and Standards (FSS) Act, 2006 repealed the PFA Act and all the six Orders under Essential Commodities Act, 1955.

- The mandate assigned to FSSAI is a) to develop science based standards for food and b) to regulate and monitor the manufacture, processing, storage, distribution, sale and import of food, so as to ensure the availability of safe and wholesome food for human consumption.
The FSS Rules came into effect on 5 August 2011 with the notification of six principal regulations on Food product standards, Contaminant, toxins & residues, Packaging and labelling of food, Licensing and registration of FBOs, Prohibition and restriction of sales, Laboratory and sampling.

Food Authority provides policy intervention through notification of various food safety regulations, provides direction and coordination at National level, States/UTs conduct enforcement at the field level to verify compliance by FBOs to food standards.

The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, rules and regulations made thereunder.

Other regulatory bodies dealing with food include BIS, EIC, APEDA, MPEDA and DMI.

FSSAI assess risks through its Scientific Panel, Scientific Committee and FSKAN. After scientific risk assessment, FSSAI manages risk and take measures which are regulatory (i.e., provisions in the regulations, end products standards), or non-regulatory (such as industry codes of practice, guidelines or information campaigns). While taking such measures, the social and economic aspects are also considered in addition to the scientific risk assessment. FSSAI communicates risks through issuing advisories, social media channels at both central and state level.

The basic purpose of establishing food standards is protection of public health and risk, promoting fair trade in food, prevent misleading or deceptive products and enable consumers to make informed choices by providing adequate information. Food standards can be broadly classified as Horizontal and Vertical Standards. These need to be harmonized with International standards.

FSSAI has laid down detailed sanitary and hygienic practices that should be followed by FBOs irrespective of their position in the food chain in order to ensure food safety. These practices are commonly called as Schedule 4 requirements (provided under Schedule 4 of FSS (Licensing and Registration of Food Business) Regulations, 2011).

Hygiene Rating and Right Place to Eat Scheme has been initiated by FSSAI recently under Project Serve Safe, with the intent of ensuring that consumers make informed choices while eating out and encouraging food businesses to showcase and improve their food hygiene standards.

Food Safety Training & Certification (FoSTaC) is a large scale training and capacity development programme initiated by FSSAI for training of food handlers working in the food businesses at supervisor level, to ensure that the establishments in which food is being handled, processed, manufactured, stored, distribute conform to the food safety requirements.

As per FSS Act, every FBO in the country is required to be licensed/ registered under FSSAI. Registration is meant for petty food manufacturers that includes petty retailer, hawker, itinerant vendor or a temporary stall holder or small or cottage
scale industry having annual turnover up to 12 lacs. All food businesses having income more than this limit are required to take a license.

- Every licensed FBO must have a documented Food Safety Management System (FSMS) plan and is required to comply with Schedule 4 of FSS (Licensing and Registration of Food Business) Regulation, 2011.

- FSSAI has the mandate to regulate import of food into the country and ensure that it is safe and wholesome for human consumption. No imports of food article are permitted in India without a valid import license from the Central Licensing Authority of FSSAI. It is done through an online Food Import Clearance System (FICS).

- Food Recall means an action to remove food products from market at any stage of the food chain, including that possessed by consumer, which may pose a threat to the public health or food that violates the FSS Act.

Keywords

Quality Standards: The standards framed, based upon the intrinsic properties of Agricultural or Food Commodities

Mandatory: Such provisions which are compulsory or binding to comply.

FoSTaC: Food Safety Training and Certification, a large-scale training and capacity building programme for food handlers

FOSCORIS: Food Safety compliance through Regular Inspections and Sampling, a web-based system to verify compliance to food safety and hygiene standards by food businesses as per regulatory requirements.

FLRS: Food Licensing and Registration System, an online system to facilitate FBOs in India to apply for License/ Registration certificate and for tracking their applications during processing.

FICS: Food Imports Clearance System, an online system of FSSAI for imported food clearance

FSKAN: Food Safety Knowledge Assimilation Network, a scientific community for collation of knowledge and expertise and for coordination of research activities across the country.

Exercises

1. What is the objective and mandate of FSSAI?
2. Describe the structure and roles of Food Authority.
3. How does FSSAI ensure food safety at central and state level?
4. Describe the bodies/organisation other than FSSAI responsible for food safety.
5. Explain the process of standards setting.
6. Explain the eligibility criteria for State and Central License.
7. Give a brief note about FoSTaC.
8. How does FSSAI ensure the safety of imported Foods?
9. What are the salient features of FOSCORIS?

References

Chapter 9: Safe Food Everywhere

- Food safety practices at home
  - Personal Hygiene
  - Selecting safe and good quality foods
  - Food handling
  - Waste disposal

- Food safety practices outside home
  - Major concerns in food service sector
  - Food hygiene and safety practices

- Tools to ensure food safety
  - Hygiene rating
  - Food safety training and certification
  - Consumer complaint handling
Chapter 9: Safe Food Everywhere

Unsafe food and poor diets create a vicious cycle of disease and malnutrition particularly affecting infants, young children, elderly and the sick. The ‘food ecosystem’, includes not only food business operators (FBOs) but also the consumers. While food businesses may adopt a casual approach in maintaining food safety and hygiene standards, consumers tend to make wrong food choices (figure 1).

![Figure 9.1: Food Ecosystem – FBO and Consumer](image)

Trap of malpractices can be broken by adequate food safety education. This chapter gives simple tips on food safety to empower consumers as well as FBOs. If we look into the food safety ecosystem closely, it can clearly be seen that, any individual eats either at home or out of home. Hence, accordingly the chapter will look at safety issues at home as well as when the individual eats out whether in restaurants, workplace, school or even at a place of worship.

Food Safety Practices at home

Culture of food safety practices should start at home. If we inculcate these habits within ourselves, we spontaneously will expect the same practices by the food service industry. This will drive the food service industry to adopt the best practices. Food safety can be ensured at the household level by being mindful of personal hygiene, selection of right food, proper food handling and waste disposal.

Personal Hygiene

We ourselves can be the biggest source of contamination. The following precautions need to be taken by all people handling food so that it does not become contaminated:

- Wash hands every time you handle food, go to the washroom or touch surfaces likely to be contaminated like doorknobs, walls, hair, skin, etc.

- Wear clean clothes and preferably an apron to keep street clothes away from food.
• Keep hair short or tied up and covered to prevent strands from falling into food.
• Keep nails short and clean.
• Avoid wearing rings and other pieces of jewellery from which stones, etc can fall into the food.
• Wear gloves while handling food which will not be cooked or reheated like salads.
• Cover all wounds and cuts on your hands properly and preferably wear gloves so that neither the wound nor the bandage comes in contact with the food.
• Do not bring street shoes into the kitchen.
• Avoid cooking if unwell especially with diarrhoea or vomiting as you could be a carrier of a foodborne illness.

Selecting safe and good quality foods

Healthy and safe eating begins with choosing the right kind of foods. It is important that we select safe and wholesome ingredients to prepare our food. Unless contamination is visible in the form of dirt, mold growth, decay, signs of insect or pest infestation (eggs, body parts, hair, excreta, etc.), it is not simple to detect if the food item is safe. One needs to look out for some cues which point to the product being unfit for consumption or at least being on the verge of spoilage.

Food adulteration, as discussed in an earlier chapter, is another menace one needs to be aware of. What can help is the knowledge about the common adulterants, foods which are likely to be adulterated and simple tests for detection of adulteration which can be done at the household level. It is also helpful to know what to look out for in packaged foods. The label of these foods can help the consumer to identify foods which are more nutritious. The sections which follow include some pointers to help consumers select both safe and nutritious foods.

Consumers need to look for certain features before buying different types of foods. Figure 2 illustrates what to look for while shopping for different food groups.
Here are some tips on what to keep in mind while purchasing food from the market:

- **Buy fresh, seasonal and locally available vegetables and fruits at the right stage of maturity.**

- **For packed items, look for FSSAI License, expiry date/best before date along with MRP. Read nutritional content, choose the food items depending on the body type and nutritional need.**

- **Spices and condiments should be closely inspected before purchase, especially powdered spices. Always buy packaged powdered spices and look for quality marks like ISI or AGMARK.**
• Buying food which is at the right temperature is also important. Certain high-risk foods are sold either chilled or frozen. Frozen foods should be frozen solid at the time of purchase. Make sure these are purchased at the end of the shopping trip so that they can be brought home as soon as possible and put in the freezer until use. Maintaining the cold chain is important for foods like meat and meat products, milk and its products as microbes tend to multiply very fast in such foods at ambient temperatures.

• Buying food from reliable sources is also an important step towards ensuring safe food. This reduces the chances of the food being adulterated.

Food handling

Once procured, foods also need to be processed, stored and handled with care to ensure that they stay safe. WHO has outlined five keys to keeping food safe (figure 3). The first is cleanliness. We need to ensure that our hands are clean before handling food. Raw food also needs to be washed and cleaned thoroughly to get rid of visible dirt. It is also important to keep all food contact surfaces clean like kitchen equipment, knives, storage containers, etc. The kitchen and storage areas need to be protected from pests as well as environmental contaminants. The second key is to separate the raw and the cooked foods as there are chances of cross-contamination. Raw food may be contaminated with dust, pesticide residues, microbes which may be passed on to cooked food if both are kept in close contact or if same utensils, knives, spoons are used for both. Raw meat, fish and poultry have a very high microbial load and the same chopping board and knives should not be used for cutting vegetables unless they have been thoroughly sanitized.
Food needs to be cooked thoroughly to destroy any disease-causing microbes which may have been present in the food even after washing and cleaning. The core temperature of the food should reach beyond 70°C, preferably 75°C in tropical climates to ensure that all pathogens have been destroyed. Previously cooked food which had been refrigerated needs to be reheated to this temperature before consumption. All food should be stored at appropriate temperatures. The danger zone between which microbes are known to multiply rapidly is 5-65°C. Hence foods which need to be kept cool should be refrigerated and kept below 5°C. Raw flesh foods are best kept frozen at below -18°C. When it is time to cook or consume frozen food, thawing should either be done in a microwave or under running tap water. Never leave the frozen food at room temperature to thaw. This encourages the growth of microbes. Once thawed the food should not be refrozen again because the microbial load has now increased, probably to dangerous levels. Hence it is advisable to freeze foods in packets or containers which contain amounts which are likely to be consumed by the family in one sitting. Cooked foods should not be left at room temperature for more than 2 hours. If the food is to be served hot after a few hours, it can also be kept hot (like in a bain-marie) above 65°C.

To begin with, it is important to procure good quality raw ingredients from reliable sources. Packaged food products need to be checked for their best before/expiry dates. Storage
instructions by manufacturers mentioned on food labels should be read and followed. Potable water should be used to clean the fruits, vegetables, flesh foods before consumption, cooking or storage.

**Waste disposal**

Households generate waste which needs to be disposed of responsibly. It is important to segregate waste so that it can be sent further for appropriate disposal (figure 4). For instance, food scraps, peels, inedible portions of fruits and vegetables, eggshells, bones, and such other organic matter can be used in homes or colonies itself for making compost. It can also be safely sent to landfills. Other waste like packaging material - paper, cardboard, plastic, tin, etc. needs to be recycled and reused. Waste bins in the kitchen should have tight fitting lids. There should be separate waste bins for biodegradable waste (vegetable matter, paper so that it may be composted later) and recyclable waste (polythene, cardboard, glass, etc.). These bins should be emptied daily and kept thoroughly clean and covered so that they don’t attract pests. They would also need to be disinfected regularly and the area kept odour free by not letting garbage spill or accumulate for long. Avoid throwing solid waste into drains as they tend to get choked and result in backflows. Keep sinks and drains clean. Drains should have traps or covers which do not permit entry of pests like cockroaches or rats.

*Figure 9. 4: Waste Segregation for Better Disposal*
Food Safety Practices Outside Home

Changing lifestyles and eating patterns coupled with increase in purchasing power have led to an increase in the number of people eating outside home. Meals prepared in restaurants, fast food outlets and street food are gaining popularity. This has led to mushrooming of several small and large-scale catering units. This has raised the concern related to food hygiene and safety.

Major concerns in food service sector

Food safety lapses can have disastrous consequences resulting in food poisoning outbreaks and monetary losses for the FBO as well as the consumer. For the FBO it may be loss of business and getting stuck in legal proceedings against them, but for the consumer it leads to loss of wages due to absence from work coupled with medical expenses. In each type of FBO there may be different concerns regarding food safety (Table 1). Irrespective of the size of the operations of any food business, the basic principles of ensuring safe food remain the same. The Codex has outlined the essential principles of food hygiene applicable throughout the food chain and has indicated how these principles should be implemented to ensure safety of food from the ‘farm to the table’. FSSAI has also developed Food Safety Management System (FSMS) Guidance Documents which have been described in the previous chapter.

To ensure food safety in an establishment, one needs to consider various features - starting with the selection of site where the unit will be set up, to the design of the premises. In the premises, the design of the kitchen is of primary importance - the layout of the kitchen, i.e. area where the food will be stored, prepared and served, the drainage and waste disposal facility, and provisions for protection from pests.

Food service establishments can be temporary/mobile units or those which are fixed and so more or less permanent. A mobile food service establishment like a van, pushcart or even a movable stand, is a self-contained food unit which prepares and serves food to consumers. Street food vendors come under this category. A fixed food service establishment on the other hand operates at a specific location and probably has all the basic facilities like water supply, electricity, waste disposal system, etc. In contrast, these facilities are mostly not available in mobile units. Fixed establishments include canteens, restaurants, cafes, as well as food served in institutions like hostels, hospitals, schools, etc. A temporary food service establishment is usually one which sets up operation for a fixed number of days at a location - usually at a fair, or gathering for a festival, exhibition, or any other celebration/event. These units may be supplied with the basic amenities (water, electricity, waste disposal) during the event organized so that they can function smoothly.

With a surge in people travelling for business or pleasure, there is a focus on providing them with safe food during their long journeys by bus or train (wheels), airlines (wings) and ships (waves). Some of these journeys may last for a few days. Contaminated food can lead to serious food poisoning affecting several people at the same time. For railway and airplane journeys the food is generally prepared in advance. Care needs to be taken that this preparation is not too much in advance. Food should be fresh when loaded on trains or airplanes. Sometimes the food is served within a few hours of the journey, however in some long-distance flights, the food may be served 10-12 hours later. And if, trains or flights are delayed, the freshness of the food is further compromised. To ensure that the food remains
safe, adequate cool and hot storage facilities should be available on board. The food should be kept safely packaged and unexposed to contaminants and pests. Only safe packaging material should be used which does not introduce chemical contaminants into the food. Also, safe potable water should be served. Maximum care must be taken for the quality of ice, which should be prepared using potable water and handled carefully.

Journeys on ships may last much longer – a few days to a few weeks. It is not possible for all food to be cooked in advance; hence ships have proper fully functional kitchens like any other hotel or restaurant. They need to follow the same principles of hygiene and sanitation as other food service establishments with proper storage facilities, food processing areas, cleaning areas and well-trained personnel.

Table 9. 1: Concerns regarding food safety in different types of FBOs

| School Meals and Canteens | Children are the vulnerable population. It is essential that food prepared is safe and hygienic. The common issues in school meal service are:
|                          | - Lack of knowledge about food hygiene and safety.
|                          | - Lack of food grade equipment, utensils and cutlery
|                          | - Use of artificial colours and flavours to make food attractive. |
| Restaurants, Cafeteria   | Restaurants and cafeteria are most common places to eat nowadays. It is essential that the food hygiene and safety practices are followed. Some issues in restaurants and cafeteria are:
|                          | - Inadequate space for food preparation area
|                          | - Lack of food hygiene and safety knowledge
|                          | - Improper handling of food
|                          | - Temperature abuse |
| Dhabas, Street Food, Food Trucks, etc. | These are majorly part of unorganised sector. There is complete lack of awareness about food hygiene and safety. The key issues in such businesses are:
|                          | - Do not have FSSAI registration
|                          | - Can be exposed to environmental pollution
|                          | - Lack adequate structures, fitting and designs
|                          | - Use of non-food grade equipment, dirty dusters, etc.
|                          | - Lack of food hygiene and safety knowledge
|                          | - Improper handling of food
|                          | - Temperature abuse
|                          | - No access to clean potable water |
Food hygiene and safety practices

It is essential that food prepared is safe and hygienic for consumption. Essential food hygiene and safety practices have been briefly described below:

1. *Location and Surrounding:* The food premise should be located away from the sources of environmental contamination. If that is not possible then suitable measures must be adopted to protect food service establishments from the source of contamination.

2. *Layout:* The food preparation area, stores, service area, waste disposal area, employee facilities, etc. should be designed in such a way that food prepared is protected from contamination.

3. *Structures and Fittings* such as floors, walls, ceilings, doors and windows should be made of impervious, non-toxic, and easy to clean material. There should be no cracks or crevices, gaps and flaking of paints. Windows should be covered with mesh. There should be adequate lighting (shatter proof lights), ventilation in the food preparation area.

4. *Food Procurement and Storage:* Food should be procured from FSSAI licensed vendor. Food should be received at the right temperature - frozen foods should be at -18°C while foods to be kept in refrigeration should be received chilled at temperatures below 5°C. They should be stored in clean, food grade containers at the required temperatures. There should be adequate space, ventilation, lighting and temperature control facilities in the storage area. Food and non-food items, vegetarian and non-vegetarian food products should be segregated during storage.

5. *Food Preparation:* There should be separate food grade equipment for food preparation of vegetarian and non-vegetarian foods. There should be adequate supply of clean potable water for washing food and equipment and, for food preparation. Food should be thoroughly cooked/reheated above 75°C (core temperature) before serving.

6. *Service and Display:* Clean, food grade utensils and cutlery should be used for food service and display. Hot food should be held at 60°C or above while cold food should be held at 5°C or below.

7. *Packaging and Transportation:* Food grade packaging material and containers should be used while food packaging and transportation. Transport or delivery vehicle should be clean and sanitized. It is preferable that food is held at adequate temperature i.e. hot food at 60°C or above and cold food at 5°C or below.

8. *Personal Hygiene:* Food handlers should go for annual medical check-ups and should be vaccinated for enteric diseases. They must maintain high level of hygiene standards which include bathing regularly, keeping hair, beard and nails trimmed, avoid wearing nail varnish, wear clean clothes/apron, cap and gloves (wherever necessary), wash hands after use of toilets, touching/scratching self, sneezing, coughing, etc. There should be adequate supply of hot and cold water, soap, clean towels and sanitizers. Food handlers should have separate changing area and toilets facilities.
9. *Cleaning and Maintenance*: The food premise (floors, drains, walls, fittings), equipment and cutlery should be thoroughly cleaned after use or end of food processing. There should be adequate facility for hot and cold potable water. The waste should also be disposed regularly from the food premise.

**Tools to ensure food safety**

Food safety can be ensured only when every stakeholder plays their respective role responsibly. For example, an FBO must be self-compliant and make available safe food for the consumers. At the same time, consumer should be aware about what to look for in an FBO and how to select safe food. Consumer organizations need to undertake drives to educate the consumer as well as FBOs about food hygiene and keeping the consumer safe.

FSSAI has devised three major initiatives, which can be used by the FBO and consumer as a powerful tool to ensure food safety. You were introduced to these in the previous chapter. Let us learn about these in greater detail.

**Hygiene rating**

It is an online, transparent rating process aimed at empowering consumers to make an informed choice when they eat out and encourage businesses to ensure hygiene standards.

It is a user-friendly, technology-driven scheme where food service establishments are given a score (between five to one) as per their hygiene and food safety compliance. The businesses can display that they are a Right Place to Eat through stickers and thus promote their business. The consumer can judge whether it is a safe place to eat by looking at the rating of the food service establishment.

Following steps are involved in obtaining a Hygiene Rating:

1. **Self-Assessment by FBO** – The FBO should log-in to Serve Safe Portal with (FLRS) Login ID and password. After the login, self-assess food safety compliance on parameters mentioned on the Hygiene Rating Checklist.
2. **Verification Process** – The FBO will have an option to choose from the empaneled Hygiene Rating Auditing Agency (HRAA)/ Food Safety Department, which will then visit and inspect the premises for food safety compliance. The Food Safety Officer (FSO)/Auditor will submit the report on Serve Safe Portal.
3. **Generation and Display of Hygiene Rating** – Once verification process is complete, FBO can download the Hygiene Rating Certificate and display where it is visible to the consumers.
4. **Overall monitoring by regulatory staff** – The regulatory staff from State or Central authority will be responsible to ensure that the Hygiene Rating of a food service establishment is done in an ethical manner.
Food safety training and certification

In terms of section 16(3) h of the Food Safety and Standards Act 2006, the Food Safety and Standards Authority of India (FSSAI) has to ensure training of persons who are or intend to become involved in food businesses, whether as food business operators or employees or otherwise. It is accordingly desired that -

a. All food businesses having central licences or state licenses should have at least one trained and certified food safety supervisor for every 25 food-handlers or part thereof on all their premises.

b. These supervisors should in turn carry out periodic onsite training of all food handlers, at least on quarterly basis and maintain record thereof for food safety audit and inspections.

c. Food handlers in all petty food businesses that are registered should be trained and certified.

Following training courses have been designed for the purpose –

**Level 1: Basic:** (5 Courses of 4 to 6 hours duration over 1 or 2 days) - (1) Street Food Vending, (2) Catering, (3) Manufacturing / Processing, (4) Storage & Transport, and (5) Retail & Distribution

**Level 2: Advanced:** (4 Courses of 8 hours duration over 1 or 2 days) - (1) Catering (2) Manufacturing / Processing, (3) Storage & Transport, and (4) Retail & Distribution


**FoSTaC Plus:** (2 Courses of 8 hours duration on 1 day or 2 days) - (1) Start-Ups, (2) Organic Food Business.

Additional training courses including customised courses could be introduced in due course as the need arises. Currently, courses are being offered on face to face mode, while this would be continued, but subject to availability of credible training partners, some of the courses could be allowed through online mode as well.

FSSAI has created training content for the above courses. The same is currently available in English and is being translated in Hindi and 10 regional languages.

FSSAI has taken on partners who are providing training. Training partners include -

1. Big food businesses (central licensees and big state licensees)
2. Academic and Vocational Institutions
3. National Skill Development Corporation (NSDC), Sector Skill Councils (SSCs) and State Skill Development Missions.
4. Training agencies approved under other government schemes
5. Industry Associations, Scientific and Technology Associations
6. Civil Society Organisations

It is desired that big food businesses, particularly all with central licenses and bigger ones with state licenses should take responsibility of training and certification of food safety supervisors and food handlers in their own premises and of the suppliers, distributors, retailers and transporters in their entire food value chain.

Each State/UT would identify resource persons, master trainers and trainers from food businesses, food technology, home science and nutrition colleges / universities, industry associations, consumer organisations and individual experts and professionals.

FSSAI has established the FoSTaC platform (available at https://fostac.fssai.gov.in/) to manage the entire food safety training and certification system.

**Consumer complaint handling**

Food Safety Connect is an initiative of FSSAI to develop a credible and robust information and feedback mechanism across various channels to create a responsive ecosystem to bring each citizen on-board to share their concerns regarding food safety violations.

This “Food Safety Connect” initiative allows a consumer to share their concerns, know their rights and track Food Business Operators license/registration certificate authenticity. The main objective of this initiative is to ensure satisfactory and timely redressal of concern and to create a robust ecosystem of ensuring food safety in the country.

If a consumer has a food concern/complaint and is looking for the right person to contact, the following steps need to be followed:

- **STEP 1:** Identify type of food and the problem observed
- **STEP 2:** Identify the recommended practices not followed under the premises
- **STEP 3:** Identify the Outlet or Product Brand Name and provide address of the Seller/Outlet of the product

Once all the details are provided, the concern will be shared with the nearest Food Safety Officer for further follow up.

Thus, in order to ensure safe food for consumers, food hygiene must be maintained at home as well as at all food service establishments. It is important to know how safe and good quality foods should be selected. It is also important to handle food safely and ensure safe disposal of waste. Lack of adequate infrastructure and knowledge of safe food handling practices among food service establishments, especially the small-scale food businesses and street food vendors, raises special concerns. Hygiene rating, training and certification of food handlers and safety supervisors, and a consumer connect mechanism are some of the initiatives introduced by the Food Regulatory Authority of India to improve the food safety scenario of the country.
Summary

• Unsafe food and poor diet create a vicious cycle of disease and malnutrition. All stakeholders of a food ecosystem need to be aware about keeping food safe.

• Food safety can be ensured at the household level by being mindful of personal hygiene, selection of right food, proper food handling and waste disposal.

• Food adulteration is a menace and one needs to be aware of the common adulterants added to our foods, foods which are likely to be adulterated and simple tests for detection of adulteration which can be done at the household level.

• Consumers need to look for certain features before buying different types of foods. Labels must be examined carefully for best before/expiry date, quality marks (ISI, AGMARK), storage instructions and ingredients.

• Once procured, foods also need to be processed, stored and handled with care to ensure that they stay safe. WHO has outlined five keys to keeping food safe – keep clean, separate raw and cooked foods, cook thoroughly, keep food at safe temperatures and use safe water and raw materials.

• It is important to segregate waste (wet, dry and recyclable waste) so that it can be sent further for appropriate disposal.

• With the mushrooming of large and small scale food service establishments including street food vending, there is a serious concern regarding safety of the food served.

• It is important to ensure that the location and infrastructure of the food preparation area is suitable. The kitchen layout and design should also ensure smooth flow of operations with minimum chances of contamination. Drainage and waste disposal facility should also be as per norms laid in the Food Safety Management System (FSMS) Guidance Documents.

• There should be separate food grade equipment for preparation of vegetarian and non-vegetarian foods. There should be an adequate supply of clean potable water for washing food and equipment and, for food preparation.

• Clean, food grade utensils and cutlery should be used for food service and display. Hot food should be held at 60°C or above while cold food should be held at 5°C or below.

• Cleaning and sanitization of premises and maintenance of good personal hygiene levels is also vital.

• Consumer organizations need to undertake drives to educate the consumer as well as FBOs about food hygiene and keeping the consumer safe.

• Hygiene ratings will help consumers make appropriate food choices.

• Food safety training and certification (FoSTaC) of FBOs will help in empowering the FBOs in serving safe food.
Basic, Advanced and Special training courses are offered by FSSAI through Training Partners suitable for different kinds of FBOs.

The consumer has been further empowered to raise grievances against FBOs who are selling unsafe food.

Key Words

- Ecosystem - the set of elements, living and non-living, that interact, over time, within a defined locale.

- FLRS: Food Licensing and Registration System, an online system to facilitate FBOs in India to apply for License/Registration certificate and for tracking their applications during processing.

- Food Safety Connect - an initiative of FSSAI to develop a credible and robust information and feedback mechanism and to bring each citizen on-board to share their concerns regarding food safety violations

- FoSTaC - Food Safety Training and Certification, a large-scale training and capacity building programme for food handlers

- HRAA - Hygiene Rating Auditing Agency

- Hygiene rating – an online, transparent rating process aimed at empowering consumers to make an informed choice when they eat out and encourage businesses to ensure hygiene standards.

Exercises

1. Explain why food safety education is important for both the consumers and FBOs.

2. Discuss the points to be kept in mind by individuals to ensure that they don’t become a source of contamination for food cooked at home (Hint: Maintain personal hygiene).

3. Describe how you will select safe and wholesome ingredients for cooking meals at home.

4. What are the five keys to keeping food safe? Discuss with reference to the guidelines given by WHO.

5. Why is waste segregation and proper disposal important?

6. What are the major concerns regarding food safety in the food service sector?

7. List some essential food hygiene and safety practices for FBOs.

8. Discuss some tools for ensuring supply of safe food by FBOs.
References


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.


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 though 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.

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.

<table>
<thead>
<tr>
<th>Safe Use of Cooking Oil</th>
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<tbody>
<tr>
<td>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.</td>
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</tbody>
</table>

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 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 compound. 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 gets accumulated in fish/shellfish which include brevetoxins, okadaic acid, saxitoxins, ciguatoxin 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.

<table>
<thead>
<tr>
<th>Types of Bacterial Spoilage in Eggs</th>
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<tbody>
<tr>
<td>- Green rot is caused by <em>Pseudomonas fluorescens</em></td>
</tr>
<tr>
<td>- Colourless rot is caused by <em>Pseudomonas, Acinetobacter</em> and <em>Alcaligenes</em></td>
</tr>
<tr>
<td>- Black rot is most commonly caused by <em>Proteus sp. Pseudomonas</em> and <em>Aeromonas</em> can also cause black rot.</td>
</tr>
<tr>
<td>- Pink rot is caused less often by strains of <em>Pseudomonas</em>.</td>
</tr>
<tr>
<td>- Red rot caused by <em>Serratia</em> occurs quite rarely</td>
</tr>
</tbody>
</table>

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.

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 microorganisms. 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.


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:
Table 10.1: Some hazards associated with different food categories

<table>
<thead>
<tr>
<th>Food</th>
<th>Physical hazard</th>
<th>Chemical hazards</th>
<th>Biological/Microbiological hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy products</td>
<td>Glass, chipped pieces from equipment, metal shavings from cans and foils, plastic pieces, lint and threads, hair, finger nails</td>
<td>Detergents, sanitizers and disinfectants, urea, hydrogen peroxide, other preservatives, neutralizers, pesticides, antibiotic and veterinary drug residue, hormones, metal contaminants, residues from packaging materials</td>
<td>Mycotoxins (Aflatoxin), Salmonella, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus, Yersinia enterocolitica, Bacillus cereus, Clostridium botulinum, Mycobacterium bovis, Brucella abortus, Brucella melitensis</td>
</tr>
<tr>
<td>Cereals and pulses</td>
<td>glass, nail chipping, hair, stones, grit, dirt, pest droppings, metal pieces plant parts, debris, weeds, seeds</td>
<td>Pesticide residues, metal contaminants, naturally occurring toxic substances (Lathyrus or Khesari dal with neurotoxin BOAA -beta-oxalyl aminoalanine; Trypsin inhibitors, Haemagglutinins, Cyanogenic glycosides), metal contaminants</td>
<td>Mycotoxins (Aflatoxin)  Bacillus cereus</td>
</tr>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>Dirt, weeds</td>
<td>Pesticide residues, heavy metals, naturally occurring toxic substances (cucurbitacins, goitrogens, solanine, etc.)</td>
<td>Insect larvae, mycotoxins Escherichia coli O157:H7, Salmonella spp., Listeria monocytogenes.</td>
</tr>
<tr>
<td>Spices and condiments</td>
<td>Dirt, weeds, foreign seeds, straw</td>
<td>Pesticide residues, heavy metals, artificial colors</td>
<td>Mycotoxins, Salmonella spp.</td>
</tr>
<tr>
<td>Food</td>
<td>Physical hazard</td>
<td>Chemical hazards</td>
<td>Biological/Microbiological hazards</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Meat</td>
<td>Dirt, shards of bone</td>
<td>Pesticide residues, heavy metals, naturally occurring toxic substances, veterinary drug residues</td>
<td>Salmonella, Campylobacter, Listeria, E. Coli, Pseudomonas spp.</td>
</tr>
<tr>
<td>Fish and seafoods</td>
<td>Dirt, microplastics, pieces of bone</td>
<td>heavy metals, naturally occurring toxic substances (Biotoxins: brevetoxins, okadaic acid, saxitoxins, ciguatoxin, domoic acid), veterinary drug residues</td>
<td>Salmonella, Shigella, E. coli, S. aureus, Clostridium botulinum, Vibrio sp., Aeromonas sp.</td>
</tr>
<tr>
<td>Eggs</td>
<td>Dirt, bird droppings</td>
<td>Pesticide residues, heavy metals, veterinary drug residues</td>
<td>Salmonella, Pseudomonas, Streptococcus, Alcaligenes, Staphylococcus, Bacillus, Flavobacterium, Proteus, Serratia, Arthrobacter and Micrococcus spp.</td>
</tr>
<tr>
<td>Fats and oils</td>
<td>-</td>
<td>Polar Compounds, adulterants like mineral oils, paraffin, argemone oil</td>
<td>Mycotoxins</td>
</tr>
</tbody>
</table>

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.
References


Chapter 11: Regulatory Food Testing Ecosystem

- Types of food testing laboratories in India
  - Role of Food laboratories

- Accreditation of laboratories

- Strengthening the food testing ecosystem
  - Capacity building of Food laboratories
  - Significance of competent staff in food laboratories
  - Significance of Rapid Test methods
  - Connecting with Consumers
Chapter 11: Regulatory Food Testing Ecosystem

In any effective regulatory food system, a food testing ecosystem is critical to evaluate the quality and safety of foods, their compliance to set standards and also identify any emerging risks from farm to fork or plate to palate. This would, directly or indirectly, help various stakeholders in eliminating unsafe food from the supply chain or avoid their consumption. Simultaneous development of infrastructure, qualified technical manpower and time-tested harmonized methods are needed to make any food testing ecosystem a robust and efficient one.

Establishment of a robust regulatory food testing ecosystem involves following vital components:

- Food testing laboratories at state and national levels with advanced facility and equipment.
- Pool of Competent Staff
- Efficient capacity building system
- System to oversee the competence of testing in these laboratories through accreditation and certification.

Food testing laboratories ensure an effective food safety mechanism in the country. They play an important role in ensuring safety and quality of food through testing of foods/food products for adulterants/contaminants and for assessment of product quality and nutritive value.

Types of food testing laboratories in India

As per FSS Act, 2006 “food laboratory means any food laboratory or institute established by the Central or a State Government or any other agency and accredited by National Accreditation Board for Testing and Calibration Laboratories or an equivalent accreditation agency and recognised by the Food Authority under section 43”. The section 43 of FSS Act 2006 empowers FSSAI

- to notify food laboratories and research institutions accredited by National Accreditation Board for Testing and Calibration Laboratories or any other accreditation agency for the purposes of carrying out analysis of samples.
- to establish or recognise by notification, one or more referral food laboratory or laboratories
- to frame regulations specifying the functions of food laboratory and referral food laboratory, procedure for submission of food samples for analysis, forms of the laboratory’s reports, analysis fee and other matters to carry out its functions effectively.
FSSAI has formulated FSS (Laboratory and Sample Analysis) Regulations, 2011 to specify the functions of Referral laboratories, sampling procedure and formats for sample submission and analysis report. Further, FSS (Recognition and Notification of Laboratories) Regulations, 2018, was framed for recognition and notification of laboratories to improve and streamline the process of notification of food laboratories. These regulations not only provide a legal foundation for the operation of the laboratory system that already exists under the ambit of FSS Act 2006, but also usher transparency by defining the procedural requirements for the recognition and notification of food testing laboratories. The categorizations of laboratories notified by FSSAI are shown in Figure 1.

![Categories of Laboratories Notified by FSSAI](image)

The roles and responsibilities of all laboratories notified by FSSAI are given below:

**National Reference Laboratories (NRL’s):** FSSAI has recognized around 15 of its primary and referral laboratories as NRLs, for the purpose of developing/verifying/validation methods of testing, assessing proficiency of notified food labs, providing training to the laboratory personnel and develop repository of information in a designated product/analyte category. These NRLs would set up a country wide standard for routine procedures, reliable testing methods and validation of such standard procedure/testing methods, development of new methods and ensuring proficiency in testing across the food laboratories with special reference to the risks or food categories. Once operationalized, all the NRLs would be brought into a single umbrella called the Network of NRLs (NNRLs) forming another subset of higher tier laboratories.

**Referral Food Laboratories (RFL’s):** FSSAI has notified around 19 referral laboratories which include state government labs, research Institutes and private NABL labs. These referral labs are responsible for the analysis of food samples submitted by food safety inspectors and providing the certificate of analysis. RFLs are also responsible for investigation for the purpose of fixation of standard of any article of food, capacity building, collaboration with state labs and food analyst, maintaining high standards of accuracy, reliability and credibility in the analysis, ensuring competency of the laboratories.

**Primary Laboratories:** Any laboratory accredited against ISO/IEC 17025 by the National Accreditation Board for Testing and Calibration Laboratories or other equivalent accreditation agency and having adequate capability and competence for testing of food safety and quality parameters as per FSS Act can apply online to be notified by FSSAI. Several such laboratories have been notified for the purpose of carrying out analysis of food samples taken under the Food Safety and Standards Act 2006 and Rules and Regulations made thereunder.
**Mobile labs:** Availability of testing facilities in remote areas is a greater challenge which needs to be addressed on a priority basis in order to assure safe food to citizens in those parts of the country. To address this issue of lack of food testing infrastructure in the remote areas and to cater to the basic analytical needs of consumers, FSSAI has also established mobile food testing laboratories referred to as Food Safety on Wheels (FSW). Apart, from conducting simple tests for common adulterants in milk, water, edible oil and other items of food of daily consumption, the FSW would also be used for awareness building around food safety, hygiene and promoting healthy eating habits in citizens at large. Apart from testing and training, the FSWs would also help regulatory staff or the field functionaries in the states to enhance their outreach; and, also help in conducting surveillance activities even in far-flung areas.

**Role of Food laboratories**

Food analysis laboratories play crucial role in enforcement of food regulations including monitoring and surveillance activities of food safety. They don’t just monitor foods produced in the country but also help in regulating imported foods and their safety. The sample taken by the food safety officer as per FSS Act is analysed by a FSSAI notified lab to test its compliance against set standards and its authenticity. The risk-based analysis of imported products for its compliance against FSS quality and safety parameters and clearance is also done by FSSAI notified labs. In addition to this, food laboratories are integral component of all monitoring and surveillance activities done by FSSAI. The INFoLNET (See Box 1) provides back-end integration with existing core IT solutions like Food Licensing & Registration system (FLRS) and Food Import Clearance System (FICS) for the ease of doing business.

**Box 1: Digitization and networking of food laboratories in India**

FSSAI has developed an information technology solution for benefit of food testing laboratories in the country called the Indian food laboratory network or INFoLNET. In this, all the laboratories in the network will be connected to a centralized system. The INFoLNET also integrates with FSSAI’s core IT system such as licence, registration, imports, surveillance etc. INFoLNET allows the laboratories to centrally digitise information related to their activities such as, their testing facility, manpower details, infrastructure details, sample management & tracking and publishing test reports. They are also provided interface to share laboratory test reports on a real time basis with stakeholders. These are hoped to result in better handling of samples and surveillance activity apart from creating a transparent system that would build stakeholder confidence in food testing.

A new online feature called Surveillance Regulatory Compliance has been introduced in this network. In this, states can plan and initiate their surveillance with the advantage of having lab information at common place under the preview of FSSAI HQ.
Accreditation of laboratories

Laboratory accreditation is a procedure by which an authoritative body gives formal recognition of technical competence for specific tests/measurements. It is based on third party assessment and follows international standards. This formal recognition of competence of a laboratory creates confidence in testing reports issued by the laboratory. It also provides feedback to the labs on their quality assurance system and technical competence for further improvement.

In India, National Accreditation Board for Testing and Calibration Laboratories (NABL), a Constituent Board of Quality Council of India is the nodal agency for the accreditation of food testing laboratories. NABL has been established with the objective to provide Government, Industry Associations and Industry in general with a scheme for third party assessment of the quality and technical competence of testing and calibration laboratories against ISO/IEC 17025. ISO/IEC 17025 is an international standard which enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.

Strengthening the food testing ecosystem

Certain critical inputs are required to strengthen the food safety ecosystem. Building the capacity of laboratories and training and developing competence of food analysts are important. In addition, there is need for innovative initiatives which can strengthen the role of laboratories in enforcement, monitoring and surveillance as well as empower consumers.

Capacity building of Food laboratories

Capacity building is as a process aimed at strengthening the skills of individuals as well as of food labs to cope with new trends and the emerging changes. FSSAI through its various initiatives and collaborations with Government institutions, International bodies and Private laboratories ensures continuous upgradation of technical skills of Food Analysts and other laboratory staff with the aim to acquaint them with latest analytical techniques and methods. State of art training facilities are critical in providing classroom training and hands on training on new and advanced analytical techniques. One such facility is being created at Mumbai in association with EIC and GFSP. This facility would also help in creation of a mechanism to share information and best practices among a network of scientific peers on continuous basis.

Significance of competent staff in food laboratories

Competency of staff is one of the important components of any food laboratory apart from its infrastructure and testing facility. In order to create a pool of competent staff, FSSAI regularly conducts Food Analyst examination through a rigorous selection process as per the FSS Act, 2006. The objective is to identify and encourage qualified technical manpower for the food testing laboratories. These certified food analysts are responsible for analysis of food samples submitted by food safety officers for enforcement or
surveillance purpose. ISO 17025 also prescribes requirements and technical qualifications for the personnel involved in the food analysis of samples. Inefficient staff may generate erroneous analytical results adversely impacting the process of prosecution of food vendors.

**Significance of Rapid Test methods**

The incidence of foodborne diseases has increased over the years and resulted in major public health problems globally. Generally, foodborne diseases are caused by the consumption of food or water contaminated with microbial or chemical contaminants. To provide safe food to the consumers and to minimize the occurrence of foodborne diseases it is essential to analyse the food for the presence of foodborne pathogens or chemical contaminants. From simple visual inspections and chemical analyses to microbial assays and culturing techniques, food quality assurance has come a long way. These conventional methods are time-consuming and multi-step processes, with prolonged incubation periods, amplifying opportunities for human error.

In recent years, different rapid methods with high sensitivity and specificity have been developed to overcome the limitations of conventional methods. Furthermore, researchers are still developing novel methods with improvements in terms of rapidity, sensitivity, specificity and suitability for analysis of food samples. Generally, rapid detection methods are categorized into nucleic acid-based, biosensor-based and immunological-based methods. Rapid methods are more time-efficient, labour-saving and able to reduce human errors. In addition, the equipment are also space saving and do not require a complex setup and advance trainings. They can be installed in mobile labs for food analysis and creating awareness. These devices can be easily operated, and data can be stored by connecting them electronically.

**Connecting with Consumers**

Section 40 of the FSS Act 2006 empowers the purchaser to get analysed any article of food from the food laboratories on submitting the requisite fees. In case the sample is found unsafe the fee submitted by the purchaser is refunded. While most of the food testing requires sophisticated equipment and highly trained manpower, there are some common adulterants and contaminants that can be tested by citizens themselves. In order to enable the citizens to ascertain the safety of their food themselves, FSSAI has compiled some of the common tests - which can be performed at home without any equipment or chemicals - in the form of a booklet titled Detecting Adulterants with Rapid Testing (DART). In addition, FSSAI has also developed a magic box, which can be used by the consumers to detect adulteration with a few simple tests at home. These magic boxes can also be used as a tool for creating awareness among citizens. The mobile labs of FSSAI i.e. ‘Food safety on wheels’ also help in creating consumer awareness on food adulteration through simple and rapid test methods.

Thus, we have seen how a food testing ecosystem is critical in assessing the quality and safety of foods and identifying emerging risks. Capacity building of laboratories notified by FSSAI as well as training of food analysts in the latest techniques of analysis is important to strengthen the food testing. Developing information technology solutions and accreditation of the laboratories will further strengthen the ecosystem. Empowering the consumer is also important for the ecosystem.
Summary

- In any effective regulatory food system, a food testing ecosystem is critical to evaluate the quality and safety of foods, their compliance to set standards and also identify any emerging risks from farm to fork or plate to palate.

- FSSAI has formulated FSS (Laboratory and Sample Analysis) Regulations, 2011 to specify the functions of Referral laboratories, sampling procedure and formats for sample submission and analysis report.

- FSS (Recognition and Notification of Laboratories) Regulations, 2018, was framed for recognition and notification of laboratories to improve and streamline the process of notification of food laboratories.

- Laboratories notified by FSSAI are categorized as National Reference Labs, Referral Labs, Primary Labs and Mobile labs.

- Food analysis laboratories play crucial role in enforcement of food regulations including monitoring and surveillance activities of food safety.

- FSSAI has developed an information technology solution for benefit of food testing laboratories in the country called the Indian food laboratory network or INFoLNET.

- Laboratory accreditation is a procedure by which an authoritative body gives formal recognition of technical competence for specific tests/measurements. It is based on third party assessment and follows international standards.

- In India, National Accreditation Board for Testing and Calibration Laboratories (NABL), a Constituent Board of Quality Council of India is the nodal agency for the accreditation of food testing laboratories.

- Capacity building is as a process aimed at strengthening the skills of individuals as well as of food labs to cope with new trends and the emerging changes.

- Competency of staff is one of the important components of any food laboratory apart from its infrastructure and testing facility.

- Different rapid methods with high sensitivity and specificity have been developed to overcome the limitations of conventional testing methods.

- The DART book, the Magic Box and Mobile labs are some consumer connect initiatives which not only spread awareness but also empower consumers.
Key Words

DART - Detecting Adulterants with Rapid Testing
FICS – Food Import Clearance System
FLRS - Food Licensing & Registration System
FSW- Food Safety on Wheels
INFoLNET - Indian Food Laboratory Network
ISO/IEC 17025 - an international standard which enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.
NNRL – Network of National Reference Laboratories

Exercises

1. What are the different categories of labs certified by FSSAI? Describe the mandate of each kind of lab.
2. What is the INFoLNET? How does it benefit the food testing laboratories?
3. Which nodal agency in India is designated for accreditation of food testing laboratories?
4. Discuss how capacity building of food laboratories and food analysts will help strengthen the food testing ecosystem.
5. What are the benefits of using rapid tests for analysis of food?
6. List the consumer connect initiatives of FSSAI which are meant for creating awareness about food testing as well as empowering the consumers to test the food themselves.

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