

UNIT 2 FACTORS AFFECTING FOOD SAFETY

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- Addressing food safety and quality completely would require an analysis of the complete food chain from seed or livestock genotype, through primary agriculture; primary, secondary and tertiary processing; formulation; packaging, distribution, retailing, domestic storage and finally consumption.
- Out-of-home consumption is steadily rising.
- Catering and food service play an increasingly important part in our experience of food quality and food safety.

2.1 Threats to Food Safety

- Food safety is not limited to microbiological safety. Food safety also includes freedom from chemical contamination and foreign bodies. Prions, the cause of mad cow disease, are an entirely new source of food-borne disease.
- Food safety is not necessarily about real risk to public health, but also about perceived risk.
- In contrast to the effects of microbial contamination, the effects of chemical contamination are less evident. Although some may trigger a swift reaction, (the concern is normally that a one-off exposure will cause a disease condition long after the exposure (e.g. carcinogens) or that chronic exposure will produce a low, reversible degeneration (e.g. lead, mercury). Such disease conditions are more readily seen as permanently impairing or fatal. Common contaminants are pesticide and herbicide residues.
- Recent developments have brought two new contaminants to the public and regulator's attention: Veterinary residues and genetically modified organisms. The veterinary residues that give rise to concern are either hormones or antibiotics. The long-term health outcomes of growth and ingestion of GMOs are still not known but concerns remain.

- Analytical techniques are becoming more sensitive and we are finding chemical traces in our foods that had not previously been identified e.g. 3 Monochloropropanediol (3-MCPD), a product of heating protein in the presence of lipids, must have been in our foods for many years.
- As for chemical contaminants, physical contaminants may pose both a safety risk and a risk of perceived degradation of quality. Foreign bodies will affect only a small number of consumers in comparison to microbiological and chemical contamination. When glass is found in baby food or a hypodermic needle in a soft drink can, the issue becomes centred on physical hazards to food safety.
- Phyto-estrogens are a newly recognized potential threat to food safety. They are an example of food components which may be intrinsic and not contaminants.

2.2 Food Safety Issues in a Nutshell

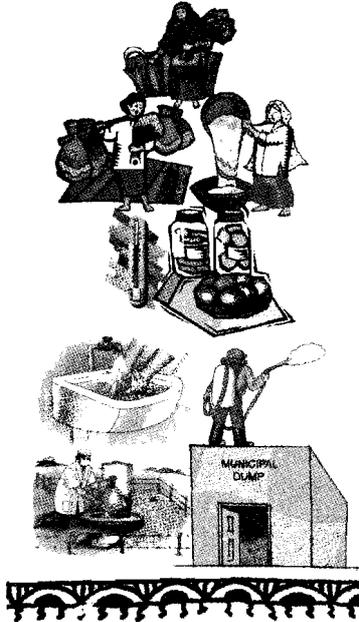
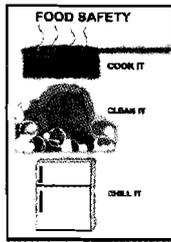
Specific food safety concerns differ markedly and include:

- Additives, colours and flavours;
- Dry residues;
- Fertilizers and other growth aids;
- Irradiation;
- Pesticides;
- Pollutants;
- Processing, packaging and labelling; and
- Adulteration and misbranding.

2.3 Hazards affecting Food Safety

- A hazard is defined as a biological, chemical or physical agent in a food, or condition of a food, with the potential to cause an adverse health effect.
- Hazards may be biological, chemical or physical.
- Biological hazards include bacterial, fungal, viral and parasitic (protozoa and worms) organisms and/or their toxins. There are two types of food-borne disease from microbial pathogens: infections and intoxications. Infections result from ingestion of live pathogenic organisms which multiply within the body and produce disease. Intoxications occur when toxins produced by pathogens are consumed. Intoxications can occur even if no viable microorganisms are ingested. This often occurs when foods are stored under conditions which allow the pathogens to grow and produce toxin. Subsequent processing of the food may destroy the microorganisms but not the toxin.

- Microorganisms are members of the Protista kingdom. The majority are prokaryotes which are distinguished from plants and animals by their simple organization i.e. they are unicellular or if multicellular, their tissue shows little differentiation.
- The growth of bacteria is generally expressed in our principal phases: (i) Lag phase (2) Log phase (3) Stationary phase (4) Death phase. After rapid growth in the log phase, cell multiplication gets stagnant due to exhaustion of nutrients or accumulation of toxic waste products. The death phase occurs when the medium is not changed as it has become incapable of supporting further growth.
- Factors affecting bacterial growth include nutrition, oxygen, temperature, pH, moisture, osmotic pressure, light, presence of inhibitory substances like chemicals. The following table summarizes the important points.



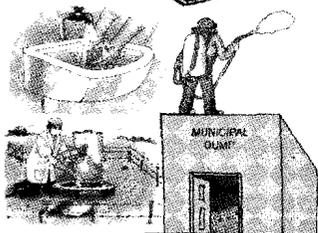
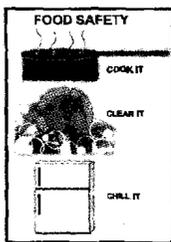
Factor	Salient Points
(a) Nutrition	Based on nutritional requirement, bacteria can be autotrophic or heterotrophic. Heterotrophic bacteria require one or several pre-formed organic compounds which are readily available for growth.
(b) Oxygen	<ul style="list-style-type: none"> ● Thrive in absence of oxygen or free air — strict or obligate anaerobes ● Survive either in presence or absence of oxygen — facultative anaerobes ● Cannot survive in absence of oxygen — obligate aerobes ● Require oxygen for survival but at lower concentrations than in air — microaerophiles. ● Grow rapidly between 45-65°C: Thermophiles ● Grow rapidly between 20-45°C: Mesophiles ● Grow rapidly at 0°C (and even below): Psychrophiles
(c) Temperature	Most bacteria grow well in media with water activity between 0.990-0.998. With increase in temperature, available water will be reduced.
(d) Water Activity	In concentrated solution (high osmotic pressure), bacterial cells lose water and shrink — a process called plasmolysis. If the concentration is low, water enters the cell and causes it to burst — a process called plasmolysis. In both situations rate of bacterial growth slows down.

(e) Osmotic pressure	Most bacteria prefer a pH near 7 (neutral).
(f) pH	Some bacteria prefer alkaline or acidic medium.
(g) Light	Ultraviolet light is absorbed by nucleic acid present in the cells which gets denatured and may result in death of cells.

- Fungi exhibit a wide range of different forms which include moulds, yeasts and mushrooms. Yeasts are unicellular, moulds are filamentous and multicellular. Mushrooms in addition to being filamentous and multicellular have a definite fruiting body which is prominent. The spores of yeast are also resistant to some adverse conditions but get destroyed at temperatures above 60°C whereas bacterial spores are quite resistant to higher temperatures.
- Viruses are called obligate intracellular parasites since they are unable to carry out any of the typical life functions until they are inside a host cell. Once inside a host cell, they thrive and direct the host cell to produce more viruses. The most important characteristic of viruses is that they are host-specific.
- Viruses are known to cause illness although they do not grow on foods or produce toxins in foods. Food items merely act as a vehicle for their transfer. They are the intestinal or enteric type and are food-borne. They spread from the hands of human carriers and from water to food e.g. Hepatitis A virus causes jaundice and spreads through foods.
- Parasites spread through several foods which may cause illness when ingested. The problem of contamination with parasites can occur when food preparations are made with polluted water and undercooking prevents the parasites from being destroyed.
- Common parasites are *Entamoeba histolytica* (causes amoebiasis), a protozoan transmitted through cysts in vegetables grown in polluted fields or from infected handlers. *Giardia lamblia*, a protozoan, causes giardiasis in poor sanitary conditions; *Trichinella spiralis*, a helminth or nematode causing trichinosis from consuming contaminated, undercooked pork. Some other protozoan and helminthes parasites like *Cryptosporidium*, *Cyclospora* are fast emerging as pathogens of concern. Their route of contamination has been traced to raw fruits, vegetables as in salads.
- Some hazardous microorganisms and parasites along with their commonly implicated foods are listed in the following table:

Table: Hazardous Microorganisms and Parasites along with their Commonly Implicated Foods

S. No.	Organisms	Foods Implicated
1	<i>Clostridium botulinum</i> types A, B, E, and F	Meat, fish, low or medium acid canned foods, home canned products
2	<i>Salmonella</i> spp. (<i>Salmonella typhi</i> ; <i>Salmonella paratyphi</i>)	Eggs, meat and meat products, bakery products, dairy products (esp. ice-cream)
3	<i>Shigella</i> spp.	Shellfish, fruits and vegetables, chicken, salad
4	<i>Clostridium perfringens</i>	Raw meat, poultry and their products
5	<i>Staphylococcus aureus</i>	Custard, cream, bakery foods, poultry, ham, dairy products (esp. khoa)
6	<i>Bacillus cereus</i>	Cereal dishes, puddings, mashed potatoes, sauces, soups
7	<i>Vibrio cholerae</i> 01, non-01 <i>Vibrio vulnificus</i> <i>Vibrio parahaemolyticus</i> <i>Listeria monocytogenes</i>	Water, potatoes, eggs, asparagus, salads, seafood (shrimps, oysters, clams, crabs, lobsters and related shellfish), finfish Milk and milk products, raw meat and poultry products, fruits and vegetables, salads, seafood
8	Enterovirulent <i>Escherichia</i> <i>coli</i> (EEC)	Cream pie, mashed potatoes, meat, poultry, dairy products like cheese
9	<i>Campylobacter jejuni</i>	Dressed chicken, meat dishes, raw milk, raw poultry
10	<i>Yersinia enterocolitica</i>	Dairy products, egg products, raw meat and poultry, raw vegetables
11	<i>Brucella abortis</i> ; <i>B. suis</i>	Milk and milk products, raw meat
12	Viruses (<i>Hepatitis A and E</i> , <i>Rotavirus</i> , <i>Norwalk virus</i> group)	Shellfish, raw fruits and vegetables, salads, sandwiches, potatoes, lettuce, coleslaw
13	<i>Entamoeba histolytica</i>	Water, raw fruits and vegetables
14	<i>Diphyllobothrium latum</i>	Fish
15	<i>Cryptosporidium parvum</i>	Raw fruits and vegetables, salads
16	<i>Giardia lamblia</i>	Water, lettuce, raw fruits and vegetables
17	<i>Taenia saginata</i> , <i>Taenia</i> <i>solium</i>	Meat (beef and pork)
18	<i>Trichinella spiralis</i>	Raw pork, meat products



- Foods may contain physical hazards such as stones, hair, parts of pests, seeds, glass fragments or small bits of metal. Small pieces of metal can come loose from processing machinery, for example. For this reason, many food processing operations have an electronic metal detector, which screens each package for metals.
- Chemicals hazards include food-borne toxicants. Food-borne toxicants can be divided into three categories:
 - Those coming from natural sources, including the food itself;
 - Those toxicants which become food contaminants because of the way in which foods are grown, produced, processed, stored or prepared. Example: Lead, polychlorinated biphenyls (PCBs), pyrolysis products from cooking.
 - Those that are intentionally added to foods for some desirable function but in excess of permissible quantities.
- Types of chemical hazards can be listed as follows:

(a) *Naturally Occurring Chemicals*

- i) Mycotoxins (e.g., Aflatoxins)
- ii) Scombrototoxin (Histamine)
- iii) Ciguatoxin
- iv) Mushroom toxins
- v) Shellfish toxins
 - Paralytic Shellfish Poisoning (PSP)
 - Diarrhoeic Shellfish Poisoning (DSP)
 - Neurotoxic Shellfish Poisoning (NSP)
 - Amnesic Shellfish Poisoning (ASP)
- vi) Pyrrolizidine and other alkaloids
- vii) Phytohaemagglutinin

(b) *Added Chemicals*

- i) Agricultural chemicals
 - Pesticides, fungicides, fertilizers, antibiotics and growth hormones
- ii) Toxic elements and compounds
 - Lead, arsenic, mercury, cyanide, cadmium, tin and aluminum
- iii) Food additives (beyond permissible limits) and non-permitted food additives.

Key Terms

Agricultural chemicals: Pesticides, fungicides, fertilizers, antibiotics and growth hormones are all known as agricultural chemicals.

Amoebiasis: is caused by *Entamoeba histolytica*, a protozoan, which is very common in a tropical country like India. About 15% of the population suffers from this disease. The disease is transmitted through infected cysts.

Good Manufacturing Practice (GMP): This code helps to assure that products are manufactured under conditions of proper storage and sanitation.

Intracellular parasites: Viruses are called obligate intracellular parasites since they are unable to carry out any of the typical life functions until they are inside a host cell. Once inside a host-cell, they thrive and direct the host cell to produce more viruses.

3-Monochloropropanediol (3-MCPD): A carcinogen that has been found to be a breakdown product in some food processes, and potentially present in a wide range of foodstuffs.

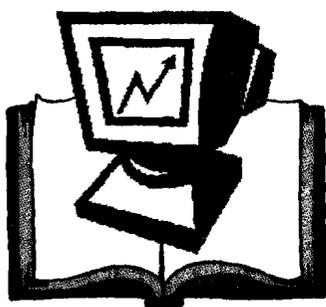
Mould: Certain multicellular fungi consisting of a filamentous branching growth known as a mycelium which is composed of individual filaments called hyphae.

Phyto-estrogens: are newly recognized potential threats to food safety. Although they may be an intrinsic component of food ingredients, and not a contaminant, they may have a deleterious effect on health if consumed in sufficient quantity over a sufficient period of time.

Trichinosis: One of the commonly found parasitic food-borne infections in the populations principally consuming undercooked pork. It is caused by the nematode, *Trichinella spiralis*.

Ultraviolet light (UV): The UV light is absorbed by the nucleic acid present in the bacterial cells, which get denatured and may result in the death of cells. Due to this property, UV light is used in surface sterilization as it is harmful to the bacteria.

Water activity (a_w): Vapour pressure of the solution / vapour pressure of pure water. Also known as the available water needed for bacterial growth



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