

Chapter 8 Food Microbiology

Learning Objectives



- Understand the role of microorganisms in food.
- Know the conditions that lead to food spoilage.
- Understand the signs of spoilage foods.
- Learn the method of prevention of food poisoning.
- Be aware of importance of kitchen hygiene and safety.

Food that is consumed should be safe and wholesome. Food should be protected from contamination at all stages till it is consumed. A number of microorganisms are associated with different kinds of food and they are divided into three groups.

- i Microorganisms that bring about useful changes in the preparation of certain foods.
- ii Microorganisms that bring about spoilage of food and
- iii Those that cause food poisoning and infections.



DO YOU KNOW?

Bacteria are in our body?

The human mouth is a home to more than 500 species of bacteria. Each square centimeter of your skin averages about 100,000 bacteria (<https://microbeonline.com/amazing-world-of-microbes-some-unbelievable-facts-about-microorganisms/>).

8.1 Role of Microorganisms in Food

A number of microorganisms are involved in bringing about changes and are useful in the preparation of certain foods. Microorganisms that are useful to mankind are utilized on a small scale in home and on a large scale in food industry. The important role of microorganisms in food are:-

1. *Production of alcoholic beverages:*

Yeast is used in great deal in the preparation of alcoholic beverages such as wine, beer, brandy, fermentation of milk.



▲ Plate 8.1 Alcoholic Beverages



2. Preparation of coffee seeds and cocoa:

Coffee berries are allowed to ferment so that pulp can be removed easily. The pulp from cocoa seeds are also removed by fermentation process.

3. Preparation of malt beverages: Malt beverages are prepared by the infusion of grains that have been subjected to malting (sprouting). This is also known as brewing. The enzyme in the grain converts starch into sugar producing an extract 'Wort'. This extract can be treated with yeast to obtain the final product beer and its varieties.

4. Bread and Idli making: When yeast converts sugar into alcohol, carbon – di-oxide is formed which helps in the raising of dough in bread. In case of idli and dosa batter the yeast naturally present on the grains make the batter to raise.

5. Cucumber pickles: Fresh cucumbers are cleaned and packed in salt resistant bacteria like *Lactobacilli* that forms lactic acid which preserves cucumber. This is then packed in fluids containing

salt, vinegar, sugar and different spices.

6. Vinegar: It is a solution containing acetic acid, obtained by further fermenting alcoholic liquids with the help of the microorganism *Acetobacter*.

7. Milk Products: Butter and cheese are the milk products where microorganisms are utilized.

i. Butter – It is composed of fat from milk with little casein and lactose. It can be separated from fresh milk or curd. The organism *Streptococcus lactis* is helpful in acid forming and *Leuconostoc citrovorum* is responsible for bringing flavour and aroma in butter. Due to the action of yeast, mould and bacteria the butter gets contaminated leading to a fishy taste and yeasty flavor.

2. Cheese – It is prepared by coagulation of casein present in milk. Hard cheese is prepared by removing much of the water e.g. Cheddar cheese, swiss cheese. The cheese is ripened by the microorganisms such as *Streptococcus lactis* and *Streptococcus cremoris*. Moulds such as *Pencillium camemberti*



▲ Plate 8.2 Fresh Breads



▲ Plate 8.3 Camembert Cheese





▲ Plate 8.4 Roquefort Cheese

and *Pencillium roquefort* gives Camembert and Roquefort cheese. Apart from these products curd, yoghurt, kumiss, leben and kefir are the fermented products obtained from the microbial action of milk.

8.2 Spoilage of Foods

8.2.1 Definition

Food spoilage is defined as decomposition and damage caused to food by various agents making it unfit for consumption.



‘Spoilt’ is the term used for foods which look harmful and unfit to eat. Spoilt food has an unattractive colour, smell, taste and appearance.

The term ‘contamination’ means foods which are not fit to be eaten for sanitary reasons. The foods may look good, and taste and smell good, but may contain harmful chemicals, non –food matter and bacteria.

8.2.2 Causes of food spoilage

Foods may be contaminated by air, water, plant, soil, food handler, machinery and equipment, sewage and trucks or carts during transport. Foods get spoilt due to any one or more of the following reasons:



▲ Plate 8.5 Bruised Tomatoes

1. Physical – damage like cuts, bruises
2. Chemical – like the enzymes in the food
3. Biological – changes brought about by the microorganisms and their enzymes.

1. Physical: Physical spoilage is caused by improper temperature, compact stacking which leads to change in the structure of the food.

2. Chemical: The changes brought about by enzymes present in food (intrinsic) or those produced by microorganisms (extrinsic) are of different kinds.

- Oxidising enzymes destroy vitamin C and produce deterioration in flavour.



- Proteolytic enzymes produce decomposition of proteins like meat, fish, eggs and milk.
 - Amylolytic enzymes hydrolyse carbohydrates.
 - Lipolytic enzymes produce a breakdown of fats into fatty acids and glycerol that are often oxidized to peroxides and aldehydes associated with rancidity or a bitter taste in fatty foods.
- 3. Biological:** Biological factors that spoil food are the microorganisms like moulds, yeasts bacteria and their enzymes which settle on food at different stages. The changes brought about in the food are mainly in the form of fermentation, putrefaction and decay.



▲ Plate 8.6 Mould Growth in Bread

- Fermentation:** It is the anaerobic enzymatic conversion of carbohydrates into ethyl alcohol. It is caused by *Streptococcus* and *Micrococcus*.
- Putrefaction:** It is the enzymatic decomposition of the proteins present in food with the production of foul

smelling compounds such as hydrogen sulphide and ammonia. It is caused by *Pseudomonas* and *Proteus*.

8.2.3 Classification of foods by ease of spoilage

Foods can be categorized into three main groups on the basis of their shelf life or perishability.

- 1. Stable or non-perishable foods:** Non-perishable foods include sugar, jaggery, hydrogenated fat, vegetable oil, ghee, whole grains, dhals, whole nuts and processed foods like dry salted fish / meat, papads, canned foods, jams and murabbas. These foods do not spoil unless they are handled carelessly.
- 2. Semi Perishable Foods:** These foods include processed cereals, pulses and their products like flour, semolina, parched rice and popcorn. Shelf life of these products depends on the storage temperature and moisture in the air. Foods like potato, onion, nuts, frozen foods and certain canned foods can be stored for a week to a couple of months at room temperature without any undesirable changes of the products.
- 3. Perishable Foods:** This includes foods such as dairy products, eggs, poultry,



▲ Plate 8.7 Spoiled Foods





meat, fish, fruits and vegetables. These foods get spoiled easily by natural enzymes.

8.2.4 Signs of Spoilage in Foods

The spoilage signs vary with the type of foods, causes of spoilage and environment.

Signs of spoilage: Spoilage generally seen are softening, hardening, discoloration, mould growth, fermentation, drying, oozing out of liquid, off odours such as mouldy, alcoholic or putrid and presence of insects.

The following gives the spoilage indicators in different categories of food:

1. **Cereals and pulses:** Although the foods do not spoil easily, the following signs could be noted if spoilt.
 - Musty odour and off flavor.
 - Presence of weevils, beetles, moths and worms.
 - Clumping of whole grains.
 - Presence of dirt, mud and stones.



▲ Plate 8.8 Spoiled Carrot

2. **Vegetables and fruits:** These show the following signs of spoilage:

- Presence of mould, leading to rot.
- Green leafy vegetables are wilted and limp.
- Discolouration and mushy texture.
- Presence of insects and worms.
- Green potatoes, sprouted potatoes and over mature vegetables.
- Skin or peel is damaged or bruised.



▲ Plate 8.9 Sprouted Potato

3. **Milk and milk products:** These products which get spoilt may show one or more of the following changes:
 - Change in taste to sour or bitter.
 - Milk, buttermilk or curds have a frothy, bubbly surface.
 - Change in smell.
 - Rope formation.



▲ Plate 8.10 Curdled Milk



- Discolouration.
- Fat separates out into clumps.
- Milk curdles when heated.
- Butter tastes rancid.
- Cheese and curd develop off odour and mould growth.

4. Meat and poultry: Spoilt meat shows the following signs

- Discolouration.
- Putrid smell.
- Slimy appearance and feel.

Organ meats such as liver, kidney and brain are more perishable than muscle meat due to the presence of fat.

5. Fish: Spoilt fish shows the following signs:

- Dull or sunken eyes.
- Gills are grey or green.
- Off odour.
- Flesh separates from bone and is flabby.
- Loose scales.
- Shellfish claws and tail lose their spring.

6. Eggs: Spoilt eggs will float when dropped in water. The signs of spoilt egg are:

- Cracked shell.
- Leaking contents.
- Exposed egg yolk.
- Eggs should be checked for blood spot, meat spot, foul odour or other contaminations.



DO YOU KNOW?

Do we get oxygen from microbes?

Yes. Microbes generate at least half the oxygen we breathe.

7. Cooked foods: Cooked foods must be consumed immediately and the left overs should be stored carefully. Cooked foods have high risk of getting spoilt.

8. Canned foods: Generally canned foods have longer shelf life and the chance of getting spoilage is possible when bacteria enters the can. Sometimes the acid from food reacts with the iron of the container and the canned foods get spoiled. The signs of spoilage in canned foods are:



▲ Plate 8.11 Sign of Leakage

- Puffy, swollen appearance of cans.
- Leaky, corroded or rusty cans.
- Contents spurt out when the can is opened.
- Contents smell putrid.
- Brine or syrup looks cloudy, bubbly, slimy or mouldy.
- Contents are discoloured.





▲ Plate 8.12 Sign of Spoilage in Canned Foods

In case any one or more signs are noted it should be discarded without tasting the contents.

9. Frozen foods:

It is very difficult to identify the spoilage in frozen foods unless there is change in colour or smell. If following precautions are taken, food borne illness can be prevented.

- Do not use frozen foods if there is off smell, taste or discolouration.
- Do not re-freeze food which has been thawed.
- Thaw only required amount.
- Do not purchase damaged packages.
- Do not keep frozen foods out of the freezer for long before cooking.
- Do not accept food which has a large quantity of ice crystals formed inside the packet.

Food that is decayed is easier to recognize than spoilt by microorganisms. Always the spoilt foods should be discarded and should not be consumed so as to prevent food poisoning and infections.

8.3 Food Poisoning and Prevention

Food poisoning is caused by the ingestion of food or drink, contaminated with bacteria or toxins. The term 'food borne disease' is defined as a disease usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food.

Types of Food Poisoning

Food poisoning may be of two types

- a. Non- bacterial: Caused by chemicals such as arsenic, certain plant and sea foods. Lathyrism and endemic ascitis are some diseases caused due to toxins in foods. In recent years there has been a growing concern about contamination of food by chemicals (eg) fertilizers and pesticides.
- b. Bacterial: Caused by the ingestion of food contaminated by living bacteria or other toxins.



DO YOU KNOW?

More than 200 diseases are spread through food

Millions of people fall ill every year and many die as a result of eating unsafe food. Diarrhoeal diseases alone kill an estimated 1.5 million children annually, and most of these illnesses are attributed to contaminated food or drinking water. Proper food preparation can prevent most food borne diseases.

Bacterial Food Poisoning

Certain bacteria present in food produce toxins that are injurious to health. The four types of food poisoning are:

1. *Salmonella* food poisoning



2. *Staphylococcal* poisoning

3. *Botulism*

4. *Clostridium perfringens* food poisoning

Table 8.1 shows the major food poisoning of bacterial origin.

Table 8.1 Major Food Poisoning of Bacterial Origin

Details	Salmonellosis	Staphylococcal poisoning	Botulism	Clostridium perfringens poisoning
Bacteria	Salmonella	<i>Staphylococcus aureus</i>	<i>Clostridium botulinum</i>	<i>Clostridium perfringens</i>
Incubation period	6-48 hours	1-6 hours	12-36 hours	8-22 hours
Duration of illness	2-3 days	1-2 days	Several days to a year	One day
Symptoms	Headache, abdominal pain.  ▲ Plate 8.13 Symptoms	Abdominal pain, nausea, vomiting, diarrhoea.	Fatigue, headache, dizziness, visual disturbances, inability to swallow.	Abdominal pain, diarrhoea  ▲ Plate 8.14 Signs of Food Poisoning
Foods affected	Meat, meat products, poultry, salads, egg products and other protein foods.	Improperly prepared products, cream filled pastries, dairy products, meat poultry, salads.	Improperly processed canned foods, mushrooms, tuna, figs.	Boiled, steamed, braised, stewed meat.
Prevention	* Strict personal hygiene * Avoidance of contamination from unclean food handlers. * Unsafe practices.	* Cleanliness and sanitary habits. * Proper heating and refrigeration. * Exclusion of infected food handlers.	* Pressure cooking food at high temperatures in a canning. * Boiling and stirring home canned food for 20 minutes.	* Careful time and temperature control. * Quick chilling of cooked meat dishes. * Isolation of raw and cooked foods.

8.4 Hygiene and Safety in Food Service

In order to prevent food spoilage in food service following need to be taken care of.

8.4.1 Safe Guarding of Food

Lack of proper attention to handling of food and negligence of personal hygiene lead to food poisoning and require serious attention. The incidence of food borne disease can be considerably reduced by certain healthy practices.

- Cook at high temperature to ensure that all bacteria are killed.
- Keep all perishable foods in a cool place or in refrigerator.
- Cover food to protect from dust, flies and other modes of infection.
- Avoid consuming moldy and foul smelling foods.
- Avoid damaged and bulging tin/ canned foods.
- Wash the foods carefully to ensure the removal of insecticide, worm, eggs, and other parasites sticking to it.
- Keep the utensils free from contamination.
- Ensure food handlers are healthy and free from disease.

- Avoid taking food with dirty fingers.
- Avoid tasting food while cooking.
- Maintain the three 'E's of safety – Engineering, Education and Enforcement.

Food hygiene and sanitation is highly important in food service operations especially in larger scale as they might affect public health. Quality control, microbial safety and good personal hygiene are essential to keep food safe.

8.4.2 Kitchen Hygiene

Hygiene in the kitchen is very important for the general cleanliness of the environment and the people working there as it requires handling of food materials.



▲ Plate 8.15 Hygienic Handling of Food

Table 8.2 Kitchen Hygiene and Sanitation

Environmental Hygiene	Hygienic Food Handling	Personnel Hygiene
Site	Receiving	Neatly Pressed Dress
Structure	Storage	Grooming
Equipment furniture/fittings	Preparation	Health
Ventilation	Cooking	Habits
Lighting	Holding	
Water supply	Serving	
Waste disposal	Cleaning	
	Disposal	



(i) Environmental Hygienic: The place where food is delivered, prepared and served.

Site should be free from air pollution and insects, water supply and sewage disposal should be taken care of. In structure, cleanliness of walls, floors, ceilings or any surface should be free from any hazards of infections.

Equipment like furniture and fittings need most attention to make it dust and dirt free. Thorough cleaning is required to avoid chemical residues that may contaminate food.

Need for proper ventilation is required in all areas of the kitchen. All kitchen should be provided with exhaust fans and extraction hoods above cooking range to remove impurities.

Kitchen should be well lighted to detect dirt, grease and infestation easily.

Water supply should be treated to ensure that it is fit for cooking and drinking and washing utensils.

Kitchen waste like peelings, trimmings, plate waste, spillage, empty



▲ Plate 8.16 Well Lighted Kitchen

cans and bottles must be disposed immediately from the kitchen, never be allowed to remain anywhere near the production, storage or service area. All these become contamination of food.

(ii) Hygienic Food Handling: In receiving food materials quality of food received will go a long way. Check for microorganisms, accidental chemicals and pesticides.

In storage proper methods should be followed.

1. Temperature prevailing in storages.
2. Humidity in the storage environment.
3. Presence or absence of any type of infection.



▲ Plate 8.17 Hygienic Food Service

Handling food at the stage of preparation is very important from hygienic point as in receiving and storing. Food should be cooked as quickly as possible after the preparation, unless frozen for later use. In food service establishment food should be held for some time before service. The holding temperature for food, within the danger zone is 10°C to 62°C. In service food care is necessary to see all serving equipment is clean and server is not in any



way contaminating the food. Tables must be clean. Clearing up is a vital part as far as hygiene is concerned. Otherwise it may spread infection quickly. All wastes should be emptied in pedal bins. Disposal should be emptied into the garbage bins. Waste food should not be transported open to safeguard the health of people.

(iii) Personnel Hygiene: It refers to the general health, personal grooming and working habits of all personnel.

In dress – Grooming – Health and Habits-following points should be adhered.

1. Wash hands, cut nails, short hair trimmed.
2. Clean shaved,
3. Do not touch food when suffering from cold, fever, diarrhoea, cholera, jaundice and wound if any
4. Avoid licking fingers.
5. Clean working area regularly.
7. Keep all food covered.
8. Have bath daily.



▲ Plate 8.18 Personnel Hygiene

9. Brush teeth twice a day.
10. Cover wounds properly.
11. Wear well-polished shoes.
12. Handle food correctly.
13. Leaning or sitting on the work table is an objectionable habit.
14. Resist from smoking.
15. Avoid chewing pans / chewing gums / betel leaves.

Safety: Safety implies the concern for providing conditions at work, which will protect people from infection, injury and theft. It also includes protection of premises, equipment and other resources from infestation, damage and destruction. Safety measures to be adhered in food service operation for a healthy environment are:

1. Wear clean cotton clothes and keep hair covered.
2. Switch off the gas first from the knob on the cylinder and then switch off the knob of the gas stove.
3. In case of fire close the main connection / gas cylinder knob.
4. Do not place any newspapers, poly bags next to the lighted gas.
5. Keep the knives in a tray and then carry.
6. Do not leave any utensil unattended on the gas stove.
7. Add sufficient water in pressure cooker, follow instructions carefully.
8. While frying hold the skillet firmly with tongs. Gently slide the food in hot oil.
9. Keep floors dry immediately wipe any spills on the floor.
10. Cool the food before grinding in the mixer / grinder.
11. Keep fire extinguishers in the lab at strategic points.



Key Words

1. **Alcoholic Beverages** : Drinks that contain alcohol (ethanol),
2. **Canning** : Method of preservation of foodstuffs, in which suitably prepared foods are placed in metal containers that are heated, exhausted, and hermetically sealed.
3. **Coagulation** : It is a process that converts or thickens a liquid into solid and semi-solid.
4. **Contamination** : The substance or a food contaminated by radioactive substance or chemicals, or through air, water.
5. **Decomposition** : The food is spoiled by microorganisms such as bacteria, molds, and yeasts, along with natural decay of the food.
6. **Diarrhoea** : A common symptom of gastrointestinal disease, characterized by increased frequency and fluid consistency of stools.
7. **Endemic ascitis** : Ascites is a gastroenterological term for accumulation of fluid in the peritoneal cavity.
8. **Food handler** : A person who directly engages in the handling of foods.
9. **Food infection** : The food contains bacteria or other microbes which infect the body after it is eaten.
10. **Food Intoxication** : Disease resulting from the ingestion of toxins, produced by microorganisms that have been grown in a food.
11. **Food Poisoning** : A general term applied to all stomach or intestinal disorders due to food contaminated with certain microorganisms, their toxins chemicals, or poisonous plant materials.
12. **Lathyrism** : It is a neurological disease of humans and domestic animals caused by eating certain legumes of the genus of Lathyrus.
13. **Putrefaction** : The decomposition of proteins by microorganisms producing disagreeable odors.
14. **Rancidity** : Undesirable changes like unpleasant smell or taste due to changes in fat.
15. **Souring** : Exposure to an acid to affect a physical and chemical change in food.
16. **Thawing** : It is a process of warming foods that has been frozen.
17. **Putrid** : Decomposed and foul- smell coming from non-vegetarian foods like meats
18. **Toxin** : Poisonous substance, such as a bacterial toxin, elaborated by an organism.
19. **Kumiss** : Fermented mare's milk
20. **Kefir and Liben** : Fermented sheep's milk
21. **FCI** : Food Corporation of India





LINKAGES

<https://www.youtube.com/watch?v=BlKP35bct2o> - Microorganism in food

<https://www.youtube.com/watch?v=tUi4wgQVQ-I> - Microorganism in food

Student Activity

- Preparation of chart on causes of food spoilage and identifying common spoilages in food at home.

Teacher Activity

- Experimentation and observe the changes in spoilage of five common foods such as bread, milk, tomato, orange and cooked egg.
- Observe the food quality control measures followed in Food Service Institutions.



Questions

I. Choose the Correct answer

1. The physical change seen in deep frozen foods is
 - a. Refrigerator burn
 - b. Refrigerator blanch
 - c. Freezer burn
 - d. Freezer blanch
2. Salmonellosis affects the
 - a. Central nervous system
 - b. Gastro intestinal system
 - c. Circulatory system
 - d. Reproductive system
3. Ice is responsible for causing food borne illnesses when
 - a. Prepared from un potable water
 - b. Melts in the beverage
 - c. Contaminated by flies, dust and dirty sawdust
 - d. All the above.
4. The illness caused commonly by consuming spoiled canned foods is
 - a. Diphtheria
 - b. Asthma
 - c. Botulism
 - d. Mumps.





5. The non-bacterial food poisoning is
 - a. Botulism
 - b. Salmonellosis
 - c. Shigellosis
 - d. Staphylococcal
6. Foods considered unfit for use should be
 - a. Fed to domestic animals
 - b. Cooked well to destroy germs
 - c. Frozen immediately to prevent further spoilage
 - d. Discard at once
7. The main symptoms of staphylococcus food poisoning is
 - a. Vomiting
 - b. Diarrhoea
 - c. Fever
 - d. Abdominal pain
8. The common spoilage in bakery products is brought about by
 - a. Bacteria
 - b. Virus
 - c. Molds
 - d. Fungi
9. Rope formation in milk is
 - a. Spoilage
 - b. Poisoning
 - c. Fermentation
 - d. Decay
10. Enzymes producing decomposition of proteins in foods like meat, fish, eggs and milk arein nature.
 - a. Proteolytic
 - b. Amylolytic
 - c. Lipolytic
 - d. All the above
11. One of the food involved in staphylococcus food poisoning is.....
 - a. Potato
 - b. Fish
 - c. Bread
 - d. Milk
12. Milk products can be kept for considerably long time by
 - a. Heating
 - b. Boiling
 - c. Pasterurization
 - d. Refrigeration
13. Foul smelling in protein foods is due to production of
 - a. Hydrogen sulphide
 - b. Aldehyde
 - c. Alcohol
 - d. Rope
14. Extraction hoods above cooking range removes
 - a. Impurities
 - b. Flavor
 - c. Nutrients
 - d. Darkness
15. Foods that spoil readily are known as
 - a. Semi-perishable foods
 - b. Non perishable foods
 - c. Perishable foods
 - d. Grains



II. Write in 3 lines (3 marks)

1. How do you classify microorganisms in food?
2. Define contamination.
3. Give three causes of food spoilage
4. Write down the changes brought by enzymes present in food
5. What is putrefaction?
6. What is fermentation?
7. How do you classify food by the ease of spoilage?
8. List the signs noted in spoilt vegetables and fruits.
9. List the signs noted in spoilt Milk and milk products.
10. List the signs noted in spoilt Meat, poultry and egg.
11. What are the signs noted in spoilt fishes?
12. List any three points for the safety in food service operation?
13. Give the precautions to be taken to prevent food –borne illness due to spoilage of frozen foods.
14. Indicate the aspects to be noted in personnel hygiene.
15. Give the symptoms of Salmonellosis.
16. State the meaning of safety.



III. Write in a paragraph (5 marks)

1. Give the symptoms of botulism and outline simple measures to prevent its occurrence in food service.
2. Write a note Salmonellosis.
3. Discuss the about staphylococcal poisoning.
4. Explain the Clostridium perfringens poisoning.
5. Brief on various causes of food spoilage.
6. Write on personal hygiene
7. Give the spoilage indicators of perishable foods noted in food service establishments.
8. Give the measures of safeguarding food in a food service outlet.



IV. Answer in detail (10 marks)

1. Describe the important role of microorganisms in food.
2. Define Food spoilage. Write on causes of food spoilage and classification of food by ease spoilage.
3. How will you maintain the kitchen hygiene?
4. Elaborate on safety measures to be followed in food service operations
5. Differentiate the major food poisoning on bacterial origin.