

SPOILAGE OF FOOD

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Food spoilage is the process in which food deteriorates to the point in which it is not edible to humans or its quality of edibility becomes reduced. It is caused due to various agents making food unsuitable for consumption.

Food can spoil at many stages in its preparations to storage. Infact spoilage in food begin as soon as- vegetables and fruits are harvested, eggs are laid, fish is caught, animals are slaughtered for meat and milk is drawn from animals.

To make a check on food spoilage, food preservation is done by increasing the shelf life by controlling changes brought about by microorganisms, enzymes, self-decomposition and auto-oxidation.

Causes of Food Spoilage

1. Intrinsic and Extrinsic factors
2. Microorganisms and insects
3. Chemical changes
4. Enzymatic action

Intrinsic and extrinsic parameters

Intrinsic factors: Intrinsic factors exist as part of the food product itself.

1. **pH**- Most microorganisms grow best at pH value around 7.0 (6.6-7.5), whereas few grow below 4.0. Bacteria tend to be more fastidious in their relationships to pH than molds and yeast.

2. **Moisture content**- Water content or moisture content is a measurement of the total water contained in a food. It is usually expressed as a percentage of the total weight:

$$M_w (\text{wet basis}) = \frac{w-d}{100} \times 100$$

M_w = moisture content on a percentage basis

w = wet weight

d = dry weight

Most food has a water activity greater than 0.95 which supports the growth of bacteria, yeast and mold.

3. **Oxidation- reduction potential (EH)**- The oxidation-reduction potential is normally expressed as Eh and measured in milli- volt unit, is defined as the tendency to yield electrons (become oxidised) or to capture electrons (become reduced). The value of EH at which microorganisms grow determines whether they are aerobic or anaerobic.

Aerobes require a substrate having a positive EH, means that aerobic microorganisms grow rapidly under a high oxidation-reduction potential. For anaerobes it requires a substrate having a

negative EH. The optimum EH values for the growth of microbes vary with species.

Yeast and molds require higher oxidation-reduction potential EH values than most bacteria, generally 200 to 400 milivolt.

Extrinsic factors- The factors in the environment external to the food, which affect both the microorganisms and the food itself during processing and storage.

1. **Temperature-** Different microorganisms grow over a wide range of temperature. Some microorganisms grow in cold, some grow at room temperature and others grow at high temperatures.
2. **Oxygen-** Many microorganisms need oxygen in order to develop and reproduce: these are called aerobic microorganisms, example- Escherichia coli, a faecal bacterium which grows readily on many foods. If food is kept in low oxygen environment, aerobic bacteria cannot grow and multiply. There are some microorganisms that grow without oxygen, called anaerobic microorganisms. Ex- Clostridium botulinum, the bacterium causing Botulism, which can survive in very low oxygen environments such as tinned foods.
3. **Humidity-** The humidity of the storage environment is an important factor for the growth of microorganisms at the food

surfaces. If food is stored at dry atmosphere, microorganisms are less able to grow than if a food is stored in a humid (moist) environment. Therefore, dry conditions are better for food than moist conditions.

Microorganisms and insects

1. Micro-organisms:

The micro-organisms responsible for food spoilage are molds, yeast and bacteria.

Molds:

Molds are in the form of threads developed on perishable foods and easily visible to the eye. They contain spores which can spread through the air and start new mold plants. When these molds find a favourable environment, they germinate and produce a fluffy growth, often white or grey but sometimes bluish-green, red, orange or some other colour, depending upon the variety of the mold. Most molds are not harmful. A relatively small proportion of the molds, found on foods are capable of producing toxic materials known as mycotoxins of which Aflatoxin is an example.

Yeasts:

Yeasts are tiny organisms which are not visible to the naked eyes, but can be seen through the microscope. They multiply very fast and cause fermentation by acting on certain components of the perishable foods like fruit juices, syrups etc. During yeast fermentation, the sugars present in the food are broken up to form alcohol and carbon dioxide. Foods liable to be spoiled

by yeasts are fruit juices, syrups, molasses, honey, jams and jellies.

Bacteria:

Bacteria are unicellular organisms and much smaller in size than either yeasts or moulds. They occur in different sizes and shapes and classified as coccus (spheroidal), bacilli (cylindrical) or spirillae (spirillar), on the basis of their shapes as seen under the microscope. They also vary in their requirement for food, moisture, acidity, temperature and oxygen. Bacteria can grow and develop rapidly between 20°C and 53°C. Bacteria are classified according to the temperature ranges that they need for growth:

1. A higher temperature than 45°C are known as thermophile, (e.g. in canning industry and milk processing plants).
2. Temperatures between 20-35°C are called Mesophiles.
3. Temperature less than 20°C are called Psychrophiles (e.g. in Refrigerator and in cold storages).

Table 1. **Common spoilage organisms and their a_w limits for growth.**

Microbial Group	Example	a_w	Products Affected
Normal bacteria	<i>Salmonella species</i> <i>Clostridium botulinum</i>	0.91	Fresh meat, milk
Normal yeast	<i>Torulopsis species</i>	0.88	Fruit juice concentrate
Normal molds	<i>Aspergillus flavus</i>	0.80	Jams, Jellies
Halophilic bacteria	<i>Walleimia sebi</i>	0.75	Honey
Xerophilic molds	<i>Aspergillus echimilatas</i>	0.65	Flour
Osmophillic yeast	<i>Saccharomyces bisporus</i>	0.60	Dried fruits

2. Insects:

Worms, bugs, weevils, fruit flies, moths cause extensive damage to food and

reduce its nutritional value and make it unfit for human consumption.

3.Spoilage by Enzymes

Enzymes are organic catalyst present in living cells. The life of every living cell depends upon the chemical reactions activated by these enzymes. Hence, they cause food spoilage due to the chemical reactions as in cutting apples; it becomes brown while tomato cause develops a black scum. Enzymes are sensitive to heat and easily destroyed by heat. They can act from 0°C to 60°C. Their optimum temperature of reaction is usually 37°C. All enzymes are inactivated by temperatures above 80°C. Therefore, enzyme activity can be prevented by heating foods to temperature which inactivate the enzymes. It can also be prevented by cooling (as in freezing and refrigeration) by elimination of air, by protection from light and by addition of anti-oxidants.

Effect of Food Spoilage on Us

Foods contaminated with [pathogenic microorganisms](#) usually do not look bad, taste bad, or smell bad. It is impossible to determine whether a food is contaminated with pathogenic microorganisms without microbiological testing. To avoid potential problems in foods, it is very important to control or eliminate these microorganisms in food products. Diseases which result from pathogenic microorganisms are of two types: **infection** and **intoxication**.

- **Foodborne infection** is caused by the ingestion of food containing live bacteria which grow and establish themselves in the human intestinal tract.
- **Foodborne intoxication** is caused by ingesting food containing toxins formed by bacteria which resulted from the bacterial growth in the food item. The live microorganism may not have to be consumed.

How to Check Food Spoilage?

Preservation by High Temperature

1. **Blanching-** Blanching is the widely used procedure in the canning and the preservation industry. The process is used to inactivate the enzymes in food which might be the cause of potential spoilage. Blanching referred to the emersion of food particularly fruits and vegetables in boiling water and then sudden dipping in cold water. The process used the principle that enzymes are denatured at high temperature and inactivated at low temperature. Therefore the use of hot and cold water ensures that denatured enzymes donot have the condition of renaturation.

2. Sterilization- It refers to the complete destruction of microorganisms. It requires a treatment of at least 121 degree Celsius of wet heat for 15 min to kill microorganisms and even some bacterial spores that are resistant to heat. Commercially sterilize means degree of sterilization at which all pathogenic and toxin forming organisms have been destroyed as well as all other types of organisms which if present could grow in the product and produce spoilage under normal handling and storage conditions. Commercially sterile food may contain small number of heat resistant bacterial spores but this will not multiply in the food supply. However if they were isolated from the food and given special environmental conditions, they could be shown to be alive.

3. Pasteurization- It involves a comparatively low order of heat recommended generally at temperature below the boiling point of water. It has two different primary objectives depending on food.

- In milk and liquid eggs, pasteurization process is specifically design to destroy pathogenic organisms that may be associated with the food and could have public health significance.

- To extend the product's shelf life from a microbial and enzymatic point of view. This is the objective when beer, wine and other fruit juices are pasteurized.

Pasteurization is of three types-

- 1) high temp short time (HTST), which is done at 71 degree Celsius for 15 sec and at 88 degree Celsius for a second.
- 2) low temp high time (LTHT), this is done at 63 degree Celsius for 30 min.
- 3) ultra high temp treatment, preservation is done at 137.8 degree Celsius for 2 sec is used.

4. Canning- Canning is the process of sealing foodstuff thermatically in food containers and sterilising them by heat for long storage. Canning is also called as appertization. Principle of canning is the destruction of spoilage organisms within the sealed container by means of heat.

Preservation and processing by Low Temperature

Low temperature of preservation may be categorised into 2 groups-
Refrigeration and Freezing

1. **Freezing-** It is the method of preserving food by lowering the [temperature](#) to inhibit microorganism growth. Most commercial freezing is done either in cold air kept in motion by fans (blast freezing) or by placing the foodstuffs in packages or metal trays on refrigerated surfaces (contact freezing). There are various methods of freezing like freezing in air, freezing by indirect contact with the refrigerant, freezing by direct contact with freezing medium.
2. **Drying-** Drying of food involves complete removal of water under controlled conditions in such a way that food is not altered. Dried food contains moisture to the extent of 1-5% and they have storage stability at room temp of a year or longer. On reconstitution with water dried foods are very close and indistinguishable from original foods used in their preparation.

Preservation by Chemicals

Food additive is the substance or mixture of substances which is added to food to improve its quality. Those additives which prevent the deterioration or decomposition of food are called as preservatives. They have antibiotic, fungistatic, germicidal and anti-oxidative property or act as neutralisers of acidity, stabilisers, forming and coating agents to prevent the spoilage of food. These preservatives are of two types- class I and class II preservative.