



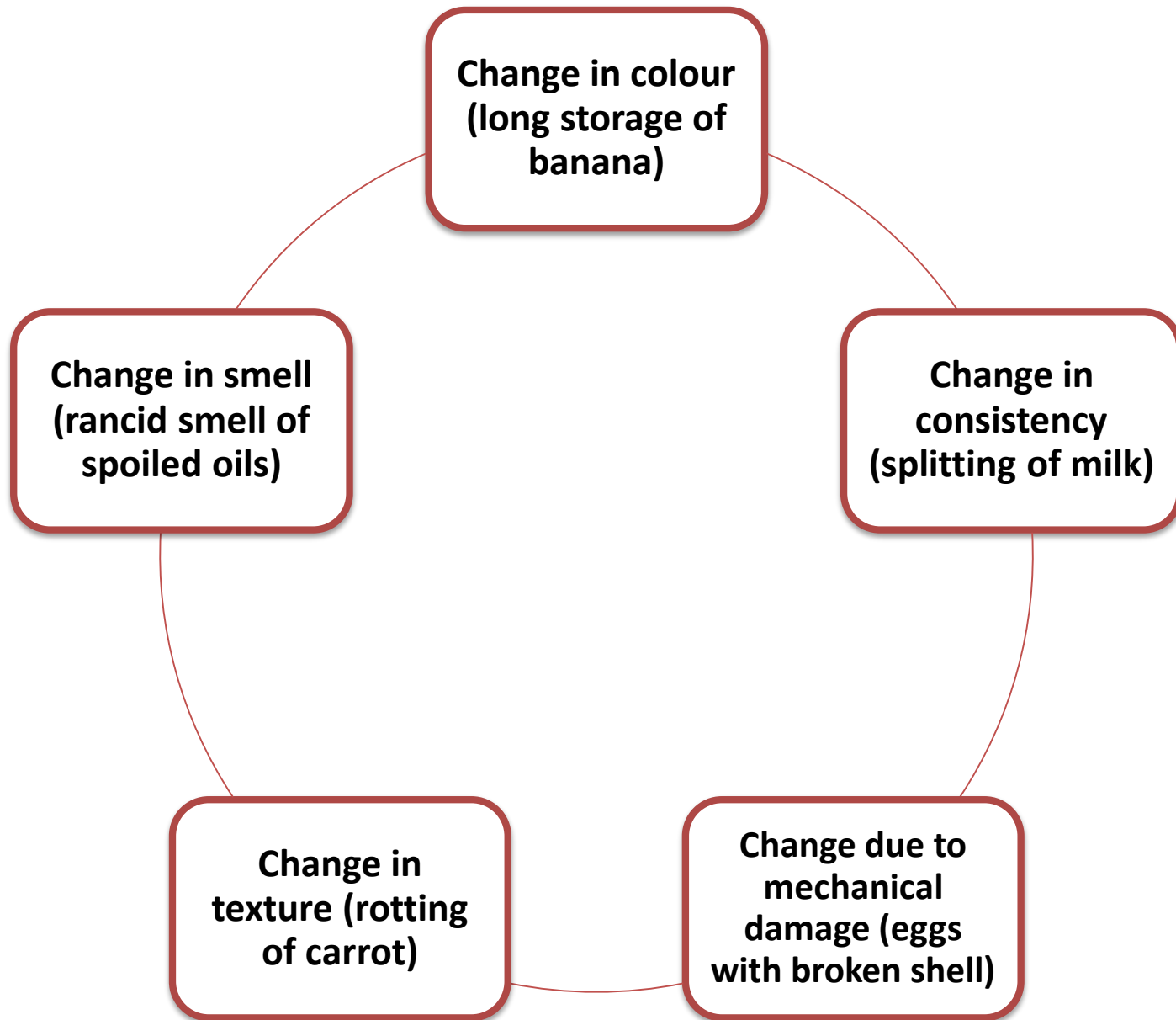
Types of Food Spoilage and Their Aetiology

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What is Food Spoilage?

Food spoilage is a process or change which renders a product undesirable or unacceptable for consumption. This complex ecological phenomenon is the outcome of biochemical activity of microbial processes which will dominate according to the prevailing ecological conditions.





Undesirable Changes in Food due to Spoilage

Major Causes of Spoilage

Biological

- Growth and activity of microorganisms (bacteria, yeast and molds) and activity of food enzymes and damage due to pests, insects and rodents etc.

Physical

- Reaction with oxygen and light and chemical reactions within food constituents

Chemical

- Consist of temperature and physical abuse

**Growth and activity
of microorganisms**

**Activities of food
enzymes**

**Inappropriate
holding
temperature (heat
and cold)**

**Gain or loss of
moisture**

**Reaction with oxygen
and light causing
rancidity and colour
changes**

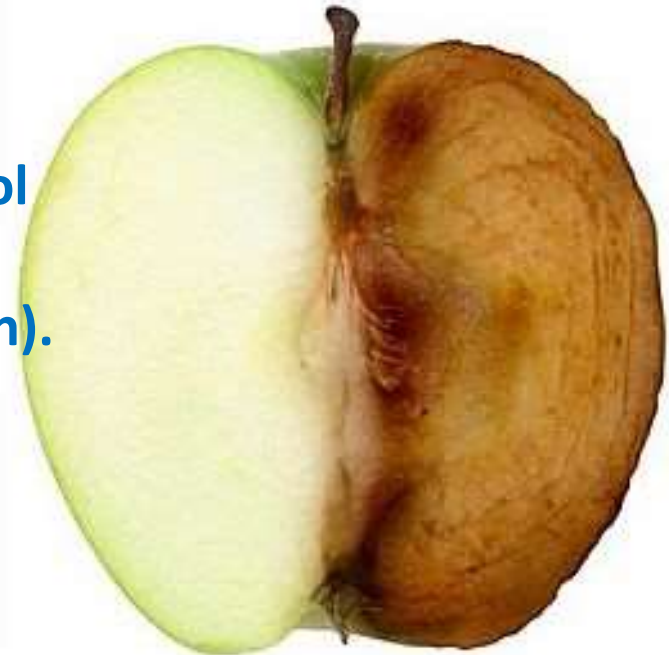
**Physical stress or
abuse**

**Damage due to
pests, insects and
rodents**

**Non-enzymatic
reactions in food
(oxidation and
mechanical damage)**

Spoilage due to Enzymatic Activity

1. Enzymes are complex chemical substances, which are present in all living organisms and tissues, that control metabolic processes.
2. Enzymatic spoilage: Food deterioration
3. Endogenous enzymes include:
 - ✓ Post-harvest senescence and spoilage of fruit and vegetables
 - ✓ Oxidation of phenols in plant tissues to orthoquinones by phenolases and polyphenol oxidases (PPO). Orthoquinone rapidly polymerize to form brown pigments (melanin).
 - ✓ Sugar-starch conversion in plant tissues by amylases.



Spoilage due to Insects, Pests and Rodents

1. Insects and pest attack fruits, vegetables, grains and their processed products. Warm humid environment promote insect growth, although most insects will not breed above 35°C or falls below 10°C.
2. Presence of insects and pests render consumable loss in the nutritional quality, production of off-flavours and acceleration of decay processes.
3. Rats and mice carry disease-producing microorganisms on their feet, feces and urine and contaminate food.



Spoilage due to Chemical Reactions

1. Chemical reactions take place in the presence of atmospheric oxygen and sunlight.
2. Lipid oxidation and non-enzymatic browning deteriorate sensory quality, colour and flavour.
3. Lipid oxidation is influenced by light, oxygen, high temperature, iron and copper.
4. Non-enzymatic browning (frying, cooking, storage of dried and concentrated foods) through Maillard and caramelization.

Maillard reaction: Reaction between reducing sugars and amino acids in presence of heat and result in formation of black brown insoluble pigments. **Caramelization of sugars:** Presence of high heat and low moisture content in food.





Spoilage due to Physical Factors

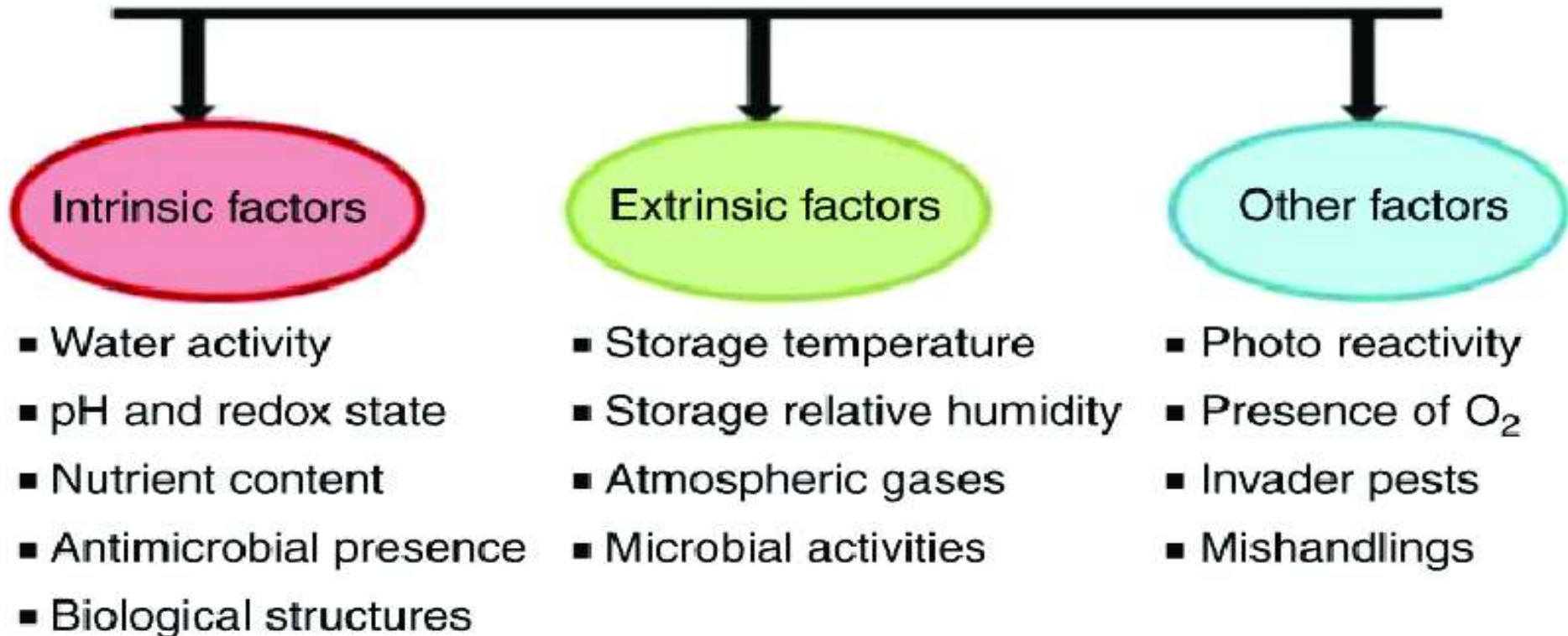
- 1. Temperature, moisture and pressure can also cause food spoilage.**
- 2. Physico-chemical reactions are caused by freezing, burning, drying and bruising of fruits and vegetables during storage, handling and transportation.**
- 3. Food processing or storage causes deterioration in colour of fruits and vegetables due to degradation of chlorophyll resulting dull olive-brown colour.**
- 4. Anthocyanins, pigment in fresh and processed foods, form complexes with metals resulting in colour change. Eg., red sour cherries react with tin and form undesirable purple complex.**

Most food spoilage is a result of microbial activity. Visible microbial growth may be apparent in the form of surface slime, degradation of structural components of the food can cause a loss of texture, but the most common manifestation will be chemical products of microbial metabolism, gas, off-odours and flavours.



Factors Affecting Growth of Microorganisms

1. Growth of microbes and their propagation in the food is one of the important factors to food spoilage.
2. They decrease the nutritive value and wholesomeness of food.



Nutrients and other constituents in food:

1. Proteins are degraded by proteolytic enzymes. Anaerobic degradation of protein may result into awful odour (putrefaction).
2. Carbohydrates are affected primarily by yeast and molds. Microbes degrade carbohydrates and produce alcohol, lactic acid, acetic acid, propionic acid, butyric acid etc.
3. Microbes break down fats in food to produce fatty acids and glycerol.



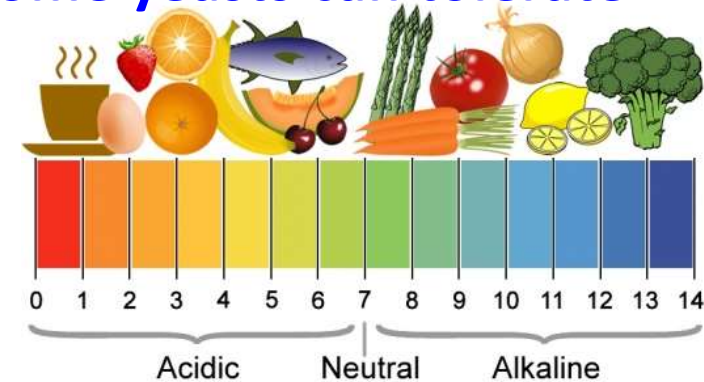
Acidity:

1. Foods having pH below 4.5 (acidic) and >4.5 (non-acidic) foods.
2. Acidic foods are mainly spoiled by molds and yeasts and non-acidic foods are particularly attacked by bacteria.



Water content:

1. Microbes require at least 13% free water for their growth and expressed in terms of available water/water activity (a_w).
2. The a_w of pure water is 1.0 and bacteria, yeasts and molds require 0.91, 0.88 and 0.80 a_w respectively.
3. Foods preserved with salt/sugar concentration do not support growth of most microbes. Eg., salt concentration of 5-15% inhibits growth of bacteria whereas, molds and some yeasts can tolerate $>15\%$.



Physical and environmental factors:

- 1. Temperature (20-50°C) is suitable for growth of microbes.**
- 2. Bacterial pathogens of fruits and vegetables will grow between 6 and 35°C.**
- 3. Some fungi (*Botrytis cinerea*) will survive and even grow at 1°C on agricultural produce.**

Availability of oxygen:

- 1. Anaerobic micro-organisms are mainly involved in the spoilage of air tight canned food under anaerobic conditions.**
- 2. Oxygen is necessary for mold growth.**

Presence of inhibitory substances:

- 1. Inhibitory substances originally present in food, added purposely or accidentally or developed thereby prevent growth of microorganisms.**

Biological structure:

- 1. The inner parts of whole, healthy tissues of living plants and animals are either sterile or low in microbial content.**
- 2. Natural coverings provide protection against entry of microbes. Eg., testa of seeds, shell of nuts, covering of fruits etc.**



TYPES OF FOODS ON THE BASIS OF SPOILAGE

Perishable Foods: Foods that are readily spoilt and require special preservation and storage conditions. e.g., milk, fruits, vegetables, fish

Semi-perishable Foods: Foods if properly stored can be used for a long duration e.g., potatoes

Non-perishable Foods: Foods remain in good form for long duration unless handled improperly. e.g., sugar, flour