University: Basrah
College: veterinary Medicine
Course Level: Master
Course: Food Preservation
Topic: Biological Preservation
Lecture prepared: Dr. Alaa Alsandaqchi

Biological preservation

Biological process: fermentation

Fermentation method uses **microorganisms to preserve food**. This method involves breakdown of **carbohydrates** with **the action of microorganisms and/or the enzymes**. **Bacteria, yeasts, and molds** are the most common groups of **microorganisms** involved **in fermentation of a wide range of food items**, such as dairy products and meat products. **Fermentation** enhances **nutritional value, healthfulness, and digestibility of foods. This is a healthy alternative of many toxic chemical preservatives**.

Classification of fermentation

Fermentation can be **spontaneous** or **induced**. There are different types of fermentation used in **food processing**. Mechanisms of different food fermentation techniques are briefly discussed below:

1. Alcohol fermentation

Alcohol fermentation (ethanol fermentation) is the result of **yeast action** on the simple sugar called '**hexose**' converting this into **alcohol** and **carbon dioxide** . **The quality of fermented products depends on the presence of alcohol**. In this process, **air is excluded** from the product to **avoid the action of aerobic microorganisms**, such as the acetobacter. **This process ensures the longer shelf life of the products**. The following equation illustrates alcohol fermentation by conversion of hexose.

$$\text{Sugar} \xrightarrow{\text{without oxygen}} \text{Ethanol} + \text{Carbon dioxide}$$

2. **Vinegar fermentation (acetic acid fermentation)** takes place after alcohol fermentation. **Acetobacter** converts **alcohol** to **acetic acid** in the presence of **excess oxygen**. Under this method, food products are preserved as pickles. **Vinegar fermentation** results in **acetic acid** and **water** by **oxidation of alcohol**.

$$\text{Ethanol} \xrightarrow{\text{oxygen}} \text{Acetic Acid+ Water}$$

Note: **Vinegar** is made from **a two-step fermentation process**. First, **alcohol** is formed from **yeast consuming sugars within fruits and grains**. Then, alcohol is transformed into vinegar, oxygen and bacteria of the genus Acetobacter must be present for the second step to take place, acetic fermentation.

3. **Lactic acid fermentation** takes place due to the presence of two types of bacteria: **homofermenters** and **heterofermenters**. **Homofermenters** produce mainly **lactic acid**, via the **glycolytic** (Embden–Meyerhof pathway). **Heterofermenters** produce **lactic acid plus** appreciable amounts of **ethanol, acetate, and carbon dioxide**, via the 6-phosphogluconate/phosphoketolase pathway.

Homolactic fermentation:

$$\text{1 mol Glucose} \longrightarrow \text{2 moles Lactic Acid}$$

Heterolactic fermentation:

$$\text{1 mol Glucose} \longrightarrow \text{1 mol Lactic Acid+ Ethanol+ Carbon dioxide}$$

In the fermentation process, different kinds of microorganisms are used exclusively to produce flavor in foods, which are presented in Table 1

Food items	**Microorganisms**	**Flavor compounds produced**
Buttermilk	***Streptococcus lactis*** ***Streptococcus cremoris*** ***Lactobacillus bulgaricus***	Lactic acid, diacetyl, small amounts of acetaldehyde
Yoghurt	***Streptococcus thermophiles*** ***Lactobacillus bulgaricus***	Acetaldehyde and diacetyl acetoin
Alcoholic fermented milk	***Saccharomyces sp.*** ***Lactobacillus sp.***	Ethanol acetoin and diacetyl
Sauerkraut	*Mixed cultures of* *Lactobacillus brevis* *Leuconostoc mesenteroides* *Lactobacillus plantarum*	Acetate and small amounts of short-chain fatty acids
Soybean milk	***Lactobacillus sp.*** ***Streptococcus thermophiles***	Aldehydes including pentanal
Soya sauce	*Aspergillus oryzae* *Lactobacillus sp.* *Saccharomyces rouxii*	Organic acids, alkyl phenols, and pyrazines
Tempeh	*Rhizopus sp.*	Fatty acid
Bread	*Saccharomyces cerevisiae*	Ethanol
Swiss cheese	***Propionibacterium shermanii***	Propionic acid
Cocoa	*Saccharomyces sp.* *Lactobacillus sp.* *Acetobacter sp.*	Fatty acids and aromatic acids