

## 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:

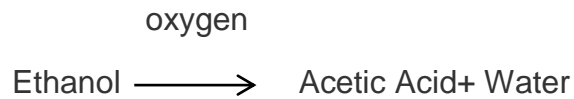
#### 1. Alcohol fermentation

**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.

without oxygen

Sugar  $\longrightarrow$  Ethanol+ Carbon dioxide

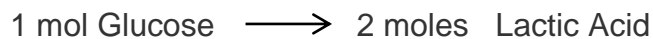
2. **Vinegar fermentation (acetic acid fermentation)** takes place after alcohol fermentation. **Acetobacter** converts **alcohol** to **acetic acid** in the presence of **excess oxygen**. Under this method, food products are preserved as pickles. **Vinegar fermentation** results in **acetic acid** and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



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:**



**Heterolactic fermentation:**



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

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