

Food Fermentations and Food Produced by Microbes

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Food fermentations and food produced by microbes

Traditional **fermented foodstuffs** include:

- **Dairy products**- cheese, yoghurt, sour cream and kefir
- **Plant products**- breads and fermented rice products, fermented fruits, vegetables and legumes, preserved olives and gherkins, sauerkraut (fermented cabbage), soy sauce, tofu, fermented cassava, cocoa and coffee beans.
- **Fish and meat products**- fish sauce and fermented sausages
- **Alcoholic beverages** - beers, wines and distilled spirits (derived from sugars and starches)

Dairy fermentations

Milk is used to produce fermented dairy products such as **cheese, butter, sour cream, kefir and yoghurt**.

The microorganisms used in the production of fermented dairy products are-

- **Lactic acid bacteria** (naturally present in milk)
- **Filamentous fungi** (maturation processes of some cheese)

Probiotics

Fermented 'health' drinks and foods are referred to as probiotics.

Probiotics contain **live bacteria** such as -

- *Lactobacillus acidophilus*
- *L. casei*
- *Bifidobacterium species*

Probiotics improve the functioning of the gut and stabilize intestinal microflora.

Yoghurt production

Yoghurts is prepared by heating milk and then inoculating cooled milk with

- *Streptococcus thermophilus* (produces mainly acid)
- *Lactobacillus delbrueckii ssp. bulgaricus* (generates more organoleptic compounds, particularly acetaldehyde)

Cheese production

Production of coagulated milk proteins or curd from pasteurized milk is achieved by the activities of

Lactic acid bacteria, such as *Lactococcus lactis*, *L. cremoris* and *Streptococcus thermophilus*

Traditionally, **rennin (chymosin, aspartic protease)** is used in cheese making.

Rennin is prepared in a crude form from the **stomach of calves** and is referred to as **rennet**.

For 'vegetarian' cheeses, **fungal proteases** are now also employed.

In addition, the calf chymosin gene has been introduced into *E.coli* for the commercial production of **recombinant enzyme**.

Cheese is ripened or aged to develop the final flavour and texture.

Butter production

Cultured butter

prepared from pasteurized cream ripened with bacteria for 24– 48 h prior to churning.

Microorganisms used are-

- *Lactococcus lactis* ssp. *diacetylactis* and
- *Leuconostoc citrovorum*

Bread

Yeast (strains of *Saccharomyces cerevisiae*) has been used to leaven bread.

Bread dough rises due to the pressure of the carbon dioxide build-up by yeast.

The yeast also add flavours, alcohol and acids.

Soya bean fermentation

Tempeh production involves fermentation of cooked soya beans by *Rhizopus* species,

Three basic stages of **soy sauce** production -

1. aerobic fermentation of cooked soya beans along with wheat flour or rice by *Aspergillus oryzae* (product anaerobic fermentation as **koji**)
2. addition of brine to the koji and anaerobic fermentation by *Pediococcus halophilus* (product is known as **moromi**)
3. Subsequently, *Candida* species or *Zygosaccharomyces rouxii* perform an alcoholic fermentation and produce additional flavour compounds such as furanones.

The product is traditionally matured for 6–9 months to develop the full flavour before the liquid is filtered, pasteurized and finally bottled.

SAUERKRAUT PRODUCTION

Shredded cabbage is fermented with lactic acid bacteria, especially *Lactobacillus plantarum* and *Lactobacillus brevis*, along with *Leuconostoc mesenteroides* for 20–30 days at 18–20°C.

These organisms are also involved in the production of fermented gherkins and olives.

Coffee

Mucilaginous material outside the coffee and cocoa beans is removed by the action of pectinolytic bacteria and fungi.

This is followed by an acid fermentation by lactic acid bacteria, primarily *Leuconostoc mesenteroides* and *Lactobacillus brevis*.

The residual pulp is washed from the beans, which are then dried, hulled and roasted.

Fermented meat and fish

Meat and fish products are salted and fermented using *Pediococcus cerevisiae*, *Lactobacillus plantarum* and *Staphylococcus carnosus* that produce lactic acid.

Alcoholic beverages

Alcoholic beverages are manufactured from fruit juices, plant sap and honey, or from hydrolysed grain and root starch.

Polysaccharide is hydrolysed to simple sugars using **fungal or plant amylases**.

The yeasts involved in these alcoholic fermentations are mostly strains of ***Saccharomyces cerevisiae***,

Fermentation products are **ethanol**, a range of desirable organoleptic (flavour and aroma) compounds and **CO₂** (provides carbonation for some products).

Beer brewing

The term beer is given to **non-distilled alcoholic beverages** made from partially germinated cereal grains like **barley**.

Wine production

Wine can be made from any **plant extract or fruit juice**.

Grape juice contains high levels of fermentable sugars (mainly glucose and fructose) and is used for wine production.

Most wines normally contain up to **14% (v/v) ethanol**.

The main **fortified wines (22% (v/v) ethanol)** are **sherry, port, madeira** and **vermouths**, which contain various flavour supplements derived from herbs and spices.

Cider production

Cider is an alcoholic beverage prepared from **apple juice**.

The cider contains **2–8% (v/v) alcohol**.

Whiskies

Whiskies are prepared from **malted barley**. It is a **distilled** beverage.

whisky contains **40%, v/v ethanol**.

Vinegar production

Vinegars are mainly produced from **fruit juices and sugar syrups**, including **maple syrup, molasses and honey**, but may also be manufactured from **cereal or root starch**.

Vinegar can be made directly **from wine, cider and spirit alcohol by acetification step** (bacterial oxidation of the ethanol to acetic acid).

Vinegar contains a minimum of **4% (w/v) acetic acid**.

Vinegar fermentations

ALCOHOLIC FERMENTATION

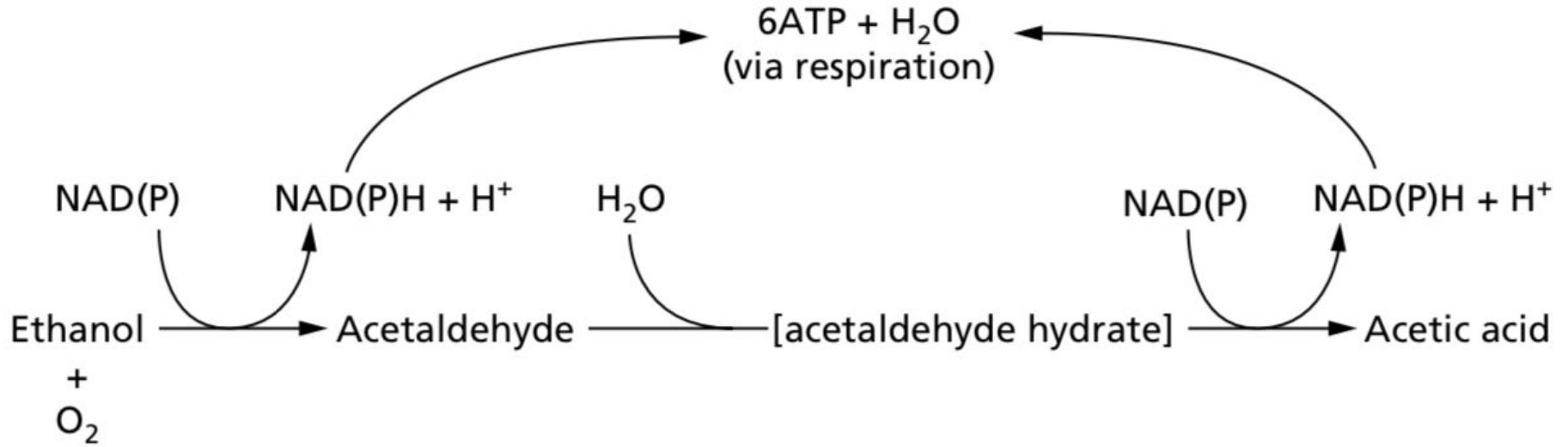
Anaerobic fermentation of fruit juices & sugar syrups by yeast, usually *S. cerevisiae* var. *ellipsoideus*.

Fermentation products are ethanol, CO₂, and small amounts of glycerol, acetic acid and some higher alcohols.

Vinegar fermentations

ACETIC ACID FERMENTATION

Incomplete oxidation of ethanol to acetic acid by aerobic *Acetobacter* and *Gluconobacter*.



Oxidation of ethanol to acetic acid

let's revise

Q. ----- convert milk to curd.

Q. Microbes present in yogurt -----

Q. In cheese making ----- enzyme is used for curdling.

Q. ----- is known as " Baker's yeast".

Q. Sauerkraut is produced by fermentation of-----.

Q. ----- used to ferment soybean and wheat to produce Soy sauce.

Q. Tempeh is an Indonesian food produced by fermentation of soybean with species of -----.

Q. ----- is a cheese like product obtained by fermenting soybeans with Mucor species.

Let's revise:

Q. -----used in the production of wine, beer and other alcoholic drinks.

Q. Enzyme employed for malting process in beer brewing industry is -----.

Q. Alcoholic beverage prepared from potato starch is -----.

Q. Beer is made by yeast fermentation of -----.