# BIOTECHNOLOGICALLY PRODUCED FERMENTED DAIRY PRODUCTS

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# BIOTECHNOLOGICAL DAIRY PRODUCTS

**Fermented dairy products :**

1. **Fermented milk (acidophilus milk, bifidus milk),**
2. **Yoghurt,**
3. **Ayran,**
4. **Kefir,**
5. **Fermented butter milk,**
6. **Fermented (sour) cream ,**

**Fermented dairy products have been classified in to 3 groups:**

-Lactic fermentation; e.g yoghurt (thermophilic), fermented buttermilk (mesophilic)

-Yeast-lactic fermentation; e.g kefir

-Mold-lactic fermentation; mold-ripened cheeses

# Acidophilus and Bifidus milk

Acidophilus and bifidus milks are fermented dairy products produced by the addition of *L. acidophilus* and *Bifidobacterium* ssp. (Bifidobacterium bifidum, B. animalis or B. longum), respectively.

During the production process, raw milk is pasteurized at 95°C and subsequently cooled down to 37°C. For acidophilus milk, 2-4 % pure *L. acidophilus* culture and for bifidus milk approximately 10% *Bifidobacterium* ssp. is inoculated into milk and following this inoculation, it is incubated at 37-40°C until the pH value reaches at 4.5-4.7 pH. The final product usually contains $10^8$-$10^9$cfu/ml bacteria.

Acidophilus milk has been referred to either as milk fermented with *L. acidophilus* or an unfermented milk containing *L. acidophilus*. For the production of unfermented acidophilus milk, pure *L. acidophilus* culture is inoculated to milk at 5-7°C and milk is kept under refrigerated temperatures.

## Acidophilus-Bifidus milk (A/B milk)

Other than acidophilus and bifidus milk, Acidophilus-Bifidus milk is an other fermented dairy product which is produced by the inclusion of L. acidophilus and Bifidobacterium ssp. in combination. It contains high levels of viable bacteria with 1:1 bacteria ratio.

For the reason that *L. acidophilus* and *Bifidobacterium* ssp., show probiotic properties, acidophilus and bifidus milk have beneficial effects on human health such as prevention of diarrhea and gastrointestinal problems caused by the activity of gas forming bacteria .

# Yoghurt

Yoghurt is a fermented dairy product produced by the addition of lactic starter cultures into milk and there after left to incubation (fermentation) at 42-43°C.

**Starter culture:** *Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* are typically used for this purpose.

-*Streptococcus thermophilus:*It is a Gram-positive, facultative anaerobic, homofermentative and thermophilic streptococcal bacteria. The main products of lactose fermentation are lactic acid, L (+) lactate, acetaldehyde and diacetyl. The optimum growth temperature is 37 ° C, while it cannot develop below 15 ° C, it can only develop at 50-52 ° C.

-*Lactobacillus bulgaricus:* It is a gram-positive, facultative anaerobic, obligatory homofermentative, thermophilic, acid-resistant, immobile, non-spore-forming rod-shaped bacterium. The main products formed by lactose metabolism are lactic acid and acetaldehyde.

Both starter bacteria have β-galactosidase enzyme systems. β-galactosidase enzyme is a hydrolytic enzyme that catalyzes the formation of glucose and galactose from lactose.

**Effects of Symbiosis:**

As a result of symbiosis of the two cultures, several benefits have been observed for the culture as well as product quality.

1. **Higher rate of acid production**

2. **Higher amount of flavour produced**

3. **Resistance to sugar**

4. **Higher cell numbers**

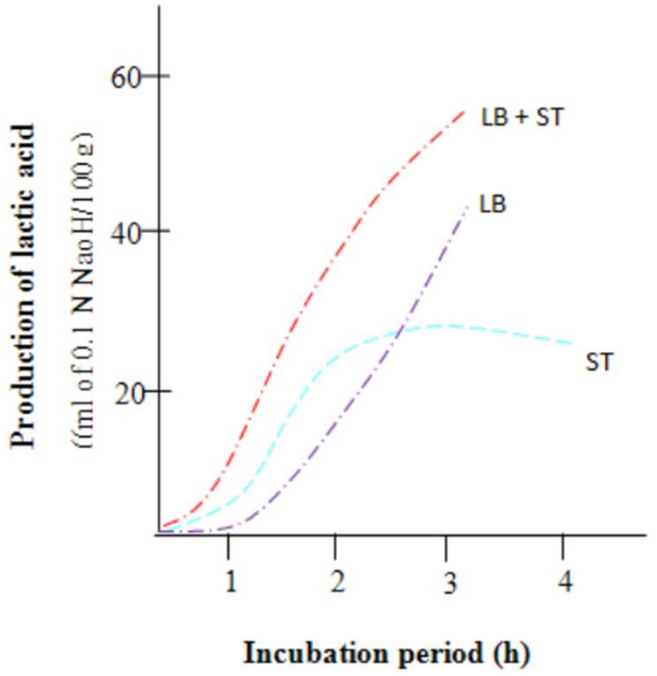


**Figure L-17-1. Effect of symbiosis on rate of acid production in yoghurt cultures**
ST= *S. thermophilus* LB= *L. bulgaricus*

**The production process (traditional):**

Heat treatment at above 85°C

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Cooling down to around 43-45°C,

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Inoculation (symbiotic lactic starter culture, 2%)

↓

Incubation (42-43 C-until pH.4.6) → protein coagulation/denaturation

**Industrial yoghurt production** includes much more stages such as;
fat and dry solid standardization of milk, de-aeration, homogenization and heat-treatment.

The milk used for industrial yoghurt production has to be of the highest microbiological quality, free of antibiotics, bacteriophages or sterilizing agents .

**Raw Milk:** free from antibiotics-mastitis

**Standardization**: total milk solids can be increased to 15-16% (normally it is 12-13%), preferably by concentration or by supplementation with skim milk powder.

**Homogenization:**The milk may be homogenized at 100 Kg/cm2 at 60-70 C

**Heat Processing:**The milk intended for fermented product manufacture must be heated in the range of 80-95 C for5-30 minutes (Could be 80C for 30 min, or 85C for 20 min or 90C for 10 min or 95 C for 5 min).

The high heat treatment is useful for;
-Pathogen inhibition
-good growth of the culture
-inactivates natural inhibitory substances in milk,
-drives out oxygen
-produce some growth stimulating agents for starters
-higher heat treatment denatures whey proteins which help in improving the gel stability

**Cooling**
Just after heating, the milk is cooled to incubation temperature, which is around 42-45C.

**Inoculation**
The milk is inoculated with active yoghurt cultures, S. thermophilus and L. delbrueckiis ubsp. bulgaricus at the ratio of 2% (v/v) of milk. Usually both the cultures are added in equal proportion (1% each).

**Incubation** temperature should be kept 42-43 C. The period of incubation varies between 3-6 h, depending upon the rate of acid production by the culture in the milk (until pH 4.6).

After the hydrolysis of lactose, the following fermentation products occur and contribute the flavor:
-Acetaldehyde
-Lactic acid
-Acetic acid
-Diacetyl

# Types of Yoghurt

**Set-yoghurt:**
The yoghurt is packaged immediately after inoculation with the starter and is incubated in the package.

**Stirred-yoghurt:**
Yoghurt is first made in a large container and then spooned or otherwise dispensed into secondary serving containers. The consistency of the ‘set’ is broken and the texture is less firm than set yoghurt. e.g. Fruit yoghurt

Drinking yoghurt (Ayran)
It is stirred yoghurt with total solid content not higher than 11% and has undergone further homogenization to reduce the viscosity (Industrial ayran production; is obtained by usage of directly lactic culture)

Ayran is also obtained as a by-product during traditional producion of butter from yoghurt. In this case, yoghurt is produced, diluted with water and churned for butter production. After removal of , the remaning  liquid part is known as Turkish buttermilk and yayik ayran.

# Kefir

Kefir is a slightly acidic fermented dairy product that is produced by using kefir grains (traditionally).

During production, kefir grains containing a wide range of symbiotic yeasts, Lactobacillus, Lactococcus, and Leuconostoc are added to milk. These mo's are trapped in a complex matrix, which comprises a polysaccharide known as **kefiran,** bound water, denaturated proteins and a small amount of fat.

The ratio of microorganisms in kefir grains are approximately as following; 83-90% LAB, 10–17% yeast and a small amount of acetic acid bacteria.

These grains contain 85-90% of water, and 5-10% dry matter. The composition of dry ma is approximately; 57% carbohydrates, 33% proteins, 4% fat, and 6% ash .

**Bacteria:** Lactobacillus spp. (*Lactobacillus brevis, Lb. casei, Lb. kefir, Lb. acidophilus, Lb. kefiranofaciens, Lb. kefirgranum, Lb. paracasei, Lb. plantarum* alt türleri sayılabilir.)
Lactococcus spp. (*Lactococcus lactis, Streptococcus durans*…)
Leuconostoc spp. (*Leuconostoc mesenteroides*..)
Acetic acid bacteria ( *Acetobacter* spp., *Acetobacter aceti*..)

**Yeast:** *Candida kefir, Candida holmii, Saccharomyces lactis, S. cerevisiae, S. delbruecki, Kluyveromyces marxianus, K. lactis, Pichia fermentans, Torulospora delkbruecki, Torulopsis holmii*

Through the fermentative activity of these microorganisms, the distinctive aroma and carbonated structure of Kefir are formed.

Basically; **lactic acid, CO2, small amounts of alcohol, acetaldehyde, acetone, diacetyl** flavor components are available.

# Kefir

Kefir can be produced by traditional or industrial processes.

While, kefir produced with kefir grains associated with starter culture is best preferred by consumers. Kefir can be produced from a variety of milk types including cow, sheep, goat, soy, and coconut. Non-fat, full fat, semi skimmed and skimmed milks can be used during kefir production .

**1. Traditional method;**

Kefir is generally produced from pasteurized (90-95°C for 5-10 minutes) full fat milk by the inoculation of kefir grains and a subsequent fermentation period of at 20-22°C until the pH drop to 4.3-4.5. Obtained kefir is waited at 10-12°C for 8-10 h before consumption for the ripening stage of product.

# Kefir

**2. Industrial method;** direct-to-vat set (DVS) freeze-dried kefir cultures (in powder form) are used during the productions.

DVS cultures include LAB and yeast species that are isolated from kefir grains.

The production process of kefir by DVS culture is roughly comparable with traditional production process by kefir grains.

When heat treated milk is cooled to 20–22°C DVS kefir starter culture is inoculated at a ratio of 2–8% in vats. The fermentation period can be continued approximately for 20-24 hours depending on the lactic acid content of the milk and the time to pH drop. It should be approximately 0.7 mL lactic acid /100 mL) at the end of the incubation time.

# Kefir

Kefir is also known with its various probiotic and functional properties such as antibacterial, anticarcinogenic, cholesterol-lowering, and other beneficial effects.

It provides healthful benefits on regulating gastrointestinal system, stimulating the immune system and improving lactose tolerance in humans, prevention and the treatment of tuberculosis, gastrointestinal diseases, diabetes, and many other diseases

# Cultured buttermilk

Buttermilk (liquid left over from churning butter from cream), is a fermented dairy product with a characteristically sour taste.

Buttermilk was originally produced as a by-product of butter production which including protein, phospholipids, fat, lactose, and minerals. Today it is more common to produce culture buttermilks from skim or whole milk.

*Lactococcus lactis* subsp. *cremoris* or
*Lc. lactis* subsp. *lactis* biovar. *diacetylactis*
typically account for this fermentation and
the production process includes a heat treatment
of the milk at around 95 ºC and a subsequent cooling
step to 20-25 ºC before the addition of the starter culture.
After the inoculation of starter culture at about 1-2%,
the starting fermentation continues for 16–20 h
at the same temperature, to an acidity of 0.9% lactic acid.
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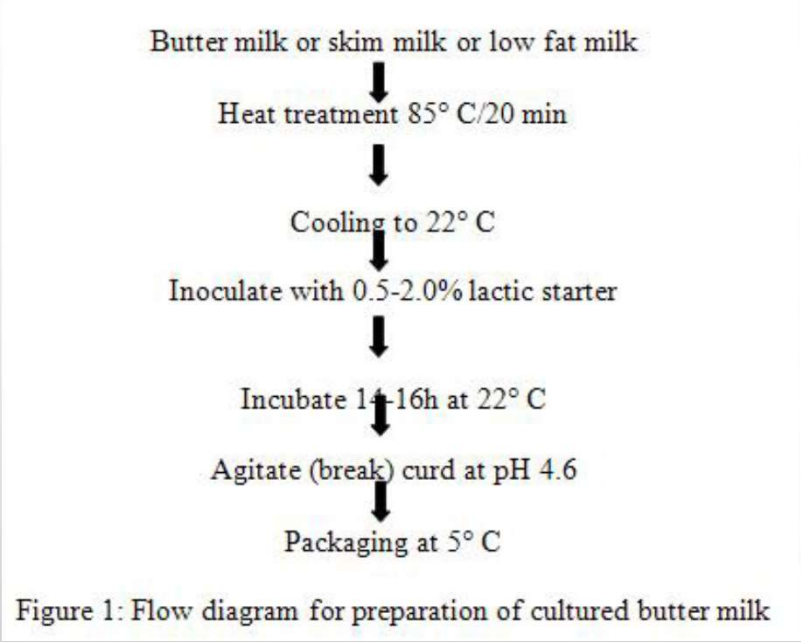

Figure 1: Flow diagram for preparation of cultured butter milk

## Some types of cheeses

Cheese ripening, especially microorganism originated intracellular and extracellular enzymes (protease and lipase enzymes) by breaking down nutrients (carbohydrate, protein, fat) in various forms (glycolysis, proteolysis and lipolysis) and levels, such as amino acids, free fatty acids, flavor components. It is the creation of breakdown products and thus the development of the distinctive taste, aroma, flavor and texture of the cheese.

# Feta type cheese