INTRODUCTION
Fermented milks are popular since ancient time throughout the world. Variety of fermented milks are popular due to its taste and apparent nutritive and therapeutic value. Microorganisms used in manufacture of fermented milk causes pre-digestion of nutrients present in milk and thus improves digestibility. Number of products, involving mainly acid production, such as acidophilus milk, yoghurt, dahi, etc. are very popular. Some other products such as kefir and koumiss involve acid and alcohol fermentation with gas production (CO$_2$). Fermented milk contain all the constituents as present in initial milk, except that lactic acid and other metabolites will increase.

CLASSIFICATION OF FERMENTED MILKS
The fermented milks are classified based on the nature of fermentation (Table 1).

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Nature of fermentation</th>
<th>Example of fermented milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High acid</td>
<td>Bulgarian sour milk</td>
</tr>
<tr>
<td>2</td>
<td>Medium acid</td>
<td>Yoghurt, Acidophilus milk</td>
</tr>
<tr>
<td>3</td>
<td>Low acid</td>
<td>Cultured butter milk</td>
</tr>
<tr>
<td>4</td>
<td>Acid-alcohol</td>
<td>Kefir, Koumiss</td>
</tr>
</tbody>
</table>

STARTER CULTURES USED FOR MANUFACTURE OF DIFFERENT FERMENTED MILKS
The starter cultures used in the manufacture of fermented milks belong to several genera of varied physiological properties. Basically starters can be classified as lactic or non-lactic starters. The types of starter cultures used in manufacture of various fermented milks are shown in Table 2.
Table 2: Types of starter cultures employed for manufacture of various fermented milks

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Product</th>
<th>Cultures employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acidophilus milk</td>
<td><em>L. acidophilus</em></td>
</tr>
<tr>
<td>2</td>
<td>Yoghurt</td>
<td><em>S. thermophilus</em> <em>L. bulgaricus</em></td>
</tr>
<tr>
<td>3</td>
<td>Koumiss</td>
<td><em>L. bulgaricus</em> <em>L. acidophilus</em> <em>Kluyveromycesfragilis</em></td>
</tr>
<tr>
<td>4</td>
<td>Kefir</td>
<td>Kefir grains (contain Lactobacilli, yeasts, Lactococci and acetic acid bacteria)</td>
</tr>
<tr>
<td>5</td>
<td>Cultured butter milk</td>
<td><em>Lactococi</em> <em>Leuconostoc</em> spp.</td>
</tr>
<tr>
<td>6</td>
<td>Bulgarian milk</td>
<td><em>L. bulgaricus</em></td>
</tr>
</tbody>
</table>

PROCESSING STEPS IN MANUFACTURE OF FERMENTED MILKs

The milk destined to be converted into fermented milks should be fresh, clean and free from developed acidity and off-flavours. It should also be free from antibiotic residues and other inhibitory substances which can adversely affect the performance of the starter.

Standardization of milk is carried out to adjust fat and solids-not-fat content, to meet legal requirements and to have uniform quality of the product throughout the year. Standardization of milk can be achieved by use of skim milk powder, whey powder, water, cream, etc. Sometimes, homogenization of milk is also done, which gives uniform dispersion of fat and other constituents added to milk. It also improves viscosity and richness of the product.

Milk is then heat treated to 80 – 85 °C for 30 min or 90 – 95 °C for 5 – 10 min or boiling for 5 min. Heat treatment of milk intended for manufacture of fermented milks have the following effects.

- Heat treatment kills most of the microorganisms and thus reduces competition for starter cultures.
- Natural inhibitory substances, enzymes, etc. are inactivated.
- Heating process drives out oxygen, which is helpful for facultative starter bacteria.
• Heat treatment converts certain components of milk which are metabolically favourable for the growth of starter culture.
• It denatures milk proteins, leading to availability of nitrogen compounds and sulfahydral compounds, which are known to stimulate starter growth in small concentration.
• Denaturation of whey proteins, gives better gel stability and decreases whey separation in fermented milk.

The common processing steps involved in the manufacture of fermented milks are depicted in Figure 1.

**Figure 1:** Flow diagram for the preparation of fermented milk

**ACIDOPHILUS MILK**

Acidophilus milk is prepared by fermentation with *Lb. acidophilus*. The salient feature of *Lb. acidophilus* is that, it is a natural inhabitant of intestinal tract of man and animals and is able to establish there. *Lb. acidophilus* imparts several therapeutic benefits to the host and hence it has become very popular.

The conventional method of acidophilus milk preparation involve inoculation of autoclaved or severely boiled milk with 2 – 5% of *Lb. acidophilus* culture. The milk is then incubated at 37 °C, till the acidity reaches 1 to 1.5% lactic acid.

Acidophilus milk has highly cooked flavour and hence it is not much popular. The recommended dose of *Lb. acidophilus* is $10^7$ to $10^8$ cells per day to derive maximum
therapeutic benefits. Table 3 shows some of the commercially popular acidophilus milk products.

Table 3: Acidophilus milk products

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Product</th>
<th>Cultures employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acidophilus sour milk</td>
<td><em>L. acidophilus</em></td>
</tr>
<tr>
<td>2</td>
<td>A – 38</td>
<td><em>Lc. Lactis</em>&lt;br&gt;<em>Leuconostocspp.</em>&lt;br&gt;<em>Lb. acidophilus</em></td>
</tr>
<tr>
<td>3</td>
<td>ACO – yoghurt</td>
<td>Yoghurt culture&lt;br&gt;<em>Lb. acidophilus</em></td>
</tr>
<tr>
<td>4</td>
<td>Acidophilus bifidus yoghurt</td>
<td>Yoghurt culture&lt;br&gt;<em>Lb. acidophilus</em>&lt;br&gt;<em>B. bifidum</em></td>
</tr>
<tr>
<td>5</td>
<td>Acidophilin</td>
<td><em>Lc. Lactis</em>&lt;br&gt;Yeast</td>
</tr>
</tbody>
</table>

**KEFIR**

Kefir is characterized by foamy, effervescent milk product. It is fermented milk product which involves mixed lactic acid and alcoholic type of fermentation. It is an old and historic product from Caucasian mountains in Russia. Kefir grains are gelatinous, white or cream coloured, irregular grains of varying size (0.5 – 2.0 cm diameter). They are made of polysaccharide called ‘kefiran’ and are insoluble in water. Within the folds of the kefir grains at least six functionally different groups of microorganism and yeast reside in symbiotic relationship. All these organisms grow in association during kefir manufacture and produce lactic acid (0.9 – 1.1 % lactic acid), alcohol (0.5 – 1.0 %) and CO₂ (0.03 – 0.07%) as a major end product.

Kefir manufacturing involves addition of kefir grains into pasteurized milk and incubated at 18 – 20 °C for 15 – 16 hrs with intermittent agitation. The grains are then filtered out for re-use. The filtrate is used at the rate of 2 – 7 % for inoculating the milk followed by two stage incubation. The first stage incubation is carried out at 25°C for 8 – 12 hrs which promotes acid production. The product is then packed in crown capped bottles and incubated further at 8 – 10 °C for 10 – 12 hrs for accumulation of CO₂ and alcohol.
Different groups of microorganisms present in kefir grains are:

- Mesophilichomofermentative lactic Streptococci
- Mesophilicheterofermentative lactic Streptococci
- Thermophilic Lactobacilli
- Mesophilic Lactobacilli
- Yeast
- Acetic acid bacteria

**KOUMISS**

Koumiss is a mare’s milk fermented product similar to kefir and is very popular in Russia and Central Asia. Mare’s milk has low casein, high whey protein, high lactose and is rich in albumin, peptone and certain vitamins. Due to its different composition koumiss prepared from mare’s milk does not form firm curd but it remains liquid. So to prepare koumiss from cow milk, certain modifications are required to be done for adjusting the composition of milk. Koumiss culture consists of *Lb. bulgaricus* subsp. *delbrueckii*, *Lb. acidophilus* and *Kluyveromyceslactis* or *Kluyveromycesmarxianus*. Yeast and Lactobacilli grow in association and produces 1 – 1.5 % lactic acid, 1 – 2 % alcohol and 0.5 – 0.9% CO₂.

**YOGHURT**

Yoghurt is a coagulated milk product obtained by lactic acid fermentation through the action of *S. thermophilus* and *Lb. bulgaricus*. It is one of the most popular fermented milk products throughout the world with different names viz. Jugurt or Eyran in Turkey, Leban in Lebanon and Arabian countries, Dahi in India, Jabady in Egypt and Sudan and Filmjolk in Scandinavia.

Both the starter cultures *S. thermophilus* and *Lb. bulgaricus* used in manufacture of yoghurt are thermophilic and grow symbiotically at 42 °C.*Lb. bulgaricus* has limited proteinase activity which produces certain amino acids (especially histidine and glycine) which stimulates the growth of *S. thermophilus*. On the other hand *S. thermophilus* produces formic acid which stimulates the growth of *Lb. bulgaricus*.

During early period of incubation, *S. thermophilus* dominates and produces much of the lactic acid. However, during the latter two hours of incubation *Lb. bulgaricus* also picks up. After reaching 0.7 – 0.9% acidity in terms of lactic acid, the growth of *S. thermophilus* stops by itself due to inhibitory effect of lactic acid. Generally, in the final product the ratio of rod:cocci remains 1:1 which gives the best quality product. The culture also produces 13 – 17 ppm of acetaldehyde, which is a major flavour compound in yoghurt.
A generalized method for preparation of set type and stirred type yoghurt is depicted in Figure 2 and 3, respectively.

**Figure 2:** Flow diagram for manufacture of set yoghurt

1. **Raw milk**
2. Preliminary treatments of milk (Pre-heating, Clarification, Addition of solids)
3. Homogenization (160 - 180 kg/cm²)
4. Heat treatment (90°C/5 min)
5. Cool to inoculation temperature (43 - 45 °C)
6. Addition of flavouring/colouring (Optional)
7. Inoculation with starter culture (1 - 3 %)
8. Pack in retail container
9. Incubation (42 °C/2 - 3 hrs.)
10. Cooling (< 10 °C)

**SET YOGHURT**
Figure 3: Flow diagram for manufacture of stirred yoghurt

Flow diagram for manufacture of stirred yoghurt

1. Raw milk
2. Preliminary treatments of milk (Pre-heating, Clarification, Addition of solids)
3. Homogenization (160 - 180 kg/cm²)
4. Heat treatment (90 ºC/5 min)
5. Cool to inoculation temperature (43 - 45 ºC)
6. Inoculation with starter culture (1 - 3 %)
7. Incubation in bulk (42 ºC/2 - 3 hrs.)
8. Breaking/stirring of coagulum
9. Mixing with colouring/flavouring/water
10. Cooling (< 10 ºC)
11. STIRRED YOGHURT
SUGGESTED READINGS

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