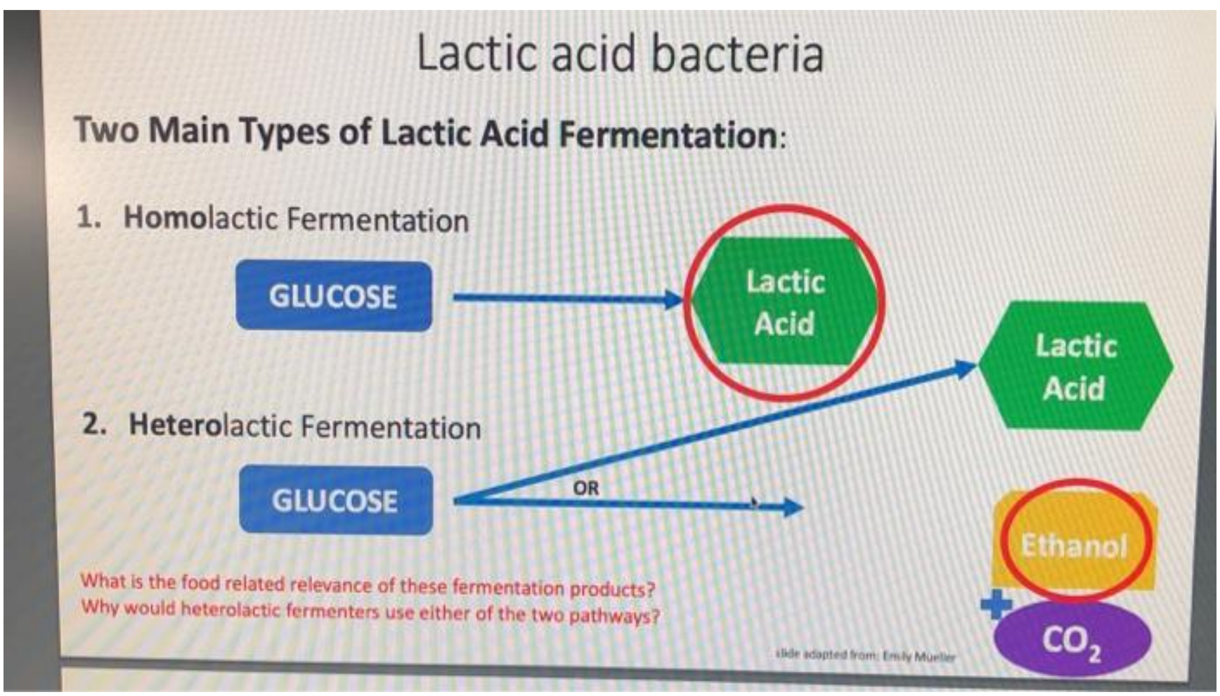
Lactic acid fermentation

Fermented dairy products

Are produced from milk after its fermentations by certain kinds of microorganisms which utilize sugar in milk and convert it to lactic acid mainly.

General basis in the processes of fermented dairy products

1-Treatment of milk with high temperature in order to kill all of the pathogenic microorganisms.
2-Addition of starter to the milk after cooling the temperature to the favorable temperature for the starter.
3-Incubation of the milk at the favorable temperature for a certain period.



Biological activities of lactic acid bacteria in starter cultures

1-Production of lactic acid from lactose
2-Production of flavor
a- diacetyl , acetate , CO_2 from citrate
b-acetaldehyde from threonine and sugar.
3-Peptide & amino acid from protein metabolism.

Major lactic acid bacteria responsible for flavor production

1-Leuconostoc mesenteroides subsp. dextrancium.

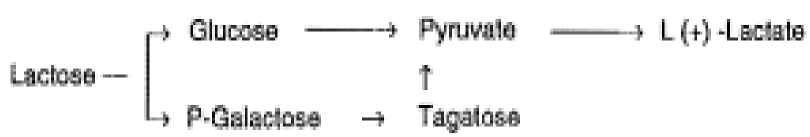
(Leuconostoc dextrancium)

2- Leuconostoc mesenteroides subsp. cremoris .
(Leuconostoc citrovoroum)

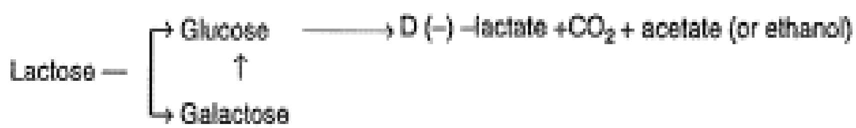
3- lactococcus lactis biovar diacetyllactis.
(Streptococcus diacetyllactis)

Biochemistry

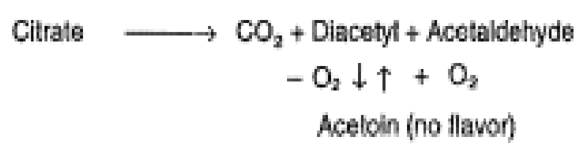
Lactose (transported by PEP-PTS system) is hydrolyzed by P-β-galactosidase in *Lactococcus* spp.:



Lactose hydrolysis by β-galactosidase of *Leuconostoc* sp.:



Citrate metabolism by *Leuconostoc* sp.:



For a desirable flavor, the diacetyl:acetaldehyde ratio should be >3 : 1 to <4.5 : 1.

Flavor production

The major flavor compound in yogurt is acetaldehyde (25 ppm), with some diacetyl (0.5 ppm) and acetate. Acetaldehyde is produced in two ways:

From glucose via pyruvate by Streptococcus sp.

and from threonine by Lactobacillus sp.

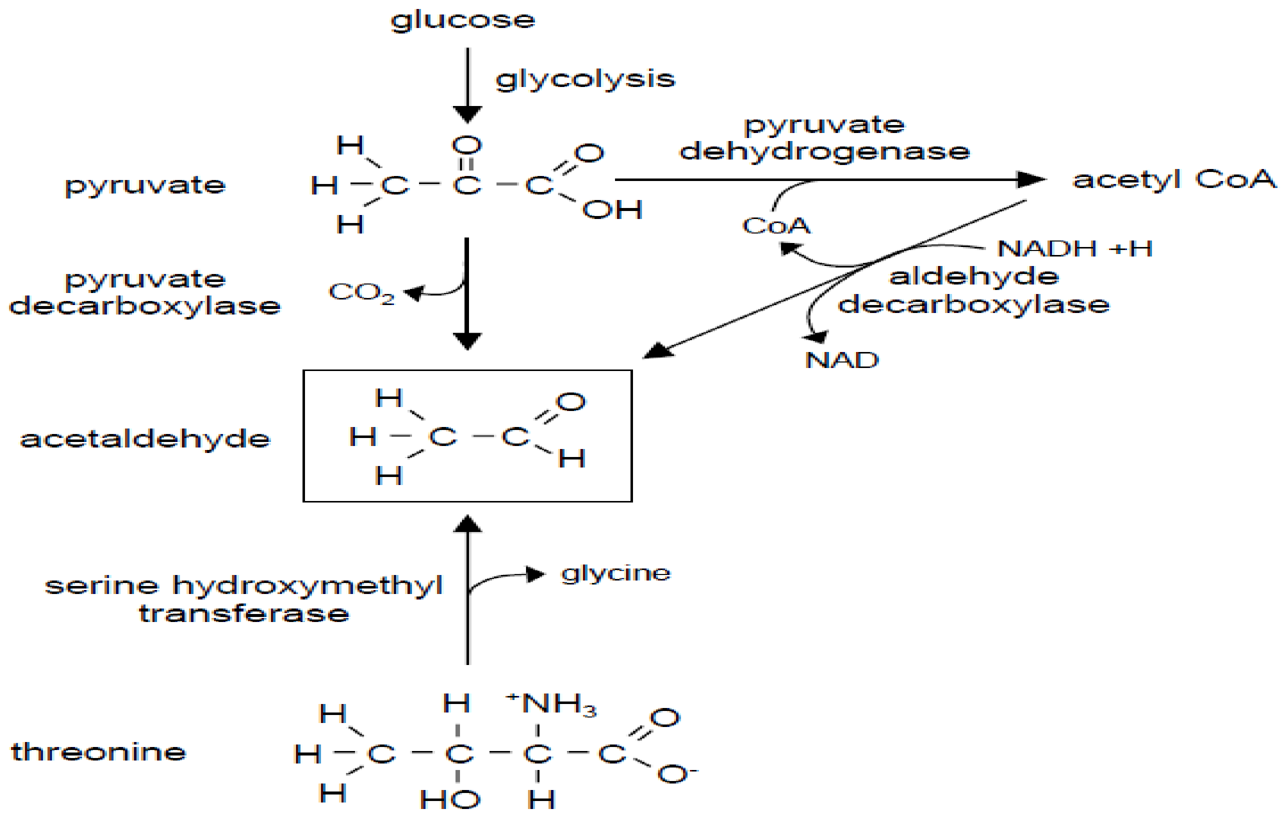


Figure 4–3. Formation of acetaldehyde by yogurt bacteria from pyruvate and threonine. Adapted from Chaves et al. 2002.

FERMENTED MILK PRODUCTS

Many types of fermented milk products are produced in different parts of the world.

A few are produced by controlled fermentation, and the microbial types and their respective contributions are known.

In many others, fermented either naturally or by back slopping, the microbial profiles and their contribution are not exactly known.

Many types of lactic acid bacteria and some yeasts are found to predominate microbial flora in these products, some of which are listed:

1. Buttermilk
Made with Lactococcus species without or with Leuconostoc cremoris; some can have biovar diacetylactis in place of Leu. cremoris (such as ymer in Denmark), whereas some can have a ropy variant of Lactococcus species (langfil in Norway) or mold (Geotrichum candidum in villi in Finland).

2. Yogurt
Made with Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus; some types can also have added Lab. acidophilus, casei, rhamnosus, and Bifidobacterium spp.; some may also have Lactococcus species and Lab. plantarum and lactose-fennentating yeasts (dabi in India).

3. Acidophilus Milk. Made with Lab. acidophilus.

4. Bifidus milk. Made with Bifidobacterium spp.

5. Yakult. Made with Lab. casei; may contain Bifidobacterium spp.

6. Kefir. Made from Lab. kefir (several species of yeasts along with Leuconostoc,Lactobacillus, and Lactococcus spp.).

7. Kumiss. Made from Lab. delbrueckii subsp. bulgaricus and yeasts.

CHEESE TEXTURE	MICROORGANISM INVOLVED
Soft(unripened)	
•Cottage	*Lactococcus lactis, Leuconostoc citrovorum*
•Cream	*Lactococcus cremoris*
•Mozzarella	*Lactobacillus bulgaricus, Streptococcus thermophilus*
Soft(ripened)	
•Brie and Camembert	*Lactococcus lactis, Lactococcus cremoris, Penicillium camemberti, Penicillium candidium, Brevibacterium linens*
Semi-soft (ripened)	
•Gorgonzola and Roquefort	*Lactococcus lactis, Lactococcus cremoris, Penicillium glaucum, Penicillium roqueforti*
Hard (ripened)	
•Cheddar	*Lactococcus lactis, Lactobacillus casei, Lactococcus cremoris, Streptococcus durans*
Very hard (ripened)	
•Parmesan	*Lactococcus lactis, Lactobacillus bulgaricus, Lactococcus cremoris, Streptococcus thermophilus*

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Single cell protein (SCP)

The protein produced by microorganisms as food has been called SCP.(Refers to the dried cells of microorganisms that are used as protein sources in human foods or animal feeds).

The desired properties that an organism should possess to be most useful as a source of SCP :-

1-Rapid growth.
2-Simple and inexpensive media.
3-Efficient utilization of energy source.
4-Simple fermentation system.
5-Simple processing and separation of cells.
6-Non pathogenic & toxigenic.
7-Harmless when eaten.
8-Good flavor (taste).
9-High nutrient content (Protein quality& content).

Selection of a suitable microbial strain for SCP production must take several characteristics into account, including:

1. Performance (growth rate, productivity and yields) on the specific, preferably low-cost, substrates to be used;
2. Temperature and pH tolerance;
3. Oxygen requirements, heat generation during fermentation and foaming characteristics;
4. Growth morphology and genetic stability in the fermentation;
5. Ease of recovery of SCP and requirements for further downstream processing.
6. Structure and composition of the final product, in terms of protein content, amino acid profile, RNA level, flavour, aroma, colour and texture.
7. Other major factors are safety and acceptability.

Raw materials used

1-Energy source (natural gas , ethanol , acetic acid)
2-Waste product (whey , sulfite liquor)
3-Plant source (Starch , sugar , cellulose)

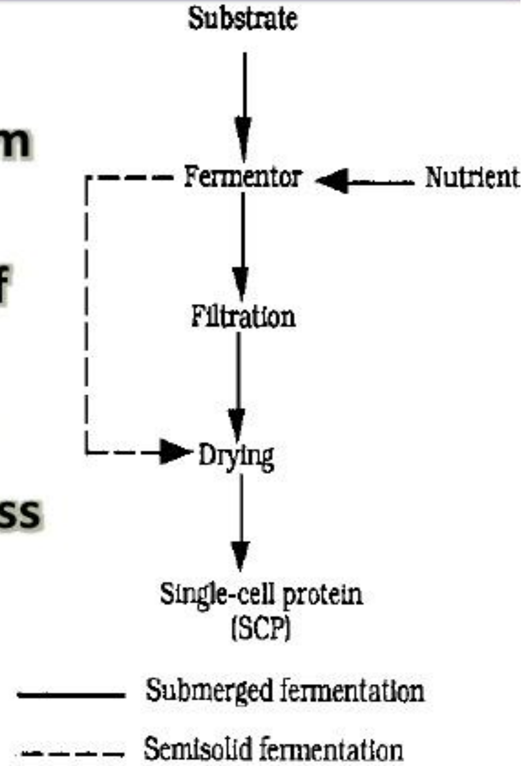
❖ MICROORGANISMS USED AS SCP:

MICROORGANISM	GROWTH CONDITIONS		PROS	CONS
	pH	Temp.		
➢ **Bacteria** Examples: • *Bacillus megaterium* • *Bacillus subtilis*	5-7	35-45°C	▪ Protein content maximum. ▪ High quality protein. ▪ Yield is higher.	▪ High content of nucleic acid. ▪ Small size. ▪ Unpleasant odour.
➢ **Filamentous Fungi** Examples: • *Aspergillus niger* • *Aspergillus oryzae*	5-6 or below	25-35°C	▪ Produce carbohydrate hydrolysing enzymes. ▪ Recovery by simple filtration methods.	▪ Protein content is low (lack of sulphur amino acid). ▪ Growth rate is slower.

MICROORGANISM	GROWTH CONDITIONS		PROS	CONS
	pH	Temp.		
➢ **Yeasts** Examples: • *Saccharomyces cerevisiae* • *Candida utilis*	5-7	25°C	▪ Source of vitamin A, E, B group. ▪ Low nucleic acid content. ▪ Low toxicity potential.	▪ Low concentration of sulphur containing amino acid.
➢ **Algae** Examples: • *Spirulina sp.* • *Porphyrium sp.*	11	25°C	▪ Photosynthetic microbe thus averts the need to add carbon as food source. ▪ Lysine content is high.	▪ Cell wall is stable thus can not be digested in mammals.

Basic Steps of SCP production:

- **Preparation** of suitable medium with suitable carbon source.
- **Cultivation** of suitable strain of microorganisms
- **Prevention** of contaminations
- **Separation** of microbial biomass with or without product.



SCP is not pure protein, but refers to the whole cells of bacteria, yeasts, filamentous fungi or algae, and also contains carbohydrates, lipids, nucleic acids, mineral salts and vitamins.

SCP has several advantages over conventional plant and animal protein sources, which include:

1. Rapid growth rate and high productivity.
2. High protein content, 30–80% on a dry weight basis.
3. The ability to utilize a wide range of low cost carbon sources, including waste materials.
4. Strain selection and further development are relatively straightforward, as these organisms are amenable to genetic modification.
5. The processes occupy little land area.
6. Production is independent of seasonal and climatic variations.
7. Consistent product quality.