STARTER CULTURES

- Fermented milks can be divided into three broad categories based on the metabolic products (e.g.. lactic fermentations, yeast-lactic fermentations and mold-lactic fermentations;

- Such fermentation processes are the result of the presence of microorganisms (bacteria, molds, yeasts, or combinations of these) and their enzymes in milk.

- In the dairy industry, these organisms are known as starter cultures;

- however, in some cheese varieties other microfloras could be present, and these are referred to as *secondary cultures*

The essential roles of starter cultures

- First, the production of lactic acid as a result of lactose fermentation; the lactic acid helps to form the gel and imparts a distinctive and fresh, acidic flavor during the manufacture of fermented milks

- Second, the production of volatile compounds (e.g., diacetyl and acetaldehyde) that contribute toward the flavor of these dairy products.

- Third, the starter cultures may possess a proteolytic or lipolytic activity that may be desirable, especially during the maturation of some types of cheese.

- Fourth, other compounds may be produced- for example, alcohol, which is essential during the manufacture of Kefir and Koumiss.

- Fifth, the acidic condition in these dairy products, and in some instances the production of bacteriocins, prevents the growth of pathogens, as well as many spoilage organisms.

Table 40.7 Major Categories and Examples of Fermented Milk Products

Category	Typical Examples
I. Lactic fermentations	
Mesophilic	Buttermilk
	Cultured buttermilk
	Långofil
	Tëtmjolk
	Ymer
Thermophilic	Yogurt, laban, zabadi, labneh, skyr Bulgarian buttermilk
Probiotic	Biogarde, Bifighurt Acidophilus milk, yakult Cultura-AB
II. Yeast-lactic fermentations	Kefir, koumiss, acidophilus-yeast milk
III. Mold-lactic fermentations	Villi

Mesophilic

- Mesophilic milk fermentations result from similar manufacturing techniques, in which acid produced through microbial activity causes protein denaturation.

- To carry out the process, one usually inoculates milk with the desired starter culture (incubates it at optimum temperature (approximately 20 to 30°C), and then stops microbial growth by cooling.

- *Lactobacillus spp. and Lactococcus lactis cultures are* used for aroma and acid production.

- The organism *Lactococcus lactis subsp. diacetilactis converts milk citrate to diacetyl*, *which* gives a buttery flavor to the finished product

Thermophilic

- Thermophilic fermentations can be carried out at temperatures around 45°C
- An important example is yogurt production.
- In commercial production, nonfat or low-fat milk is pasteurized, cooled to 43°C or lower, and inoculated with a 1:1 ratio of *Streptococcus thermophilus and Lactobacillus delbrueckii subspecies bulgaricus (L. bulgaricus).*
- *S. thermophilus grows more rapidly at first and* renders the milk anaerobic and weakly acidic. *L. bulgaricus then* acidifies the milk even more.
- Acting together, the two species ferment almost all of the lactose to lactic acid and flavor the yogurt with diacetyl (*S. thermophilus) and acetaldehyde (L. bulgaricus).*

Yeast-Lactic Fermentation

- ➢Yeast-lactic fermentations include kefir, a product with an ethanol concentration of up to 2%.

- ➢This process is based on the use of kefir “grains” as an inoculum.

- ➢These are coagulated lumps of casein that contain yeasts, lactic acid bacteria, and acetic acid bacteria.

- ➢In this fermentation, the grains are used to inoculate the fresh milk and then recovered at the end of the fermentation.

Mold-Lactic Fermentation

- Mold-lactic fermentation results in a unique Finnish fermented milk called viili.

- The milk is placed in a cup and inoculated with a mixture of the fungus *Geotrichium candidum and lactic acid* bacteria

- The cream rises to the surface, and after incubation at 18
- to 20°C for 24 hours, lactic acid reaches a concentration of 0.9%.

- The fungus forms a velvety layer across the top of the final product

Cheese Production

- Addition of lactic acid starter bacteria and coagulant

- Coagulation followed by cutting the curd

- Cooking to temperatures from 32°C to 54"C, which, together with acid production,assist expulsion of whey from card.

- Separation of the curds and whey –

- Molding and pressing the curd at low (soft cheese) or relatively high (hard cheese) pressure

- Salting or brining –

- Ripening at temperatures of 6°C to 24°C to allow the characteristic flavor and texture to develop

Starter Culture for cheese production

Primary objective of cheese manufacture was to extend the shelf life of milk and conserve its nutritive value. This was achieved by either acid production and/or dehydration.

The microflora of cheese may be divided into two groups: starter lactic acid bacteria and secondary microorganisms.

Starter lactic acid bacteria are involved in acid production during manufacture and contribute to the ripening process.

Secondary microorganisms do not contribute to acid production during manufacture but play a significant role during ripening.

The secondary microflora consist of (a) nonstarter lactic acid bacteria (NSLAB), which grow internally in most cheese varieties, and (b) other bacteria, yeasts, and/or molds, which grow internally or externally and are usually unique to the specific cheese variety.

Starter Culture

Basically, two types of starter bacteria are used in cheese-making: thermophilic with optimum temperatures of 42°C and mesophilic, with optimum temperatures of 30°C .

The starter bacteria are members of the genera *Lactococcus*, *Lactobacillus*, *Streptococcus*, *Leuconostoc*, *and Enterococcus.*

The primary function of the starter bacteria is to produce acid during the fermentation process. They also provide a suitable environment, with respect to redox potential, pH, moisture, and salt contents, to allow enzyme activity from the chymosin and starter (along with growth of the secondary flora) to proceed favorably in the cheese.

Their enzymes are involved in the conversion of protein and fat into amino acids and fatty acids, repectively, from which the flavor compounds are produced

GROWTH OF STARTERS DURING MANUFACTURE

Early in the manufacture of most cheeses a coagulum, called curd, is formed as a result of chymosin activity on casein.

The coagulum is subsequently cut into different size particles, depending on the type of cheese being made

The curds then begin to expel whey and contract (this is called syneresis) at a rate that is dependent on the size of the particle, the rate of stirring, the rate of acid production by the starter, and the temperature.

Acid production during cheese-making is the direct result of growth of the starter.

Cooking temperatures are also important in controlling the growth of, and acid production by, starters.

GROWTH OF STARTERS DURING RIPENING

Much (-900/,) of the lactose is lost in the whey, but there is still sufficiently large amounts of it retained in the curd to result in production of at least 1.Og lactic acid/100g cheese within a day of the beginning of manufacture.

The salt diffuses relatively slowly into the cheese, and thus brining has no immediate effect on the growth of the starter LAB. All of the lactose disappears very quickly from the curd in brined cheese due to the ability of the high numbers of starter bacteria present to metabolize lactose.

The subsequent metabolism of the lactose depends directly on the salt or, more specifically, on the SM ratio. Salt is a major factor controlling microbial growth in cheese.

The final pH of the cheese generally lies between 4.6 and 5.3 and is reached within 1 day of manufacture.

Starter lactococci have an optimum pH of 6.3, and growth rates will be much lower at these low pH values.

AUTOLYSIS OF STARTERS

Proteolysis is probably the most important biochemical reaction in developing the flavor of most hard cheeses.

This is mainly due to chymosin and starter proteinase activity.

The proteinases hydrolyze the casein into small and large peptides.

Autolysis of starters is also important in this regard because intracellular enzymes, particularly peptidases, are released that will hydrolyze further any peptides, which are present.

Amino acids are the products of peptidolysis. They accumulate faster following starter autolysis and are the major precursors of the compounds required for flavor production.

Some amino acids (e.g., glycine, proline, and alanine) are quite sweet, whereas others (e.g., glutamate) may potentiate flavor.

SECONDARY FLORA

In all hard cheeses, a secondary flora also develops during ripening

These include nonstarter lactic acid bacteria (NSLAB), propionic acid bacteria (PAB), staphylococci, micrococci, and coryneform bacteria, yeasts, and molds.

They are either (a) adventitious contaminants (e.g., lactobacilli, staphylococci, some coryneforms and some yeasts and molds) or

b) deliberately added (e.g., other coryneforms, *Bwvibacterium linens, PAB, and other yeasts and molds).*

Yogurt