Lactic Acid ($C_2H_4OHCOOH$)

Lactic acid is produced by many organisms: animals including man produce the acid in muscle during work.

Properties and chemical reactions of lactic acid

(i) Lactic acid is a three carbon organic acid: one terminal carbon atom is part of an acid or carboxyl group; the other terminal carbon atom is part of a methyl or hydrocarbon group; and a central carbon atom having an alcohol carbon group. Lactic acid exists in two optically active isomeric forms (Fig. 20.3).

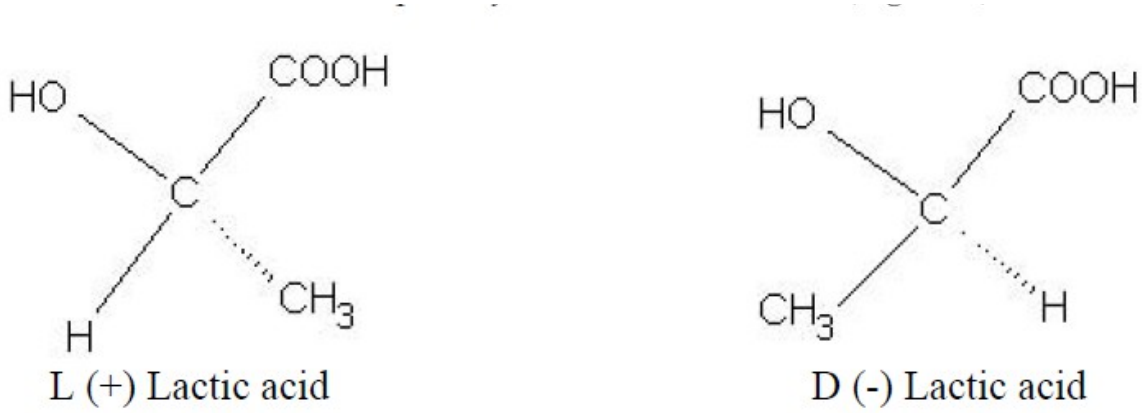

Fig. 20.3 Optical Isomers of Lactic Acid

(ii) Lactic acid is soluble in water.

(iii) It exhibits low volatility.

(iv) The acid reactions of lactic acid are those that form salts and undergo esterification with various alcohols.

(v) Liquid chromatography and its various techniques can be used for quantitative analysis and separation of its optical isomers.

Uses of lactic acid

(1)It is used in the baking industry
(2) In medicine it is sometimes used to introduce calcium in to the body in the form of calcium lactate, in diseases of calcium deficiency.
(3) Esters of lactic acid are also used in the food industry as emulsifiers.
(4) It is used in the manufacture of plastics.
(5) Lactic acid is used as acidulant/ flavoring/ pH buffering agent or inhibitor of bacterial spoilage in a wide variety of processed foods. It has the advantage, in contrast to other food acids in having a mild acidic taste.
(6) It is non-volatile odorless and is classified as GRAS (generally regarded as safe) by the FDA.
(7) It is a very good preservative and pickling agent.
(8) Lactic acid has many pharmaceutical and cosmetic applications .

Extraction
The main problem in lactic acid production is not fermentation but the recovery of the acid. Lactic acid is crystallized with great difficulty and in low yield. The purest forms are usually colorless syrups which readily absorb water.

1-Calcium hydroxide at pH 10 is mixed in and the mixture is allowed to settle.
2- The clear calcium lactate is decanted off and combined with the filtrate from the slurry.
3-It is then treated with sodium sulfide, decolorized by adsorption with activated charcoal, acidified to pH 6.2 with lactic acid and filtered.
4-The calcium lactate liquor may then be spray-dried.

For ***technical grade*** lactic acid the calcium is precipitated as $CaSO_4.2H_2O$ which is filtered off. It is 44-45% total acidity.
Food grade acid has a total acidity of about 50%. It is made from the fermentation of higher grade sugar and bleached with activated carbon.
Plastic grade is obtained by esterification with methanol after concentration.

High-grade lactic acid is made by various methods: steam distillation under high vacuum, solvent extraction etc.

COMMERCIAL STARTER CULTURE PREPARATIONS
Manufacturers of cultured dairy foods have several options for meeting their culture needs.

A. Frozen Concentrated Cultures
B. Freeze-Dried Cultures
C. Spray-Dried Cultures

Starter culture problems

1. BACTERIOPHAGES
2. CULTURE INHIBITORS
A. Raw Milk–Associated Inhibitors

Lactic starter cultures grow more slowly in raw than in heated milk; a phenomenon caused by the presence of natural inhibitors. The lactoperoxidase system is the most significant microbial inhibitor in raw milk, but the presence of agglutinins is an important problem in acid-coagulated cheeses. Other naturally occurring microbial inhibitors in milk include lysozyme and lactoferrin.

B. Antibiotics
Treatment of mastitis in cows involves application of antibiotics. Milk from treated cows cannot be legally sold, but, occasionally, it becomes mixed with salable product. The resulting low-level antibiotic contamination may be sufficient to inhibit starter culture microorganisms
C. Chemical Sanitizers
Occasionally, chemical sanitizers may contaminate milk, usually as a result of human error. Chlorine- and iodine-based sanitizers lose their activity in milk and are, therefore, unlikely to cause starter culture inhibition. Quaternary ammonium compounds present more potential problems, because they maintain activity in milk, and lactic acid bacteria are sensitive to low concentrations.

probiotics and health aspects

Probiotics have been defined as ‘a preparation of or a product containing viable, defined micro-organisms in sufficient numbers, which alter the microbiota (by implantation or colonisation) in a compartment of the host and by that exert beneficial health effects in this host’ .

The prebiotic as 'a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon'.
A synbiotic is a synergistic combination of a probiotic and prebiotic.

Lactic acid bacteria
Bacteria that taxonomically belong to the heterogeneous group of LAB all have the following characteristics: Gram-positive; catalase-negative; acid tolerant; devoid of cytochromes; aerotolerant; non-sporulating; and they are strictly fermentative rods or cocci which produce lactic acid as the major product from the energy-yielding fermentation of sugars .
The LAB genera generally associated with the fermentation of a variety of foods are *Lactobacillus, Lactococcus, Leuconostoc, Streptococcus, Enterococcus, Pediococcus*. LAB are also natural inhabitants of the oral cavity and the gastrointestinal track of mammals, living in a complex symbiosis with the host .

Based on these **two fermentation** pathways, LAB can be sub-categorised into two distinct groups, **homofermentative** or **heterofermentative** .
The Embden-Meyerhof-Parnas pathway or Glycolysis where lactic acid is produced as **the major** or only end-product of **homolactic** metabolism, other end-products including CO2 and ethanol are produced during **heterolactic** metabolism . Homofermentative LAB include *Streptococcus, Lactococcus, Enterococcus, Pediococcus* and heterofermentative LAB include *Weissella and Leuconostoc* .

Yoghurt and Fermented Milk Foods

Many types of fermented milks are produced and drunk around the world (Tabl.1) While yoghurt has been present for many years, it is only recently (within the last 30-40 years) that it has become popular.

Fermented milks and their presumed countries of origin

Name	*Presumed country of origin*	*Description*	*Cultures*
Yoghurt	Asia, Balkans	Acidic, set or stirred, characteristic aroma	*S. thermophilus, Lb. bulgaricus,* (*and Lb. acidophilus, Bifidobacterium* spp.) *
Acido-philus milk	USA	Set, stirred or liquid, mild flavor	*Lb. acidophilus*
Kafir	Caucasus	Stirred beverage,	*Lc. lactis, Lc. cremoris, Lb. kefir, Lb. casei,Lb.*
Leben	Middle East	Set or stirred product, pleasant taste and aroma	*S. thermophilus, Lb. bulgaricus, Lb. acidophilus,*

In the manufacture of yoghurt, two kinds of lactic acid bacteria, *Lactococcus* spp. And *Lactobacillus* spp., are generally used with usually unpasteurized milk. Most commonly used are *Lactococcus salivarius* and *Streptococcus thermophilus*, and *Lactobacillus* spp., such as *Lacto.acidophilus*, *bulgaricus* and *bifidus*.
The bacteria produce lactic acid from lactose in the milk causing the pH to drop to about 4-5 from about 7.0. This drop in pH causes the milk to coagulate. The lactic acid gives yoghurt its sour taste and limits the growth of spoilage bacteria. Yoghurt is flavored usually with fruits.