Lactic Acid

1 Nonproprietary Names

BP: Lactic acid
JP: Lactic acid
PhEur: Acidum lacticum
USP: Lactic acid

2 Synonyms

E270; *Eco-Lac*; 2-hydroxypropanoic acid; α-hydroxypropionic acid; *L18*; DL-lactic acid; *Lexalt L*; milk acid; *Patlac LA*; *Purac 88 PH*; racemic lactic acid.

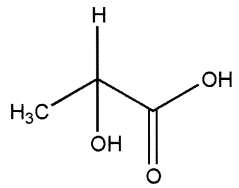
3 Chemical Name and CAS Registry Number

2-Hydroxypropionic acid [50-21-5]
(*R*)-(−)-2-Hydroxypropionic acid [10326-41-7]
(*S*)-(+)-2-Hydroxypropionic acid [79-33-44]
(*RS*)-(±)-2-Hydroxypropionic acid [598-82-3]
See also Section 8.

4 Empirical Formula and Molecular Weight

$C_3H_6O_3$ 90.08

5 Structural Formula



6 Functional Category

Acidifying agent; acidulant.

7 Applications in Pharmaceutical Formulation or Technology

Lactic acid is used in beverages, foods, cosmetics, and pharmaceuticals (*see* Table I) as an acidifying agent and acidulant.

In topical formulations, particularly cosmetics, it is used for its softening and conditioning effect on the skin. Lactic acid may also be used in the production of biodegradable polymers and microspheres, such as poly(D-lactic acid), used in drug delivery systems.[1,2] *See also* Aliphatic Polyesters.

Lactic acid is also used as a food preservative. Therapeutically, lactic acid is used in injections, in the form of lactate, as a source of bicarbonate for the treatment of metabolic acidosis; as a spermicidal agent; in pessaries for the treatment of leukorrhea; in infant feeds; and in topical formulations for the treatment of warts.

Table I: Uses of lactic acid.

Use	Concentration (%)
Injections	0.012–1.16
Topical preparations	0.015–6.6

8 Description

Lactic acid consists of a mixture of 2-hydroxypropionic acid, its condensation products, such as lactoyllactic acid and other polylactic acids, and water. It is usually in the form of the racemate, (*RS*)-lactic acid, but in some cases the (*S*)-(+)-isomer is predominant.

Lactic acid is a practically odorless, colorless or slightly yellow-colored, viscous, hygroscopic, nonvolatile liquid.

9 Pharmacopeial Specifications

See Table II.

Table II: Pharmacopeial specifications for lactic acid.

Test	JP 2001	PhEur 2002 (Suppl 4.1)	USP 25
Identification	+	+	+
Appearance of solution	—	+	—
Specific rotation	—	—	−0.05° to +0.05°
Calcium	—	≤200 ppm	—
Heavy metals	≤10 ppm	≤10 ppm	≤0.001%
Iron	≤5 ppm	—	—
Sulfate	≤0.01%	≤200 ppm	+
Chloride	≤0.036%	—	+
Citric, oxalic, phosphoric, and tartaric acids	+	+	+
Ether-insoluble substances	—	+	—
Cyanide	+	—	—
Sugars and other reducing substances	+	+	+
Glycerin and mannitol	+	—	—
Methanol and methyl esters	—	≤500 ppm	—
Reducing substances	—	+	—
Readily carbonizable substances	+	—	+
Bacterial endotoxins	—	≤5 IU/g	—
Volatile fatty acids	+	+	—
Residue on ignition	≤0.1%	—	≤3.0 mg
Sulfated ash	—	≤0.1%	—
Assay	+	88.0–92.0%	88.0–92.0%

10 Typical Properties

Boiling point: 122°C at 2 kPa (15 mmHg)
Dissociation constant: pK_a = 4.14 at 22.5°C
Flash point: >110°C

Heat of combustion: 15.13 kJ/kg (3615 cal/kg)
Melting point: 17°C
Osmolarity: a 2.3% w/v aqueous solution is isoosmotic with serum.
Refractive index: $n_D^{20} = 1.4251$
Solubility: miscible with ethanol (95%), ether, and water; practically insoluble in chloroform.
Specific heat: 2.11 J/g (0.505 cal/g) at 20°C
Specific gravity: 1.21
Specific rotation $[\alpha]_D^{21}$:
−2.6° (8% w/v aqueous solution) for (*R*)-form
+2.6° (2.5% w/v aqueous solution) for (*S*)-form
Viscosity (dynamic): 28.5 mPa s (28.5 cP) for 85% aqueous solution at 25°C.

11 Stability and Storage Conditions

Lactic acid is hygroscopic and will form condensation products such as polylactic acids on contact with water. The equilibrium between the polylactic acids and lactic acid is dependent on concentration and temperature. At elevated temperatures lactic acid will form lactide, which is readily hydrolyzed back to lactic acid.

Lactic acid should be stored in a well-closed container in a cool, dry place.

12 Incompatibilities

Incompatible with oxidizing agents, iodides, and albumin. Reacts violently with hydrofluoric acid and nitric acid.

13 Method of Manufacture

Lactic acid is prepared by the fermentation of carbohydrates, such as glucose, sucrose, and lactose, with *Bacillus acidi lacti* or related microorganisms. On a commercial scale, whey, corn starch, potatoes, or molasses are used as a source of carbohydrate. Lactic acid may also be prepared synthetically by the reaction between acetaldehyde and carbon monoxide at 130–200°C under high pressure, or by the hydrolysis of hexoses with sodium hydroxide.

Lactic acid prepared by the fermentation of sugars is levorotatory; lactic acid prepared synthetically is racemic. However, lactic acid prepared by fermentation becomes dextrorotatory on dilution with water owing to the hydrolysis of (*R*)-lactic acid lactate to (*S*)-lactic acid.

14 Safety

Lactic acid occurs in appreciable quantities in the body as an end product of the anaerobic metabolism of carbohydrates and, while harmful in the concentrated form (*see* Section 15), can be considered nontoxic at the levels at which it is used as an excipient. A 1% v/v solution, for example, is harmless when applied to the skin.

There is evidence that neonates have difficulty in metabolizing (*R*)-lactic acid and this isomer and the racemate should therefore not be used in foods intended for infants aged less than 3 months old.[3]

There is no evidence that lactic acid is carcinogenic, teratogenic, or mutagenic.

LD_{50} (guinea pig, oral): 1.81 g/kg[4]
LD_{50} (mouse, oral): 4.88 g/kg
LD_{50} (mouse, SC): 4.5 g/kg
LD_{50} (rat, oral): 3.73 g/kg

15 Handling Precautions

Lactic acid is caustic in concentrated form and can cause burns on contact with the skin and eyes. It is harmful if swallowed, inhaled, or absorbed through the skin. Observe precautions appropriate to the circumstances and quantity of material handled. Eye protection, rubber gloves, and respirator are recommended. It is advisable to handle the compound in a chemical fume hood and to avoid repeated or prolonged exposure. Spillages should be diluted with copious quantities of water. In case of excessive inhalation, remove the patient to a well-ventilated environment and seek medical attention. Lactic acid presents no fire or explosion hazard but emits acrid smoke and fumes when heated to decomposition.

16 Regulatory Status

GRAS listed. Accepted for use as a food additive in Europe. Included in the FDA Inactive Ingredients Guide (IM, IV, and SC injections, oral syrups and tablets, topical and vaginal preparations). Included in medicines licensed in the UK.

17 Related Substances

Aliphatic polyesters.

18 Comments

The EINECS number for lactic acid is 200-018-0.

19 Specific References

1 Brophy MR, Deasy P. Biodegradable polyester polymers as drug carriers. In: Swarbrick J, Boylan JC, eds. *Encyclopedia of Pharmaceutical Technology*, vol. 2. New York: Marcel Dekker, 1990: 1–25.
2 Kim IS, Jeong YI, Cho CS, Kim SH. Core–shell type polymeric nanoparticles composed of poly(L-lactic acid) and poly(*N*-isopropylacrylamide). *Int J Pharm* 2000; **211**: 1–8.
3 FAO/WHO. Toxicological evaluation of certain food additives with a review of general principles and specifications. Seventeenth report of the FAO/WHO expert committee on food additives. *World Health Organ Tech Rep Ser* 1974; No. 539.
4 Lewis RJ, ed. *Sax's Dangerous Properties of Industrial Materials*, 10th edn. New York: Wiley, 2000: 2197.

20 General References

Al-Shammary FJ, Mian NAZ, Mian MS. Lactic acid. In: Brittain HG, ed. *Analytical Profiles of Drug Substances and Excipients*, vol. 22. San Diego: Academic Press, 1993: 263–316.

21 Author

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22 Date of Revision

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