Lactic Acid Bacteria (Lab), Classification, Desirable Characteristics and It's Role

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The term LAB refer to a taxonomically diverse group of Gram positive, facultative anaerobic, non-spore forming, non-motile and acid-tolerant cocci, coccobacilli or rods that appear as single cells or pairs, tetrads or long chains with common metabolism and physiology capable of fermenting sugars primarily into lactic acid. LAB are found in two phyla, the Firmicutes and the Actinobacteria. Firmicutes include genera of LAB such as Lactobacillus, Streptococcus, Leuconostoc, Enterococcus, Pediococcus that are low in G + C with 31–49 %, belonged to the Bacillus class and the Lactobacillales order, while the Bifidobacterium genus with a high G + C content (58–61 %) belonged to the Actinobacteria phylum. LAB are a group of Gram-positive bacteria which produce lactic acid as a main fermentation product into the medium. The main groups include Lactobacillus, Leuconostoc, Pediococcus and Streptococcus. Lactic acid bacteria are the most commonly used starters in fermented milk products like curd, yogurt, cheese and so on.

Classification of starters LAB

The starters used in fermented milk product preparation are classified as mesophilic and thermophilic based on optimum growth temperature. Mesophilic starters include Lactococci, Pediococci, Leucocnostoc, Lactobacillus brevis, while *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus, Lb. acidophilus* belong to thermophilic starters. Based on fermentation, starters may be homofermenters or heterofermenters or miscellaneous fermenters. Homofermenters like Lactococci, *Streptococcus thermophilus*, *Lactobacillusdelbrueckii* ssp. *bulgaricus*, *Lb. acidophilus* that produce only lactic acid; heterofermenters include Leuconostoc, Lb. brevis, Lb. fermentum, Bifidibacterium spp that produce lactic acid, other acids like acetic acid or ethanol with or without carbon dioxide; *Propionibacterium freudenreichii* ssp. *shermanii*, Kluveromyces, Torula are included under the miscellaneous starters that yield other acids (propionic acid, acetic acid) or ethanol with carbon dioxide.

LAB can be mainly divided into two groups based on the end products formed during the fermentation of glucose. Homofermentative LAB such as Pediococcus, Streptococcus, Lactococcus and some Lactobacillus produce lactic acid as the major or sole end product of glucose fermentation. Homofermentative lactic acid bacteria use the Embden-Meyerhof-Parnas pathway to generate two moles of lactate per mole of glucose and derive approximately twice as much energy per mole of glucose as heterofermentative lactic acid bacteria. Heterofermentative lactic acid bacteria such as species of Weissella, Leuconostoc and some 13 Lactobacillus produce equimolar amounts of lactate, CO2 and ethanol from glucose via the hexose monophosphate or pentose pathway.

The classification of LAB into different genera is largely based on morphology, mode of glucose fermentation, growth at different temperatures, configuration of the lactic acid produced, ability to grow at high salt concentrations,

and acid or alkaline tolerance. The LAB group is currently classified in the phylum Firmicutes, class Bacilli, and order Latobacillales. LAB are classified based on cellular morphology, mode of glucose fermentation that include Lactobacillus, Lactococcus, Leuconostoc, Pediococcus Streptococcus, Aerococus, Alloiococcus, Carnobacterium, Dolosigranulum, Enterococcus, Oenococcus, Tetragenococcus, Vagococcus and Weissela with Lactobacillus being the largest genus, including more than 100 species

that are abundant in carbohydrate rich substances.

Desirable characteristics of LAB

LAB are rod shaped bacteria as lactobacilli while cocci shaped bacteria include Lactococcus, Streptococcus, Leuconostoc and Pediococcus under LAB. Lactic acid bacteria are prokaryotic in nature having the following general characteristics: they are non-spore formers, do not produce catalase and cytochrome oxidase. Most are non-pigmented. They are facultative anaerobic to microaerophilic in nature. They ferment sugar with lactic acid as major end product or other acids and/or may be gases. These are nutritionally fastidious bacteria requiring specific growth factors such as vitamins, amino acids and minerals. They are unable to use complex carbohydrate like starch and cellulose.

The desirable characteristics of lactic acid bacteria include:

- It should be non-pathogenic in nature.
- Should produce desirable characteristics in milk required for fermented milk products (flavour & textural changes).
- Should dominate competitive microflora.
- Should be easily propagated, easily preserved, should be stable during culturing and storage.
- Probiotic cultures used in FMP should be of human origin and resistant to HCl of stomach and bile of intestine.
- Able to colonize in intestine and bring beneficial properties like inhibition of putrefactive bacteria, produce anticholesterolemic, anticarcinogenic properties, bacteriocin production, calcium absorption and vitamin synthesis.

Function	Changes	Effect
Primary	Lactic acid production	Inhibit undesirable bacteria like Pseudomonas, Micrococci
Secondary	Acid coagulation of milk	Curdling effect on milk
	Flavor production of diacetyl; acetaldehyde by aroma producing LAB	Curdling effect on milk
	Bacteriocins are polypeptides synthesized by LAB, example – Nisin – Lactococcus lactis ssp. lactis NIZO2218, Acidophilin from Lactobacillus acidophilus	Suppress potential pathogens and spoilage organisms - S. aureus, Micrococci & bacterial spores.
	Some LAB, example Lactobacillus helviticus produce exopolysaccharide	Improves texture by increasing the viscosity of fermented milk products.

Role of LAB

Species of Lactobacillus, Leuconostoc, Lactococcus and other LAB are the most frequent microbes found in fermented milk products. LAB can be found in a variety of genera within the Lactobacillaceae family. They are potential microorganisms that have been frequently used in food fermentation around the world because of their well-known GRAS (Generally recognized as safe) status. They are also known for their fermentative abilities, which help to improve food safety, organoleptic qualities, nutrient enrichment and health advantages.

References

Fraqueza, M. J., 2015. Antibiotic resistance of lactic acid bacteria isolated from dry fermented sausages. *Inter. J. Food Microbiol*., 212:76-88.

Cisneros. A. Y. M. and Alquicira. P. E., 2018, Antibiotic Resistance in Lactic Acid Bacteria. doi: 10.5772/intechopen.80624.

Robinson. R. K., Tamime. A.Y. and Wszolek, M., 2002. Microbiology of fermented milks. Dairy Micro. Handbook (ed. R.K. Robinson), 3rd edn. John Wiley & Sons, NY, 367– 490.

Rattanachaikunsopon, P and Phumkhachorn P., 2010. Lactic acid bacteria: their antimicrobial compounds and their uses in food production. *Ann. Biol Res*., 1(4):218– 228.

Mokoena. M. P., 2017. Lactic Acid Bacteria and Their Bacteriocins: Classification, Biosynthesis and Applications against Uropathogens: *A Mini-Review. Molecule*.,22(8):1255.

Wang, Y., Wu, J., Lv, M., Shao, Z., Hungwe, M., Wang, J., Bai, X., Xie, J., Wang, Y. and Geng, W., 2021. Metabolism Characteristics of Lactic Acid Bacteria and the Expanding Applications in Food Industry. *Front. Bioeng. Biotechnol*.9.

Widyastuti, Y. and Febrisiantosa, A., 2014. The role of lactic acid bacteria in milk fermentation. *Food Sci. Nutr*. 2014.

Rakhmanova. A., Khan. Z. A. and Shah. K., 2018. A mini review fermentation and preservation: role of Lactic Acid Bacteria. *Med., Crave Onlin.eJ. Food Pro and Tec*hnol., 6(5): 414–417.

Hao, Y., Zhao, L., Zhang, H., Zhai, Z., Huang, Y., Liu, X. and Zhang, L., 2010. Identification of the bacterial biodiversity in koumiss by denaturing gradient gel electrophoresis and species-specific polymerase chain reaction. *J. Dairy Sci*., 93(5): 1926-1933.

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