

Biopreservation by lactic acid bacteria: a review

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Abstract

Biopreservation can be defined as extending the shelf life and enhancing the safety of food by the use of microorganisms or their products. Lactic Acid Bacteria (LAB) is such a group of microorganisms which are Generally Recognized as Safe (GRAS). They preserve food from spoilage and are commonly used in food fermentation. These strains are potential for bacteriocin production. LAB may include *L.bulgaricus*, *L.lactis*, *L.acidophilus* etc. They not only preserve food but also give texture and flavor. They have high demand compared to chemical preservatives because chemical preservatives are not hundred percent safe and also have some adverse effects.

Keywords: Bacteriocin, biopreservation, lactic acid bacteria, microorganisms

Introduction

Biopreservation can be defined as the extension of shelf life and food safety by the use of natural or controlled microbiota and/or their antimicrobial compounds. One of the most common forms of food biopreservation is fermentation, a process based on the growth of microorganisms in foods, whether natural or added. These organisms mainly comprise lactic acid bacteria, which produce organic acids and other compounds that in addition to antimicrobial properties also confer unique flavours and textures to food products (Ananou et al, 2007). Among alternative food preservation strategies, particular attention has been paid to biopreservation techniques, which enhance the hygienic quality and minimizing the negative impact on the nutritional and sensory properties. Lactic acid bacteria are interesting

candidates which can be used for this approach (Mahdi Ghanbari et al, 2013).

Lactic acid bacteria

Lactic acid bacteria (LAB) are Gram positive, non-spore forming, cocci or rod shaped, catalase-negative and fastidious organisms, considered as 'Generally Recognized as Safe' organisms (Mahantesh M Patil et al, 2010). They grow well under anaerobic conditions but may grow in microaerophilic as well as aerobic conditions. They exhibit optimum growth at slightly lower acidic conditions (pH 5.5-6.0) while growth is often restricted at neutral or somewhat alkaline conditions (pH above 7.0 to 7.5). They are strictly fermentative, with lactic acid as the major end product during sugar fermentation (Md.Ibrahim Khalil and Md.Nurul Anwar 2016). They also have low proportions of G+C in their DNA

(<55%)(Ananou et al, 2007).LAB are often inhibitory to other microorganisms and this is the basis of their ability to affect the keeping quality and safety of many food products. The principal factors which contribute to this inhibition are low pH, organic acids, bacteriocins, hydrogen peroxide,ethanol, nutrient depletion and low redox potential(Sani Sambo Datsugwai Mohammed, Udeme Josiah Joshua Ijah,2013).

Occurrence of lab

LAB are naturally present in milk and milk products.LAB is generally associated with habitat rich in nutrients such as milk, cheese,meat,beverages,and vegetables.Lactic acid bacteria could also be isolated from soil,lakes, intestinal tract of animals and humans(Misganaw Wassie, Teketay Wassie,2016).Some LAB are associated with the mouth flora, intestine and vagina of mammals, while others are

present in fermented sea foods.LAB are the most important bacteria used in the fermentation industry of dairy products such as yogurt, cheese, sour milk, and butter in combination with yeast(Belal.J.Muhiadin et al, 2013).Lactic acid bacteria are widely distributed in nature. They could be isolated from soils,water, plants,silages,waste products and also from the intestinal tract of animals and humans .They are often associated with animal oral cavities and intestines, plant leaves as well as decaying plants or animal matter, compost etc.LAB could be isolated from many sources such as milk products,sugar cane plants, fresh water fishes etc(Choksi Nikita and Desai Hemangi, 2012). LAB can be isolated from grains,dairy and meat products and fermenting vegetables as well as mucosal surface of animals. LAB was also isolated from curd and cucumber samples (Mahantesh M Patil et al, 2010).

Table 1: Sources of lactic acid bacteria.

SI No:	Topic	Name of author & year	Source of LAB
1.	Isolation and characterization of lactic acid bacteria from curd & cucumber	Mahantesh M Patil et al, 2010	Curd & cucumber
2.	Isolation, identification and characterization of lactic acid bacteria from milk & yoghurt	Md. Ibrahim Khalil et al, 2016	Milk& yoghurt
3.	Isolation and screening of lactic acid bacteria from fermented milk products for bacteriocin production	Sani Sambo Datsugwai Mohammed et al, 2013	Fermented milk products
4.	Isolation and identification of lactic acid bacteria from raw cow milk	Misganaw Wassie et al, 2016	Raw cow milk
5.	Isolation, identification and characterization of lactic acid bacteria from dairy sludge sample	Choksi Nikita et al, 2012	Dairy sludge sample
6.	Lactic acid production using lactic acid bacteria under optimized conditions	A.Sheeladevi et al, 2011	Milk, curd, whey, fermented idly and pickles
7.	Isolation and characterization of lactic acid bacteria isolated from ripe mulberries in Taiwan	Yi- Sheng Chen et al, 2010	Ripe mulberries

8.	Isolation and identification of lactic acid bacteria from soil using an enrichment procedure	Y.S. Chen et al, 2005	Soil
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Classification of lab

According to morphology LAB are classified in to rods and cocci(Anna Halasz,2009). LAB can be classified in to two groups: homofermentative and heterofermentative. One important characteristic used in the differentiation of lactic acid bacterium genera is the mode of glucose fermentation under standard conditions. Based on this, LAB can be grouped in to two groups. Homofermentative and heterofermentative bacteria.Homofermentative LAB convert sugars in to lactic acid. They usually metabolize glucose via the Embden-Meyerhof Pathway. Only the homofermentative LAB are used for the commercial production of lactic acid. Heterofermentative bacteria catabolize glucose in to ethanol and CO₂ as well as lactic acid(Anna Halasz,2009). Homofermentative LAB are *Lactobacillus delbrueckii*, *Lactobacillus plantarum*, *Lactobacillus bulgaricus*, *Lactobacillus helveticus*, *Lactobacillus casei*, *Streptococcus lactis*, *Streptococcus cremoris*, *Streptococcus faeclis*, *Streptococcus thermophiles* and *Pedicoccus cerevisiae*. The heterofermentative LAB are *Leuconostoc mesenteroides*, *Lactobacillus cremoris*, *Lactobacillus brevis* and *Lactobacillus fermentum* (A.Sheela Devi, N.Ramanathan, 2011)

Antimicrobial components from lab

Bacteriocins are naturally occurring antibiotic peptides produced by Grampositive bacteria. They are usually small such as 24 amino acids. Many bacteriocins are active against food-borne pathogens. The important bacteriocins are nisin, diplococins, acidophilins, bulgarican, helveticins, lacticins and plantaricins. Nisin

is produced by *Lactococcus lactis* is the only bacteriocin commercially available and marketed. Nisin is more effective against gram positive bacteria,particularly the spore formers (Mahdi Ghanbari et al, 2013).

Several lactobacilli species are reported to have antifungal activity. These antifungal compounds consists of organic acids,reuterin, hydrogen peroxide, and other peptides (Belal.J.Muhiadin, Zaiton Hassan and Nazamid Saari, 2013).

LAB bacteriocins were divided in to 4 classes. (Ananou et al, 2007)have proposed four classes for gram positive bacteriocins that could also be applied to LAB bacteriocins. Class 1 comprises the lantibiotics which are small peptides that differ from other bacteriocins by their content in dehydro aminoacids and thioether aminoacids. They include nisin, lacticin cytolysin of *E.faecalis*, and lacticin 3147 of *C. lacti*(Ananou et al, 2007).

Class 11 comprises of thermostable, non-lantibiotic linear peptides, class111 includes the heat –labile bacteriocins that encompass many bacteriolytic extracellular enzyme that may mimic the physiological activities of bacteriocins.Class 1V is a new class created to include the circular antibacterial peptide produced by bacteria, plants and mammalian cells(Ananou et al, 2007).

Applications of lab

LAB has been used to improve storage qualities, palatability and nutritive value of perishable foods such as milk, meat, fish and vegetables. They are also used in dairy industry, in cereal processing, in bread making, meat industry, sea food products etc. Compared to dairy products, nisin used

in meat products has not been very successful because of its low solubility,

irregular distribution and lack of stability (Ananou et al, 2007).

Table 2: Biopreservation by LAB.

Sl No:	Topic	Author & year	Inference
1.	Bacteriocins from lactic acid bacteria, purification properties and use as bio preservatives	Jose Luis Parada et al, 2007	Bacteriocin produced by lactic acid bacteria are safe and is good to control the development of pathogens
2.	Production of GABA by microorganisms: A review	Radhika Dhakal et al, 2012	GABA producing organisms are lactic acid bacteria, which make food spoilage pathogens unable to grow and act as probiotics in the gastrointestinal tract
3.	Determination of the bacteriocin like substances produced by some lactic acid bacteria isolated from Turkish dairy products.	B.Aslim, et al, 2005	The strains isolated from Turkish dairy products showed antimicrobial activity against test bacteria. The inhibitory activities of the strains were due to bacteriocin like substances.
4.	Antimicrobial effects of bacteriocin like substance produced by <i>L.acidophilus</i> from traditional yoghurt on <i>P.aeruginosa</i> and <i>S.aureus</i>	A.M.Mobarez, et al, 2008	<i>L.acidophilus</i> was isolated from bio-yoghurt and bacteriocin like substance was active against the gram positive bacteria <i>Bacillus</i> and <i>staphylococcus</i> .
5.	Isolation of lactic acid bacteria and their antibacterial spectrum against gram positive and gram negative bacteria	Muneera Naz Baloch et al, 2015	Selected as good candidates for commercial use as bio preservatives and can also contribute in improving human health by using them as probiotics in different foods.
6.	Isolation and characterization of two bacteriocins of <i>Lactobacillus acidophilus</i> LF 221	Bogovic-Matijasic B et al 1998	<i>L. acidophilus</i> LF 221 produced bacterium like activity against different bacteria. They produces atleast two bacteriocins acidocins LF 221A and acidocin LF 221 B
7.	Optimization, characterization and partial purification of bacteriocin produced by <i>Staphylococcus haemolyticus</i> MSM an isolate from seaweed.	Murugan Suresh et al, 2014	Evaluated the antimicrobial potential of bacteriocin produced by seaweed associated bacterium.
8.	Purification and characterization of acidocin D 20079 a bacteriocin produced	Sahar F Deraz et al, 2005	<i>L.acidophilus</i> DSM 20079 produces a small bacteriocin, designated as acidocin D20079.

	by <i>Lactobacillus acidophilus</i> DSM 20079		
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Conclusion

Several studies have been reported to isolate and identify the lactic acid bacteria from various sources. Several LAB are found to produce bacteriocins which can be used as bio preservatives. The presence of LAB in substances such as milk, meat etc enhances bioavailability of nutrients and act to extend the shelf life.

References

- Ananou.S, Maqueda.M, Martinez Bueno and Valdivia.E (2007), Biopreservation, An ecological approach to improve the safety and shelf life of foods, Communicating Current research and educational topics and trends in applied microbiologyA. Méndez-Vilas (Ed.) ,475-486
- Anna Halasz (2009) Food quality and standards-vol 111, Lactic acid bacteria, Encyclopedia of life support system, United Kingdom
- Aslin.B, Yuksekdag.Z.N, Sarikaya.E, Beyatli.Y(2005), Determination of the bacteriocin like substances produced by some lactic acid bacteria isolated from Turkish dairy products, LWT-Food science and technology, 38, 6, 691-694
- Belal.J.Muhiadin, Zaiton Hassan and Nazamid Saari (2013), Lactic acid bacteria-R & D for food, health and livestock purposes, Chapter 6: Lactic acid bacteria in biopreservation and enhancement of the functional quality of bread, Intech,155-172
- Bogovic-Matijasic B, Rogelj I, Nes IF, Holo H(1998), Isolation and characterization of two bacteriocins of *Lactobacillus acidophilus* LF 221, Applied microbiology and biotechnology, 49,5, 606-612
- Y.S.Chen, F. Yanagida and T.Shinohava (2005), Isolation and identification of lactic acid bacteria from soil using an enrichment procedure, Letters in applied microbiology, 40, 195-200
- Choksi Nikita and Desai Hemangi(2012), Isolation, identification and characterization of lactic acid bacteria from dairy sludge sample, Journal of environmental research & development, 7, 1A, 234-245
- Jose Luis Parada, Carolina Ricoy Caron, Adriane Bianchi P Medeiros, Carlos Ricardo Soccol(2007), Bacteriocins from lactic acid bacteria, purification, properties and use as biopreservatives, Brazilian archives of biology and technology, 50,3, 512-542
- Mahantesh M Patil, Ajay Pal,T.Anand and K.V.Ramana (2010), Isolation and characterization of lactic acid bacteria from curd & cucumber, Indian journal of biotechnology, 9,166-172
- Mahdi Ghanbari, Mansooreh Jami, Konrad.S.Domig, Wolfgang kneifel (2013), Seafood biopreservation by lactic acid bacteria:Areview, LWT-Food science and technology, 54,315-324
- Md.Ibrahim Khalil, Md. Nural Anwar(2016), Isolation,identification and characterization of lactic acid bacteria from milk and yoghurt, Journal of food and dairy technology,4,3,17-26
- Misganaw Wassie, Teketay Wassie (2016), Isolation and identification of lactic acid bacteria from raw cow milk, International journal of advanced research in biological science, 3,8,44-49
- Mobarez.A.M, Hosseini Doust.R, Sattari .M and Mantheghi.N (2008), Antimicrobial effects of bacteriocin like substance produced by *L. acidophilus* from traditional yoghurt on *P. aeruginosa* and *S. aureus*. Journal of biological sciences, 8: 221-224.
- Muneera Naz Baloch, Roquya Siddiqi, Wajeeha Asad, Abdul Wahab(2015),

- Isolation of lactic acid bacteria and their antibacterial spectrum against gram positive and gram negative bacteria, International journal of current research , 7, 3, 13450-13456.
- Murugan Suresh, PalanisamyIyyapparaj, Perumal Anantharaman, optimization (2014), Characterization and partial purification of bacteriocin produced by *Staphylococcus haemolyticus* MSM an isolate from seaweed, Biocatalysis and agricultural biotechnology, 3,4, 161-166
- Radhika Dhakal, Vivek.K.Bajpal, kwang-Hyun Back(2012), Production of GABA by microorganisms: a review, Brazilian journal of microbiology, 43, 4, 1230-1241
- Sani Sambo Datsugwai Mohammed, Udeme Josiah Joshua Ijah (2013), Isolation and screening of lactic acid bacteria from fermented milk products for bacteriocin production, Annals.Food science and technology, 14, 1,122-128
- Sahar F Deraz , Eva Nordberg, Karlsson, Martin Hedstrom, Maria M Anderson, Bo Mattiasson (2005), Purification and characterization of acidocins D20079, a bacteriocin produced by *Lactobacillus acidophilus* DSM 20079, Journal of biotechnology, 117, 4, 343-354
- Sheela Devi. A, Ramanathan.N (2011), Lactic acid production using lactic acid bacteria under optimized conditions, International journal of pharmaceutical and biological archives,2,6,1686-1691
- Yi-Sheng Chen, Hui-chung Wu, Fujitoshi Yanagida (2010), Isolation and characteristics of lactic acid bacteria isolated from ripe mulberries in Taiwan, Brazilian journal of microbiology, 41, 916-921