Henry
Journal of Nutrition & Food Sciences

Mini Review

Lactic Acid Bacteria (LAB) Applications in the Food Industry: Probiotic Foods-A Mini Review

Natalia Barboza[1,2*] and Jessie Usaga[2]

[1]Food Technology Department; University of Costa Rica (UCR), San Jose 11501-2060, Costa Rica

[2]National Center for Food Science and Technology (CITA),UCR, San Jose 11501-2060, Costa Rica

Abstract

Lactic Acid Bacteria (LAB) is a diverse group of cocci and rods characterized by the production of Lactic Acid (LA). Some LAB, with probiotic traits, have been extensively used since ancient times on food production. Advances in science have given the opportunity to understand the organization of LAB genomes considering their habitats and interactions with other species. Nowadays, it is possible to carry out *in vitro* and *in vivo* tests to search for different LAB profiles and therefore applications, and to learn about the benefits they can offer to consumers. Some advantages that have been associated with their consumption is having a healthy intestinal microbiota, as well as the reduction of some digestive disorders. It is known that LAB can produce compounds such as LA, acetic acid, and other desirable by-products such as bacteriocins. These compounds are associated with the inhibition including of some pathogenic microorganisms among other properties.

Keywords: Health benefits; Industrial applications; Probiotics

***Corresponding author:** Natalia Barboza, Food Technology Department, UCR, San Jose 11501-2060, Costa Rica, E-mail: natalia.barboza@ucr.ac.cr

Received Date: August 17, 2020

Accepted Date: August 31, 2020

Published Date: September 08, 2020

Citation: Barboza N, Usaga J (2020) Lactic Acid Bacteria (LAB) Applications in the Food Industry: Probiotic Foods-A Mini Review. J Nutr Food Sci 3: 019.

Introduction

Lactic Acid Bacteria (LAB)

Lactic Acid Bacteria is a diverse group of non sporulating, nonmotile, acid-tolerant and nonrespiring aerotolerant catalase-negative Gram-positive cocci or rods [1-4]. Most LAB belongs to the phylum Firmicutes, class Bacilli and order Lactobacillales but the genus *Bifidobacterium*, from the phylum Actinobacteria, is also considered LAB [5]. This bacterial group obtain energy through substrate-level phosphorylation following a heterofermentative or homofermentative pathway for carbohydrates fermentation. Heterofermentative LAB produce CO_2 and ethanol or acetate besides LA or lactate and for homofermentative species, LA is the major metabolic end-product [1]. LAB may be isolated from fermented foods, feed, soil, plants, animals and humans [5,6], and they have been extensively used in the food industry as a hurdle of control for spoilage and pathogenic microorganisms, starter cultures on dairy and fermented foods, probiotics, nutraceuticals producers, antifungal and anti-mycotoxigenic agents and bacteriocins producers [1,5-8]. Numerous LAB have been generally recognized as safe according to the US Food and Drug Administration (FDA) or have granted the qualified presumption of safety status from the European Food Safety Agency (EFSA) [1].

Genetics of LAB

The most common methods for LAB identification use sequencing of regions of the 16S RNA gene. These methods can be used for the preliminary identification of an isolate or to identify bacterial communities ina particular habitat. Phylogenetic analysis of the sequences can be used to distinguish among species [2,9,10]. Some studies complement these results with Multilocus Sequence Typing (MLST), genetic fingerprinting, or complete genome sequencing of promising species [11].These advances can be combined with proteomic and transcriptomic studies for a better understanding of the function of these bacteria in foods, including their role as probiotics [12]. Databases such as that of the National Center for Biotechnology Information (NCBI) contain partial and complete genome sequences of LAB that are available to the scientific community. Different groups of researchers have taken on the task of determining the taxonomic and evolutionary relationships in this group of microorganisms [2,13]. Their analyses have increased our understanding of the genetic organization of LAB by assigning genes to a core genome or pan-genome. Pan-genome refers to all of the genes of the members of a phylogenetic line, while core genome refers to genes that are shared by all members of a group [14].

LAB as probiotics and their functional characterization (*in vitro* and *in vivo* tests)

Some LAB species have been used as probiotics for many years and their use as food supplements has been shown to provide benefits to consumers if ingested in specific amounts over time [15]. These benefits can include the maintenance of a healthy intestinal microbiota [16], a reduction in skin inflammation [17], and anti-colitis [18] and anti-obesity effects [19].

The genera *Lactobacillus, Enterococcus, Streptococcus* and *Bifidobacterium* contain species that have been used as probiotics. These bacteria became commercially available after having passed a series of tests *in vivo* and *in vitro* [20]. Industrial-scale testing of these microorganisms is also necessary to evaluate their growth in bioreactors [21]. Preliminary tests to characterize potential probiotic bacteria are important as they provide results that can be extrapolated to estimate behavior *in vivo*. Some of these tests simulate survival in the gastrointestinal tract by evaluating resistance to low pH and to lysozyme [22, 23]. Other tests can evaluate bile resistance, susceptibility to antibiotics and the ability to adhere to the intestinal mucosa [23-25]. Tests for inhibitory effects in culture media can be used to evaluate the effectiveness of a particular microorganism on pathogen growth [26]. On the other hand, the use of cell cultures allows the observation of interactions between the microorganism and cells of the tissue under study, thus providing a better understanding of the infection process at the tissue level [27].

The effect of probiotics on the immune response can be evaluated in co-cultures of probiotics and immune system cells. Co-culture allows the detection and quantification of cytokines, which are indicators of the inflammatory process [28,29]. Studies can also be conducted *in vivo* to understand how probiotic bacteria interact with the host. The production of organic acids and antimicrobial compounds, the interaction with host microbiota, and the production of secondary metabolites that are beneficial to the host are some of the effects that can be studied and characterized, depending on the species under study.

Effectiveness in their application as probiotics

Recent studies have demonstrated that changes in the human intestinal microbiota maybe associated with an increased predisposition to some physiological disorders [30]. Probiotic microorganisms have been shown to help reestablish the microbiota of the gastrointestinal tract and prevent some systemic diseases [30,31]. Because probiotic bacteria may prevent or provide therapeutic effects against diseases such as diarrhea, they are of great interest to both the pharmaceutical and food industries. The mechanisms of action are diverse. The production of acids such as LA or acetic acid by probiotic bacteria is associated with a decrease in the pH of the medium in which they are found and inhibition of the growth of other microorganisms, such as pathogenic bacteria. Other mechanisms of action include the production of organic acids, exopolysaccharides, biosurfactants, and other metabolites with inhibitory effects, such as bacteriocins [8,21]. Probiotics also compete for binding sites, receptors, and nutrients, to inhibit pathogen proliferation [32].

Probiotic foods

Probiotic foods are represented by those containing live single or mixed strain probiotic bacteria, most frequently *Lactobacillus* and *Bifidobacterium* species. According to the Food and Agriculture Organization of the United Nations and the World Health Organization (FAO/WHO) probiotics are “microorganisms which when administered in adequate amounts confer a health benefit on the host” [33]. Also, FDA and EFSA, mention that these microorganisms should be Generally Recognized as Safe (GRAS) and Qualified Presumption of Safety (QPS).

Culture dairy products (yogurt, fermented milk, Amasi, Doogh, cheese, among others) are good sources of live and health-promoting organisms but probiotic foods also include fruit and vegetable-based products (i.e. Kimchi, Sauerkraut, Jiang-gua) and a wide variety of traditional artisan-style and ethnic fermented foods and beverages such as fermented sausage, soy-fermented foods, and fermented cereal products (i.e. Fura, Boza, Uji, Hardaliye and more) [34,35]. Moreover, ice cream and chocolate represent examples of modern probiotic foods. A number of health benefits have been linked to the consumption of probiotic products such as treatment of diarrhea, alleviation of symptoms of lactose intolerance, reduction of blood cholesterol, treatment of irritable bowel syndrome, and inflammatory bowel disease, anti-carcinogenic properties, synthesis of vitamins, enhancing immunity, protect against pathogens, osteoporosis, diabetes, obesity, atherosclerosis and anti-allergic properties [35-37]. Microbiota composition has also importance on brain development [38]. Modifying the microbiota is desired by people with neuropsychiatric disorders. Because it has been associated with neuronal development and microglial modulation, its modification is a therapeutic target for patients with these disorders [39].

The consumption of fermented foods containing live microorganisms has emerged as an important dietary strategy for improving human health with the additional benefits that fermentations may enhance the shelf-life and safety, flavor, texture, functional properties, sensory and nutritional properties of food [34].

Conclusion

Promising uses of LAB for food industry applications are endless due to the wide diversity of this bacterial group and their well-known performance enhancing shelf-life, safety, functionality, sensory, and nutritional properties in different food products. Probiotic foods containing live microorganisms may represent great health benefits for consumers and further developments are yet possible given the numerous existing LAB and still to be isolated and characterized species besides the potential for industrial production and commercialization of ethnic fermented foods. Products that are consumed on a regular or even daily basis in different cultures and which popularity has emerged since they represent a natural source of live bacteria with promising health benefits for consumers.

References

1. Von Wright A, Axelsson L (2019) Lactic acid bacteria: An introduction. In Vinderola G, Ouwehand AC, Salminen, S, von Wright A. (eds): Lactic Acid Bacteria Microbiological and Functional Aspects, 5th ed, Boca Ratón, FL: CRC Press 2-6.

2. Salvetti E, Harris HMB, Felis GE, O'Toole PW (2018) Comparative genomics of the genus *Lactobacillus* reveals robust phylogroups that provide the basis for reclassification. Appl Environ Microbiol 84: 3-18.

3. Endo A, Tanizawa Y, Arita M (2019) Isolation and identification of lactic acid bacteria from environmental samples. Methods in molecular biology 1887: 3-13.

4. Sabatine N (2010)Chapter 24-A Comparison of the volatile compounds, in Spanish-style, Greek-style and Castelvetrano-style green olives of the Nocellara del Belice cultivar: Alcohols, aldehydes, ketones, esters and acids. In Preedy VR, Watson RR,(eds): Olives and Olive Oil in Health and Disease Prevention. United States: Elsevier, Academic Press, 219-231.

5. Duar RM, Lin XB, Zheng JZ, Martino ME, Grenier T, et al. (2017) Lifestyles in transition: Evolution and natural history of the genus *Lactobacillus*. FEMS Microbiol Rev 41: 27-48.

6. Ruiz Rodríguez LG, Mohamed F, Bleckwedel J, Medina R, De Vuyst L, et al. (2019) Diversity and functional properties of lactic acid bacteria isolated from wild fruits and flowers present in northern Argentina.Front Microbiol 10: 1-26.

7. Ahmed-Sadiq F, Yan B, Tian F, Zhao J, Zhang H,et al. (2019) Lactic acid bacteria as antifungal and anti-mycotoxigenic agents: Comprehensive review. Compr Rev Food Sci Food Saf 18: 1403-1436.

8. Venegas-Ortega MG, Flores-Gallegos AC, Martínez-Hernández JL, Aguilar CN, Nevárez-Moorillón GV (2019) Production of bioactive peptides from Lactic Acid Bacteria: A sustainable approach for healthier foods. Compr Rev Food Sci Food Saf 18: 1039-1051.

9. Moraes PM, Martins-Perin L, Silva-Júnior A, Nero LA (2013)Comparison of phenotypic and molecular tests to identify lactic acid bacteria. Braz J Microbiol 44: 109-112.

10. Zheng J, Wittouck S, Salvetti E, Franz C, Harris H, et al. (2020) A taxonomic note on the genus Lactobacillus: Description of 23 novel genera emended description of the genus Lactobacillus Beijerinck 1901 and union of *Lactobacillaceae* and *Leuconostocaceae*. Int J Syst Evol Microbiol 70: 2782-2858.

11. Montanari C, Barbieri F, Magnani M, Grazia L, Gardini F, et al. (2018) Phenotypic diversity of *Lactobacillus sakei* strains. Front Microbiol 9: 2003.

12. Vinusha KS, Deepika K, Johnson TS, Agrawal GK, Rakwal R (2018) Proteomic studies on lactic acid bacteria: A review. Biochem Biophys Rep 14: 140-148.

13. Pasolli E, De Filippis F, Mauriello I, Cumbo F, Walsh A, et al. (2020) Large-scale genome-wide analysis links lactic acid bacteria from food with the gut microbiome. Nat Commun 11: 2610.

14. Kim KH, Chun BH, Baek JH, Roh SW, Lee SH, et al. (2020) Genomic and metabolic features of *Lactobacillus sakei* as revealed by its pangenome and the metatranscriptome of kimchi fermentation. Food Microbiol 86: 103341.

15. Kumar H, Salminen S, Verhagen H, Rowland I, Heimbach J, et al. (2015) Novel probiotics and prebiotics: Road to the market. Curr Opin Biotech 32: 99-103.

16. De Vrese M, Offick B (2010) Probiotics and prebiotics: Effects on diarrhea. In Watson R, Preedy V (eds.): Bioactive Foods in Promoting Health: Probiotics and Prebiotics. London: Academic Press. 205-227.

17. Rather IA, Bajpai VK, Huh YS, Han YK, Bhat EA, et al. (2018) Probiotic *Lactobacillus sakei* proBio-65 extract ameliorates the severity of imiquimod induced psoriasis-like skin inflammation in a mouse model. Front Microbiol 9: 1021.

18. Seo S, Shin JS, Lee WS, Rhee YK, Cho CW, et al. (2017) Anticolitis effect of *Lactobacillus sakei* K040706 via suppression of inflammatory responses in the dextran sulfate sodium-induced colitis mice model. J Funct Foods 29: 256-268.

19. Lim SM, Jeong JJ, Woo KH, Han MJ, Kim DH (2017) *Lactobacillus sakei* OK67 ameliorates high-fat diet-induced blood glucose intolerance and obesity in mice by inhibiting gut microbiota lipopolysaccharide production and inducing colon tight junction protein expression. Nutr Res 36: 337-348.

20. Isolauri E, Ouwehand AC, Salminen S (2002) Probiotics: An overview of beneficial effects. Antonie van Leeuwenhoek 82: 279-289.

21. Mora-Villalobos A, Montero-Zamora J, Barboza N, Rojas-Garbanzo C, Usaga J, et al. (2020)Multi-product Lactic Acid Bacteria fermentations: A review. Fermentation 6: 23.

22. Castillo NA, Perdigán G, De Moreno A (2011) Oral administration of a probiotic *Lactobacillus*modulates cytokine production and TLR expression improving the immune response against *Salmonellaenterica* serovar Typhimurium infection in mice. BMC Microbiol11: 177.

23. García-Ruiz A, González de Llano D, Esteban-Fernández A, Requena T, Bartolomé B, et al. (2014) Assessment of probiotic properties in lactic acid bacteria isolated from wine. Food Microbiol 44: 220-225.

24. Dlamini ZC, Langa RLS, Aiyegoro OA, Okoh AI (2019) Safety evaluation and colonisation abilities of four Lactic Acid Bacteria as future probiotics. Probiotics Antimicrob Proteins 11: 397-402.

25. Mathara JM, Schillinger U, Kutima PM, Mbugua SK, Guigas C, et al. (2008) Functional properties of *Lactobacillus plantarum*strains isolated from Maasai traditional fermented milk products in Kenya. Curr Microbiol 56: 315-321.

26. Shukla P, Sharma J (2015) A Study showing antagonistic effect of *Lactobacilli casei* and *Lactobacilli sporogenesis* against some common pathogens *in vitro*. Int J Curr Microbiol App Sci 4: 36-40.

27. Tsai CC, Hsih HY, Chiu HH, Lai YY, Liu JH, et al. (2005) Antagonistic activity against *Salmonella* infection *in vitro* and *in vivo* for two Lactobacillus strains from swine and poultry. Int Journal Food Microbiology 102: 185-194.

28. Gad M, Ravn P, Søborg DA, Lund-Jensen K, Ouwehand AC, et al. (2011) Regulation of the IL-10/IL-12 axis in human dendritic cells with probiotic bacteria. FEMS Immunol Med Microbiol 63: 93-107.

29. Haghighi HR, Gong J, Gyles CL, Hayes MA, Sanei B, et al. (2005) Modulation of antibody - mediated immune response by probiotics in chickens. Clin Diagn Lab Immunol 12: 1387-1392.

30. Valdes AM, Walter J, Segal E, Spector TD (2018) Role of the gut microbiota in nutrition and health. BMJ 361: k2179.

31. Hemarajata P, Versalovic J (2013) Effects of probiotics on gut microbiota: Mechanisms of intestinal immunomodulation and neuromodulation. Ther Adv Gastroenter 6: 39-51.

32. Arias B, Reyes M, Navarro L, Solis B, Márquez, et al. (2013) Antagonistic effect of probiotic strains against two pathogens : *Salmonella Typhimurium and E. coli* O157: H7 resistant to antibiotics. E-Gnosis 11: 1-16.

33. Aspri M, Tsaltas D (2020) Review on non-dairy probiotics and their use in non-dairy based products. Fermentation 6: 30.

34. Rezac S, Kok CR, Heermann M, Hutkins R (2018) Fermented foods as a dietary source of live organisms. Front Microbiol 9: 1785.

35. Behera SS, Panda SK (2020) Ethnic and industrial probiotic foods and beverages: Efficacy and acceptance. Curr Opin Food Sci 32: 29-36.

36. Kerry RG, Patra JK, Gouda S, Park Y, Shin HS, et al. (2018) Benefaction of probiotics for human health: A review. J Food Drug Anal 26: 927-939.

37. Orisakwe O, Nwadiuto C, Frazzoli C, Dokubo A (2020) Nigerian foods of probiotics relevance and chronic metal exposure: A systematic review. Environ Sci Pollut R 27: 19285-19297.

38. Eltokhi A, Janmaat IE, Genedi M, Haarman BCM, Sommer IEC (2020) Dysregulation of synaptic pruning as a possible link between intestinal microbiota dysbiosis and neuropsychiatric disorders. J Neuro Res 98: 1335-1369.

39. Genedi M, Janmaat IE, Haarman B, Sommer IEC (2019) Dysregulation of the gut-brain axis in schizophrenia and bipolar disorder: Probiotic supplementation as a supportive treatment in psychiatric disorders. Curr Opin Psychiatr 32: 185-195.

Henry Journal of Acupuncture & Traditional Medicine

Henry Journal of Anesthesia & Perioperative Management

Henry Journal of Aquaculture and Technical Development

Henry Journal of Cardiology & Cardiovascular Medicine

Henry Journal of Case Reports & Imaging

Henry Journal of Cell & Molecular Biology

Henry Journal of Tissue Biology & Cytology

Henry Journal of Clinical, Experimental and Cosmetic Dermatology

Henry Journal of Diabetes & Metabolic Syndrome

Henry Journal of Emergency Medicine, Trauma & Surgical Care

Henry Journal of Haematology & Hemotherapy

Henry Journal of Immunology & Immunotherapy

Henry Journal of Nanoscience, Nanomedicine & Nanobiology

Henry Journal of Nutrition & Food Science

Henry Journal of Obesity & Body Weight

Henry Journal of Cellular & Molecular Oncology

Henry Journal of Ophthalmology & Optometry

Henry Journal of Perinatology & Pediatrics

Henry Publishing Groups, 41341 Red Birch Dr, Aldie, VA, 20105, USA
Tel: +1 571-275-4480; E-mail: contact@henrypublishinggroups.org
https://www.henrypublishinggroups.com/