MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Microbiology & Biotechnology
ISSN: 2576-7771

Therapeutic Properties of Lactic Acid Bacteria

Kilic T*

Vocational School of Health Services, Department of Medical Services and Techniques, Gazi University, Türkiye

***Corresponding author:** Tugba Kilic, Vocational School of Health Services, Department of Medical Services and Techniques, Gazi University, Program of Medical Laboratory Techniques, 06830, Ankara, Türkiye, Tel: +90 531 465 80 14; Email: tugbakilic@gazi.edu.tr

Mini Review
Volume 9 Issue 2
Received Date: April 23, 2024
Published Date: May 17, 2024
DOI: 10.23880/oajmb-16000287

Abstract

Lactic acid bacteria (LAB) are considered a significant member of the human and animal intestinal microbiota due to their effects on host health, such as regulating the balance of the human and animal gastrointestinal microbiota. Thus, microecological balance can be maintained, and microbial infections can be prevented. In addition, LAB are used in bioprotective cultures to prevent spoilage and pathogenic microorganisms in the food industry. The therapeutic agents possessed by LAB include metabolites containing antibacterial, antifungal, antiviral, antioxidant, anticancer, immunomodulatory, and anti-inflammatory properties. *Lactobacillus* and *Lactococcus* may have potential therapeutic properties. In conclusion, LAB are commonly used in several industries, including food, clinical, agricultural, and animal husbandry. This Review aims to summarize the therapeutic properties of LAB, including recombinant and antimicrobial. LAB metabolites with therapeutic properties may be an alternative strategy to antibiotics in controlling infections, or these metabolites may be used synergistically with antibiotics. Additionally, this Review presents the advantages of LAB's therapeutic properties.

Keywords: Antimicrobial Agents; Lactic Acid Bacteria; Metabolites; Therapeutic

Abbreviations: GIT: Gastrointestinal Tract; LAB, Lactic Acid Bacteria; EPS: Extracellular Polysaccharides.

Introduction

Lactic acid bacteria (LAB) play a multifaceted role in the food, agricultural, clinical, and pharmaceutical industries. The bacteria's different nutritional, environmental, and advanced adhesion adaptive properties enable them to grow easily in other environments, such as fermented dairy products, meat, fish, fruit, vegetable, and cereal products. Moreover, LAB is a common inhabitant of human mucosal surfaces, including the oral cavity, vagina, and gastrointestinal tract (GIT) [1,2]. The region between the duodenum and the terminal ileum is the primary site colonized by LAB species such as *Lactobacillus*. This area is covered with a layer of mucus composed mainly of mucin-type glycoproteins [3]. Probiotic *L. rhamnosus* GG can remain in the intestine long by adhering to mucus, thanks to its strain-specific pili [4].

Microorganisms with phylogenetic, genomic and metabolic variations can colonize the digestive system and provide beneficial effects on health. LAB plays an active role in nutrition and host resistance against pathogen microorganisms, in the regulation of the immune system and the maturation of host tissues [5]. Moreover, LAB possesses therapeutic properties that are vital for human health enhancement [1]. Therapeutic agents of LAB can be used in the treatment of autoimmune diseases and protection against cancer [5]. The metabolic activity created by LAB during fermentation positively affects the immunomodulatory activity by changing the structure of herbal medicine components [6].

Recombinant Lactic Acid Bacteria

As a vector carrying prophylactic and therapeutic molecules, LAB can specifically produce, amplify, and deliver the protein of interest orally, intranasally, and vaginally. Moreover, recombinant LAB can be used to deliver functional proteins to these mucosal tissues in the treatment of many different pathologies, such as GIT-related diabetes, cancer, and viral infections [7]. These recombinant LAB, such as *Lactococcus lactic* and *Lactobacillus plantarum*, have generated increasing interest as they may provide advantages over different mucosal delivery systems [8]. Mucosal delivery of therapeutic and prophylactic molecules is achieved using LAB. One significant advantage of LAB as a vaccine delivery vehicle is that it delivers therapeutic and prophylactic molecules to mucosal surfaces. It can elicit antigen-specific secretory immunoglobulin A responses at mucosal surfaces [9]. In addition, LAB provides advantages for the production of therapeutic proteins due to their safety status and ability to survive passage through the GIT [10]. Therefore, creating a safe delivery environment of recombinant proteins for the treatment of a wide range of diseases may be a promising alternative [7]. Over the past two decades, the significant health benefits of recombinant LAB administered via the mucosa have been successfully indicated using mostly animal models. However, recently, it has been applied in clinical studies on humans [10]. Additionally, LAB as a live vector precisely replicates, produces and delivers the relevant protein, which can provide a significant reduction in the production cost of therapeutic agents [7]. *Lactococcus* and *Lactobacillus* are two crucial LAB genera used to generate recombinant molecules [10]. Moreover, *Lactococcus lactis* is one of the most commonly used species for cloning and producing recombinant proteins [7].

Developments

Lactobacillus plantarum has been shown to limit colon inflammation and promote oral tolerance induction. Moreover, *Lactobacillus fermentum* ME-3 has been demonstrated to have antimicrobial activity against intestinal pathogens and high antioxidative activity [11]. A new technology, mini cells and SimCells, can be produced from LAB. These cells can be loaded with a number of different chemotherapeutic drugs in nanosized drug delivery systems with specific ligands that target tumor cells with minimal toxicity to healthy cells. *Lactobacillus fermentum*, *Lactobacillus farciminis*, and *Lactobacillus rhamnosus* were able to produce AgNPs in different sizes of 11.2, 17, and 15.7 nm, respectively [12]. The intestinal system of animals contains a complicated ecosystem in which nutrients, microbiota, and host cells interact highly. Probiotics are part of the natural microbiota in the intestine and play a role in maintaining homeostasis. In livestock and poultry farming, LAB is considered a probiotic due to its curative effects on the health of the host and its important effects in the treatment of animal diseases. For these reasons, they are considered the alternative to antibiotics to advance animal health [13].

Antimicrobial Agents

The treatment of intestinal infections has two purposes: improving clinical symptoms (symptomatic treatment) and eliminating pathogenic microorganisms (etiological antimicrobial therapy). It has been determined that LAB may be effective in eliminating intestinal pathogens [14]. In addition, since LAB produce antimicrobial agents such as bacteriocins that help the biological preservation of food, they function as a strong antagonistic, inhibitory, and antimicrobial defence system against pathogens and spoilage microorganisms. LAB can synthesise bioactive metabolites such as bacteriocins (reuterin, reutericyclin, nisin enterocin pediocin, and lacticin), hydrogen peroxide, pyroglutamic acid, carbon dioxide, acetoin, diacetyl, ethanol, acetaldehyde, antifungal compounds (3-hydroxy fatty acids, propionate, phenyl-lactate, hydroxyphenyl-lactate, and cyclic dipeptides), and organic acids (lactic, acetic, formic, propionic, and butyric acids) as antimicrobial agents [1,12-15]. Hydrogen peroxide and antimicrobial peptides are substantial in competitive exclusion and probiotic features [16]. Lactocidin, the bacteriocin of *Lactobacillus acidophilus*, showed inhibitory effects against many pathogens such as *Salmonella, Staphylococcus, Bacillus, Escherichia, Streptococcus* and *Proteus* [15]. Hydrogen peroxide-producing LAB strains can effectively inhibit *Staphylococcus aureus* and *Pseudomonas* spp. Hydrogen peroxide, whose antimicrobial effect blocks glycolysis, is active only in the upper part of the GI tract and in the mouth where oxygen is present [16]. Furthermore, LAB generate an anti-inflammatory such as chemoattractants that can prevent lipopolysaccharide-induced production of proinflammatory cytokines in macrophages. *L. plantarum* A41 and *L. fermentum* SRK414 together can reduce the levels of inflammation-promoting cytokines such as TNFα, IL1b and IL8 [17].

LAB-metabolites can prevent the growth of spoilage and food-borne pathogenic microorganisms, and they are classified as natural antimicrobial agents [18]. Concerns about antibiotic resistance of important food pathogens and efforts to eliminate or reduce the use of synthetic additives as antimicrobial agents remain. It is of great importance to investigate new effective alternatives to ensure food quality and safety [19].

Conclusion

Natural and synthetic products are used as antimicrobial agents. Although synthetic products impact consumer health, they may raise safety and toxicity concerns. Thus, new natural products, such as metabolites of microorganisms, need to be discovered. Due to its advantages, such as good characterization and short production time, the proteins from which LAB is synthesized are of commercial interest compared to other therapeutic agents [5]. Furthermore, LAB-biosurfactants have broad applications in bioremediation, biodegradation, and the agricultural, cosmetic, and pharmaceutical industries [20]. Biosurfactants provide advantages over other synthetic counterparts due to their biodegradability, low toxicity, structural diversity, and ability to remain stable over a wide range of pH, temperature, and salinity [21].

More studies are needed since therapeutic agents may have different properties from strain to strain. However, LAB has excellent potential for biotechnological studies to solve problems in the medical and food sectors. Future perspectives on LAB studies may relate to discovering new metabolites, combining antibiotics and metabolites, and advances in genetics.

References

1. Ayivi RD, Gyawali R, Krastanov A, Aljaloud SO, Worku M, et al. (2020) Lactic acid bacteria: Food safety and human health applications. Dairy 1(3): 202-232.

2. Bintsis T (2018) Lactic acid bacteria as starter cultures: An update in their metabolism and genetics. AIMS Microbiol 4(4): 665-684.

3. Nishiyama K, Sugiyama M, Mukai T (2016) Adhesion properties of lactic acid bacteria on intestinal mucin. Microorganisms 4(3): 34.

4. Arena MP, Capozzi V, Spano G, Fiocco D (2017) The potential of lactic acid bacteria to colonize biotic and abiotic surfaces and the investigation of their interactions and mechanisms. Appl Microbiol Biotechnol 101(7): 2641-2657.

5. Erginkaya Z, Konuray-Altun G (2022) Potential biotherapeutic properties of lactic acid bacteria in foods. Food Bioscience 46: 101544.

6. Zhu H, Guo L, Yu D, Du X (2022) New insights into immunomodulatory properties of lactic acid bacteria fermented herbal medicines. Front Microbiol 13: 1073922.

7. Cano-Garrido O, Seras-Franzoso J, Garcia-Fruitos E (2015) Lactic acid bacteria: reviewing the potential of a promising delivery live vector for biomedical purposes. Microbial Cell Factories 14: 137.

8. Wang M, Gao Z, Zhang Y, Pan L (2016) Lactic acid bacteria as mucosal delivery vehicles: a realistic therapeutic option. Appl Microbiol Biotechnol 100(13): 5691-5701.

9. Wells JM, Mercenier A (2008) Mucosal delivery of therapeutic and prophylactic molecules using lactic acid bacteria. Nat Rev Microbiol 6(5): 349-362.

10. Daniel C, Roussel Y, Kleerebezem M, Pot B (2011) Recombinant lactic acid bacteria as mucosal biotherapeutic agents. Trends Biotechnol 29(10): 499-508.

11. Aoudia N, Rieu A, Briandet R, Deschamps J, Chluba J, et al. (2016) Biofilms of *Lactobacillus plantarum* and *Lactobacillus fermentum*: Effect on stress responses, antagonistic effects on pathogen growth and immunomodulatory properties. Food Microbiology 53(Part A): 51-59.

12. Alavi M, Rai M, Menezes IRAD (2022) Therapeutic applications of lactic acid bacteria based on the nano and micro biosystems. Nano Micro Biosystems 1(1): 8-14.

13. Deng Z, Hou K, Zhao J, Wang H (2021) The probiotic properties of lactic acid bacteria and their applications in animal husbandry. Curr Microbiol 79(1): 22.

14. Marteau P, Rambaud JC (1993) Potential of using lactic acid bacteria for therapy and immunomodulation in man. FEMS Microbiol Rev 12(1-3): 207-220.

15. Reis JA, Paula AT, Casarotti SN, Penna ALB (2012) Lactic acid bacteria antimicrobial compounds: characteristics and applications. Food Engineering Reviews 4: 124-140.

16. Dicks LMT, Botes M (2010) Probiotic lactic acid bacteria in the gastro-intestinal tract: health benefits, safety and mode of action. Beneficial Microbes 1(1): 11-29.

17. Saravanan P, Pooja R, Balachander N, Singh KRK, Silpa S, et al. (2023) Anti-inflammatory and wound healing properties of lactic acid bacteria and its peptides. Folia Microbiol (Praha) 68(3): 337-353.

18. Souza ELD, Oliveira KÁD, Oliveira MED (2023) Influence of lactic acid bacteria metabolites on physical and chemical food properties. Current Opinion in Food Science 49: 100981.

19. Fidan H, Esatbeyoglu T, Simat V, Trif M, Tabanelli G, et al. (2022) Recent developments of lactic acid bacteria and their metabolites on foodborne pathogens and spoilage

bacteria: Facts and gaps. Food Bioscience 47: 101741.

20. Raman J, Kim JS, Choi KR, Eun H, Yang D, et al. (2022) Application of lactic acid bacteria (LAB) in sustainable agriculture: Advantages and limitations. Int J Mol Sci 23(14): 7784.

21. Mouafo HT, Sokamte AT, Mbawala A, Ndjouenkeu R, Devappa S (2022) Biosurfactants from lactic acid bacteria: A critical review on production, extraction, structural characterization and food application. Food Bioscience 46: 101598.