OPEN ACCESS Freely available online

Journal of Probiotics & Health

Research Article

Probiotics in Promoting Health Benefits: An Overview

Shailza Dogra, Amit Kumar, Duni Chand*

Department of Biotechnology, Himachal Pradesh University, Shimla, India

ABSTRACT

Probiotics have gained significant attention in recent years due to their potential health benefits for humans. As a result, they have been extensively studied and clinically investigated across a wide range of applications globally. Numerous scientific studies have demonstrated the health-promoting effects of probiotics, and industries worldwide are actively involved in researching and promoting their use. Probiotics are now commercially available in various forms, including fermented foods, dietary supplements, cosmetics, and pharmaceuticals, providing accessible ways to incorporate them into daily life. In addition to these common products, probiotics have also been explored for their potential role in preventing and supporting the treatment of diseases, including as a complementary therapy during the COVID-19 pandemic. These studies have sparked further interest in how probiotics might influence immune function and overall health, particularly in the context of viral infections. Given the wide range of health benefits associated with probiotics, it is crucial to continue researching their safety and efficacy for human health applications. While probiotics have shown promise in improving gut health, immune function, and even mental well-being, comprehensive studies are needed to fully understand their long-term safety and optimal usage. This review highlights the beneficial attributes of probiotic microorganisms, emphasizing the growing body of evidence supporting their positive effects on human health. With continued research, we can better evaluate their potential as a key component in health maintenance and disease prevention.

Keywords: Probiotics; Lactic acid bacteria; Health; COVID-19

INTRODUCTION

Probiotics have been associated with human beings since they are consuming fermented food. Probiotics are non-disease-causing live micro-organisms (can be bacteria, yeasts and archaea), which impart good health benefits to the host when consumed in a certain amount into the body. Human body possesses both good/helpful and bad bacteria, usually good bacteria are known as probiotics. Probiotics help to strengthen the immune system, provide protection against pathogenic bacteria such as *Salmonella typhimurium*, *Escherichia coli* and *Helicobacter pylori* and keep the digestive system healthy. Probiotics also offer other various health benefits such as improvement of lactose intolerance, treatment of inflammatory bowel disease (ulcerative colitis and Crohn's disease), cancer, depression, obesity, oral health, diabetes, irritable bowel syndrome, allergies and reduction in cholesterol levels and help in the restoration of gut microflora after antibiotic treatment to prevent antibiotic-induced diarrhea. Besides these health benefit properties, the physical traits, texture, appearance, and flavor of probiotic products are also important factors to maintain for prolonged duration and consumer acceptability. The low viability of the probiotics results in the short life of fermented products. Therefore texture, flavor, and acid production by bacteria during fermentation and storage can be modified by altering process conditions or by the addition of supplementary ingredients. The ingredients that determine the nutritional variations and/or technical applications of the fermented product include milk protein, prebiotics and herbs [1].

Furthermore, interest in plant-based food additives has increased in recent years, as plant extracts have demonstrated health-enhancing properties, including antimicrobial and antioxidant effects. The effects of Korean plant have been reported

Correspondence to: Duni Chand, Department of Biotechnology, Himachal Pradesh University, Shimla, India, Tel: 9418276448; E-mail: duni-chand2000@yahoo.com

Received: 02-Jan-2025, Manuscript No. JPH-25-36712; **Editor assigned:** 07-Jan-2025, PreQC No. JPH-25-36712 (PQ); **Reviewed:** 21-Jan-2025, QC No. JPH-25-36712; **Revised:** 07-Jul-2025, Manuscript No. JPH-25-36712 (R); **Published:** 14-Jul-2025, DOI: 10.35248/2329-8901.25.13.373

Citation: Dogra S, Kumar A, Chand D (2025) Probiotics in Promoting Health Benefits: An Overview. J Prob Health. 13:373.

Copyright: © 2025 Dogra S, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

extensively the water-soluble extract from leaves of *Morus alba* and *Cudrania tricuspidata* on inhibition of lipid peroxidative formation, the extracts of *Nelumbo nucifera* leaf and *Curcuma longa* L. on preventing hypercholesterolemia, and *Cudrania tricuspidata* fruit essential oil on antibacterial efficacy. In cosmetics application of *Lactobacillus rhamnosus* has shown to elucidate the antioxidant and whitening mechanisms for skin care. Despite these established evidences safety profile of probiotics for their applications in human health care needs to be further investigated as the current knowledge of the characteristics that are necessary for their functionality in the gut is not complete.

MATERIALS AND METHODS

Definition of probiotics and other related important terms

Etymological meaning of the probiotic is 'for life', which has been derived from the Greek language. Scientists have defined probiotics in different ways as per evolution over time with the increasing use of beneficial live bacteria and exploration of their mechanism of action [2].

- Probiotics were described as living organisms used as food supplements with exert beneficial effects on healthy host by balancing microbial flora in gastrointestinal tract. The most widely used definition at present was given by Food and Agriculture Organization of the United Nations World Health Organization and probiotics have been defined as 'live microorganisms which when administered in adequate amounts confer a health benefit on the host'.
- Prebiotics are non-digestible food components, typically fibers or complex carbohydrates, that selectively stimulate the growth and activity of beneficial microorganisms (like probiotics) in the gut. By promoting the growth of beneficial bacteria, prebiotics help maintain a healthy gut microbiota, improve digestion, and support overall health. Common examples of prebiotics include inulin, Fructo-Oligosaccharides (FOS), and Galacto-Oligosaccharides (GOS), found in foods like garlic, onions, bananas, and whole grains [3].
- Postbiotics are the bioactive compounds or metabolic byproducts produced by probiotics during fermentation or microbial activity in the gut. These substances, such as Short-Chain Fatty Acids (SCFAs), bacteriocins, and enzymes, provide health benefits to the host even after the probiotics have died or been removed. Postbiotics can influence gut health, modulate the immune system, reduce inflammation, and support the intestinal barrier. Unlike probiotics, which are live microorganisms, postbiotics are typically non-living substances that contribute to the overall well-being of the host.
- A synbiotic is a combination of prebiotics and probiotics that work together to enhance the health benefits for the host. The prebiotic component stimulates the growth or activity of beneficial gut microorganisms, while the probiotic component provides live beneficial bacteria. By combining both, synbiotics aim to improve gut health more effectively than either prebiotics or probiotics alone. This synergistic effect supports the balance of the gut microbiota, enhances digestion, and boosts the immune system [4].
- A paraprobiotic refers to inactivated or non-living microorganisms (typically probiotics) that still retain their bioactive properties and can exert health benefits when consumed. Unlike probiotics, which are live bacteria, paraprobiotics are heat-killed or otherwise non-viable microbes that continue to influence the host's gut health and immune system. Despite being non-living, paraprobiotics can still interact with the immune system, modulate inflammation, and support gut microbiota balance, offering benefits similar to live probiotics without the need for them to be viable.

RESULTS AND DISCUSSION

Microbial species as probiotics applications

A variety of microbial species have been reported to contain probiotic attributes. Most important strains were reported to have probiotic properties are belonging to *Lactobacillus* and *Bifidobacterium* genera. Some of the important examples are enlisted in Table 1 [5].

Table 1: List of microorganisms considered as probiotics.

***Lactobacillus* species**	
1	*L. acidophilus*
2	*L. casei*
3	*L. gallinarum*
4	*L. crispatus*
5	*L. gasseri*
6	*L. rhamnosus*
7	*L. paracasei*

8	*L. plantarum*
9	*L. reuteri*
10	*L. johnsonii*
11	*L. selivarius*
12	*L. curvatus*
13	*L. helveticus*
14	*L. fermentum*
15	*L. farciminis*
16	*L. brevis*
17	*L. cellobiosus*
***Bifidobacterium* species**	
1	*B. adolescentis*
2	*B. animalis*
3	*B. longum*
4	*B. breve*
5	*B. lactis*
6	*B. infantis*
7	*B. bifidum*
8	*B. thermophilum*
Other bacteria	
1	*Enterococcus faecalis*
2	*E. faecium*
3	*Lactococcus lactis*
4	*Leuconostoc mesenteroides*
5	*Pediococcus acidilactici*
6	*Sporolactobacillus inulinus*
7	*Sreptococcus thermophilus*
8	*Baclilus sereus* var. toyoi
9	*Escherichia coli* strain nissle
10	*Propionibacterium freudenreichii*
Yeast	

1	*Saccharomyces cerevisiae*
2	*S. boulardii*

Lactic Acid Bacteria (LAB) and *Bifidobacterium* excluding pathogenic strains are commonly used microorganisms generally recognized as safe for probiotic use because of their native residency of healthy human gut. Generally, LAB are gram positive, non-spore forming, catalase-negative and produces organic acids, hydrogen peroxides, antifungal compounds and bacteriocins during lactic acid fermentation. *Bifidobacterium* undergoes different metabolic pathways and therefore listed as phylogenetically separated among LAB. Both LAB and *Bifidobacterium* genera had regulatory approval for their use in intestinal applications. There are another competitive species, *Streptococcus thermophiles* and *Lactococcus lactis*, have been shown to possess potential probiotic traits in food industries [6].

Essential probiotics traits

There are several criteria to be considered while selecting probiotic strains and are determined by *in vitro* tests. These are as follows.

Safety attributes: This is the one of the most essential traits to be considered and highly recommended by the US Food and Drug administration that probiotic must be 'Generally Recognized as Safe' (GRAS). Strains used for human products, should be of healthy human origin and not be associated with disease. Acid and bile salt tolerance for oral consumption is desirable for probiotic bacterium [7].

Functional attributes: *In vivo* and *in vitro* assays are to be established while considering functional aspects of probiotic strains. Probiotics must be able to withstand with the gastrointestinal tract harsh acidic and bile salt hydrolase conditions and should be able to multiply themselves. Human controlled studies should be conducted to reflect the results.

Technological attributes: Probiotic food production, processing and storage are also necessary criteria along with the safety and functional aspects to be fulfilled by the probiotics. At commercial scale, during food production, processing and storage results in the decrease in the viability of bacteria and hence reduces the shelf life of the product. Viable microorganisms in probiotic products impart good health beneficial effects and product must contain a minimum concentration of viable bacteria (10^6-10^7 cfu/g). It is claimed that at least 10^8 to 10^9 probiotic microorganisms should be consumed daily to provide a probiotic effect. However, many studies claimed that viability is not important factor for all probiotic affects, only a probiotic DNA and cell wall constituents may sometime impart good health effects. Therefore, during storage initially optimal growth is sufficient for some probiotic strains not the good viability [8].

Mechanism of action of probiotics

Probiotics exert their beneficial effects through several mechanisms as shown in Figure 1. First, they help restore the balance of gut microbiota by outcompeting harmful microorganisms for nutrients and adhesion sites on the intestinal lining. This competitive exclusion prevents pathogen overgrowth. Probiotics also modulate the immune system, enhancing both local and systemic immune responses, including the production of antibodies and activation of immune cells. They improve intestinal barrier function by strengthening tight junctions between epithelial cells, reducing gut permeability (often referred to as "leaky gut"). Additionally, probiotics produce bioactive compounds like Short-Chain Fatty Acids (SCFAs) during the fermentation of dietary fiber, which nourish gut cells and exert anti-inflammatory effects. They can also inhibit pathogen growth by producing antimicrobial substances like bacteriocins. Lastly, probiotics may influence the gut-brain axis, affecting mood and stress responses, further promoting overall health. Together, these actions contribute to digestive health and immune balance [9].

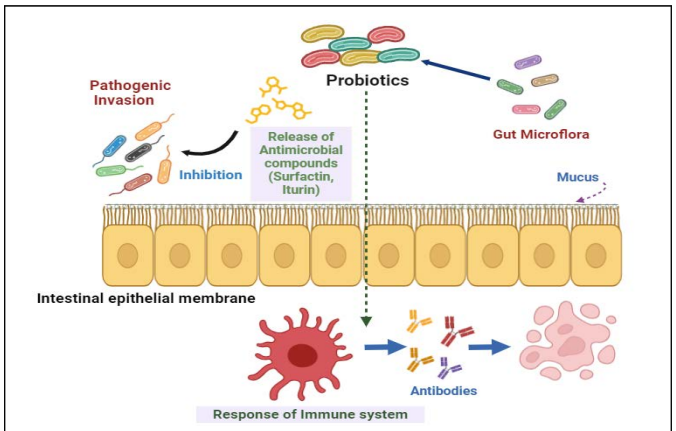


Figure 1: Mechanism of action of probiotics.

Probiotics as dietary products

Nowadays, consumers are more concerned and curious about their health due to change in routine lifestyle. They are more eager about to use health benefit providing food products and supplements. Therefore, agriculture and food industries are constantly working on developing healthcare related food products due to their greater demand in market. Probiotics has taken remarkable place in healthcare food products. Mostly, a wide range of probiotics food products are emerging and existing in market as dairy based and non-diary based fermented foods. Dairy based fermented foods included, fermented milks, buttermilk, yogurt, milk powder and ice creams and accounting for largest sale. A variety of juices, beverages, cereals, and nutritional bars became a part of soya based non-diary fermented foods. Due to greater demand of probiotic food products, therefore it became necessary to check on food quality

and added value food functionalities in order to deliver them safely to the customers. The effectiveness of probiotics in food products is defined by their compatibility with food matrix, viability in food processing, storage and packaging. Various food delivering technologies have been developed and growing to overcome the viability and stability problems encountered by bacteria *i.e.,* stress factor, temperature, pH, acid, bile, exposure to oxidative and osmotic pressure and GI passage transient time. Pharmaceutical formulations have evolved as effective delivery technology for probiotics such as capsules, powder beads, tablets and liquids. Immobilized and microencapsulation is the most protective technology has been developed to protect bacteria from harsh environment while delivering into the gut. Other technologies like dry probiotics straw system, viable spores and bifidobacteria antibiotics antimicrobial substances are being continuously be developing in probiotics delivery system.

Probiotics in health

Scientists reported various studies depicting beneficial health effects of probiotics to the human use. Research has exhibited in improvement of intestinal health, strengthening of immune system, cancer prevention and cholesterol reduction in serum. Particular probiotic strain is responsible for particular health properties. Although scientists have well documented various studies depicting the beneficial health effects, but more extensive research is required to explore the additional probiotic properties (Figure 2). Probiotics were reported to use in the treatment of various diseases such as, antibiotic associated diarrhea, inflammatory bowel disease, lactose metabolism and acute diarrheal diseases. Due to lack of sufficient evidences probiotics are restricted to use for another clinical indications.

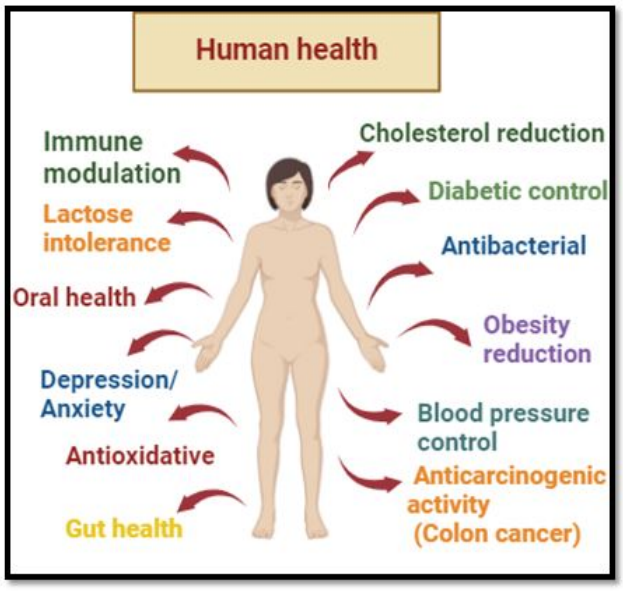


Figure 2: Probiotics in human health.

Probiotics in ulcerative colitis and Crohn's disease

It is evident that patients with inflammatory bowel disease have positive health benefits of using probiotics. Historically, during initial periods of 20th century, Alfred Nissle isolated bacterial strain of *Escherichia coli* (serotype 06: K5:H1) and characterized its therapeutic effects for human in maintaining ulcerative colitis remission. Efficacious effect of *Escherichia coli* Nissle 1917 and GOLD standard mesalazine therapy in maintaining ulcerative colitis remission were investigated by Rembacken et al. and found effective. Probiotic therapy including Nissle 1917 and VSL#3 strains were also investigated in patients with Crohn's disease and not found as robust effect in them maintaining remission. Nissle 1917 and VSL#3 strains were found to exert modest effect in patients with Crohn's disease.

In contrarily, the use of probiotic bacterium *Lactobacillus* GG in a placebo-controlled trial for the prevention of post-operative relapse in patients with ileocecal resection did not show the promising results. A meta-analysis of 23 clinical trial involving 1763 patients, showed a 23.3% increase in the remission rate in patients with active ulcerative colitis when using probiotics, but not in maintaining the remission rate. However, data is not sufficient for probiotic use in inflammatory bowel disease, but the effectiveness of treatments is being investigated since decades to current century.

Antibiotic related and infectious diarrhea

Antibiotic therapy resulted in the misbalancing of the normal microbial flora of the intestine and in return given rise to mild to severe antibiotic related diarrhea, due to the dominant growth of pathogenic strains replacing the normal microflora. *Clostridium difficile* infection emerges as dominant species after the use of antibiotics. Probiotics strains *L. rhamnosus* and *S. boulardii* were investigated for the treatment and prevention of antibiotic related and infectious diarrhea and contributed reduction in the infectious agents by preventing their adhesion to the gastrointestinal mucosal layer. It is reported that continuous use of probiotics for about 1-2 weeks from the first day of antibiotic use till the whole therapy prevented diarrhea.

A meta-analysis of 23 studies demonstrating the probiotic effect of strains *L. rhamnosus* or *Saccharomyces boulardii* in prevention of antibiotic-associated diarrhea in 3938 children was analyzed. Patients with C. *difficile* infection related diarrhea, who received probiotics from controlled group, had shown 11% decrease in risk of developing diarrhea along with the decrease in stool frequency and disease duration with speedy recovery.

Lactose intolerance (Beta-galactosidase deficiency)

Low levels of lactase enzyme activity affect the lactose metabolism, unable to hydrolyze lactose into its monosaccharide units *i.e.,* glucose and galactose. Beta-galactosidase deficiency is genetically determined condition of lactose intolerance and is being affected by the age, integrity of small intestinal membrane and transit time. Patients with lactose intolerance are unable to absorb lactose, degraded by bacterial enzyme after the consumption of milk and milk products and causes unpleasant symptoms such as bloating, abdominal cramps, nausea, and osmotic diarrhea. To overcome lactase enzyme inefficiency, probiotics have gained greater interest to treat the underlying condition for the restoration of normal lactase levels. Probiotics were reported to enhance lactose digestion in small intestine by

increasing the hydrolytic capacity and colonic fermentation. Studies were carried out, in order to establish probiotic use for the prevention and treatment of lactose intolerance. In the year of 2000 Rizkalla et al., studied the effect of live and heated *L. bulgaricus* and *Streptococcus thermophilus* strains in yogurt and claimed in the improvement of lactose metabolism in fresh yogurt. To evaluate the probiotic strain's effectiveness Segers et al had conducted a study and illustrated that, bacterial strains may be considered as potential probiotics if they have ability to withstand with the harsh conditions of gastric juice and are able to adhere with the intestinal mucus layer cells. This study with *L. rhamnosus* strain demonstrated the positive results and showed improvement is the symptoms of decrease in duration of diarrhea, relief in abdominal distention and strengthening of immune system.

Probiotics as adjuvant therapy in COVID-19

In early January 2020, a new RNA coronavirus belonging to the same family as Severe Acute Respiratory Syndrome (SARS-CoV) and Middle East Respiratory Syndrome (MERS-CoV) was identified and designated as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). It first appeared as a pneumonia outbreak in Wuhan, China, and quickly spread across the globe. World Health Organization (WHO) stated this condition as an emergency, named the disease Coronavirus Disease 2019 (COVID-19) and subsequently declared as pandemic. At present, several efficacious vaccines have been created and are accessible to people globally. However, the reduction in gut microbiota diversity and the presence of dysbiosis in COVID-19 patients did not revert to baseline levels even six months post-recovery and this persistent gut dysbiosis was associated with the severity of the illness and the inflammatory response. Researchers conducted possible adjuvant treatments with natural bioactive compounds, vitamins, and trace elements in coronavirus infected animal models. A study reported the use of *L. plantarum* strain, acting on the intestinal mucus, made it possible to prevent epithelial cell infection by coronaviruses in an animal model study. ACE receptors were reported as gateways for SARS-CoV-2 to attack GI cells and use of probiotics by producing bioactive peptides are already stated for ACE inhibitor. Therefore, probiotics were proposed as a potential blocker to the ACE receptor as a treatment approach against COVID-19 by Fernández-Fernandez.

Atopic indications and probiotics

Allergic reactions are life-threatening conditions which impart their unpleasing effects on the quality of life. About 20 percent of the population was expected to have various atopic indications, such as asthma, allergic rhinitis, atopic dermatitis, food allergy, and conjunctivitis. Disturbance in gastrointestinal microflora due to antibiotic use has been postulated to develop and raise in the risk allergies by promoting antiallergenic processes. Infants have been studied very less for the prevention and treatment of allergies. *L. rhamnosus* GG and *B. lactis* strains were studied in breast fed infants who were suffering from eczema and these strains were found effective in treating severe eczema. Many clinical controlled studies have reported promising results in treating food allergies and simultaneously preventing their symptoms. However, probiotics have not been found much effective in treatment of asthma. Probiotics were also studied for milk induced inflammatory symptoms in adults and reported to have good immune modulatory effects in reducing the milk related inflammatory response, despite of this evidence further research is needed in this area.

Probiotics in oral health

Regarding commensal oral microbes, several factors support the potential for identifying bacteria that may aid in preventing or treating oral diseases. Notably, some probiotic effects are believed to extend beyond a few well-studied strains and may be common across multiple species. The ecological plaque hypothesis suggests that changes in environmental conditions can shift the balance between oral health and disease. Since bacteria can influence their environment and exhibit both synergistic and antagonistic interactions within dental plaque, these environmental pressures could partially arise from bacterial activity. Additionally, the normal oral microbiota is well known to play a protective role against infections in the oral cavity. Furthermore, while certain bacterial species are associated with oral diseases, others appear to be linked to oral health. However, it remains uncertain whether bacteria delivered through food can significantly alter the relatively stable oral microbiota, particularly in adults. It is also important to note that the mechanisms discussed here are based on *in vitro* findings, and the clinical evidence primarily stems from short-term pilot studies.

Other probiotics related health benefits

Probiotics have been proposed for many indications, based on scientific studies providing good health benefit effects. Still there have been insufficient data for describing their inability to improve or cure some diseases. Some studies were found to report dysfunctions, alteration of metagenome in supporting disease by probiotic approach. *Lactobacilli* genera have been shown to have protective effects against gastrointestinal cancer *via* the production of toxic metabolites. *Bifidobacterium* spp. was also reported to reduce carcinogenesis as well as strengthening the host's immune system and producing antimutagenic organic acids. There are lists of other indications which have been evidenced to treat cure and prevent *via* probiotics therapy such as, coronary heart disease by reducing the cholesterol levels in serum and maintaining the blood pressure; obesity and diabetes by producing the short-chain fatty acids and being absorbed by mucosa allowing restoration of energy; and in women with bacterial vaginosis by supporting the normal growth of *Lactobacilli microflora*. Nevertheless, some evidences for probiotic effects are debatable, further more human related trials are needed to carry out for the use of probiotics in human health benefits.

CONCLUSION

Based on scientific evidences, it can be concluded that probiotics imparts various human health benefits and are effective practices to prevent and treat certain disease. But due

to lack of the sufficient data, probiotics are restricted to use for some indications. Lack of high-quality studies, variability of probiotic strains, microbial diversity and their response to modulation attempts are the reasons for their restricted recommendation in some diseases. There are well documented exhibits of probiotics use in inflammatory bowel diseases, antibiotic associated diarrhea, lactose intolerance, allergic disease and infectious diarrhea. Although probiotics use in the treatment of respiratory viral infection is not established, but many studies have suggested potential role of probiotics that can modulate immune system responses in order to improve the viral infections and balance the inflammatory responses. SARS-CoV-2 is novel coronavirus and to till date there are few effective drugs, vaccine and no other interventions (prebiotics and probiotic) to treat COVID-19 infection. So far, there are some ongoing clinical trial studies, investigating the efficacy of probiotics for the treatment of COVID-19 and patient segments.

In order to establish efficient probiotic strains; effective dosage and dose of greater efficacy for particular indications and patient segments, more extensive research in controlled human clinical trials is needed.

REFERENCES

1. Iqbal Z, Ahmed S, Tabassum N, Bhattacharya R, Bose D. Role of probiotics in prevention and treatment of enteric infections: A comprehensive review. 3 Biotech. 2021;11(5):242.
2. Peng Y, Horne DS, Lucey JA. Impact of preacidification of milk and fermentation time on the properties of yogurt. J Dairy Sci. 2009;92:2977–2990.
3. Jung MA, Lee SY, Han SH, Hong J, Na JR, Lee JY, et al. Hypocholesterolemic effects of *Curcuma longa* L. with *Nelumbo nucifera* leaf in an *in vitro* model and a high cholesterol diet-induced hypercholesterolemic mouse model. Animal Cells Sys. 2015;19(2):133-143.
4. Bajpai VK, Sharma A, Baek KH. Antibacterial mode of action of *Cudrania tricuspidata* fruit essential oil affecting membrane permeability and surface characteristics of food-borne pathogens. Food Control. 2013;32(2):582–590.
5. Tsai CC, Chan CF, Huang WY, Lin JS, Chan P, Liu HY et al. Applications of *Lactobacillus rhamnosus* spent culture supernatant in cosmetic antioxidation, whitening and moisture retention applications. Molecules. 2013;18(11):14161–14171.
6. Dou J, Feng N, Guo F, Chen Z, Liang J, Wang T, et al. Applications of probiotic constituents in cosmetics. Molecules. 2023;28(19):6765.
7. Das TK, Pradhan S, Chakrabarti S, Mondal KC, Ghosh K. Current status of probiotic and related health benefits. Appl Food Res. 2022;2(2):100185.
8. Rashmi B, Gayathri D. Molecular characterization of gluten hydrolysing *Bacillus* sp. and their efficacy and biotherapeutic potential as probiotics using Caco-2 cell line. J Appl Microbiol. 2017;123(3):759–777.
9. Davani-Davari D, Negahdaripour M, Karimzadeh I, Seifan M, Mohkam M, Masoumi SJ, et al. Prebiotics: Definition, types, sources, mechanisms and clinical applications. Foods. 2019;8(3):92.