



Probiotics and Their Applications

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In the industrialized world, functional foods have become an integral part of the daily diet, offering health benefits that extend beyond their conventional nutritional value. Among these, the most prominent and widely utilized compounds are probiotics and prebiotics, which, when combined, are referred to as synbiotics. Dairy products, already associated with a healthy image, serve as an excellent medium for the development of nutritious functional foods. Probiotic-enriched dairy foods provide multiple health benefits to the host by enhancing the survival and colonization of beneficial microorganisms in the gastrointestinal tract, selectively stimulating the growth or metabolic activity of health-promoting bacteria, and thereby improving the microbial balance within the gut. This article, therefore, reviews probiotics and highlights their potential applications.

Introduction

Microorganisms, such as bacteria, fungi, archaea, protists, plankton, and amoebae, are prevalent in our day-to-day lives. The most recent estimate is that about 38 trillion microorganisms live in and on human individuals and play a crucial role in stimulating the immune system, detoxifying potential toxins, and synthesizing vitamins and amino acids essential for cellular metabolic functions. Among all the genera of microorganisms, *Lactobacillus*, *Bifidobacterium*, *Escherichia coli*, *Clostridium*, *Streptococcus*, *Peptococcus*, *Ruminococcus*, *Fusobacterium*, *Bacteroidetes*, *Actinobacteria*, *Proteobacteria*, *Bacteroides*, and *Eubacterium* are dominant in the regulation of human metabolic homeostasis. Human gut microbiome diversity and abundance are significantly reduced when exposed to therapeutic leads like antibiotics, proton pump inhibitors, non-steroidal anti-inflammatory drugs, antacids, antidepressants, sleeping pills, laxatives, and statins. This is followed by changes in the metabolic activity of the host gut microbiota. The reduction or removal of these microbial flora causes toxic product accumulations that impair cellular processes and prevent vitamin synthesis, resulting in malnourishment and impairing the host system's anabolic and catabolic reactions, which are crucial for the regulation of the biological system. As a result, there is a growing variety in the market of probiotic-containing foods and supplements. In 2001, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) organized an expert meeting that resulted in the definition of probiotics as "live microorganisms that, when administered in adequate amounts, confer a health benefit on the host".

Probiotics-a brief introduction -Probiotic is a Greek word meaning "for life," coined by Lilley and Stillwell. Probiotics refer to microbes of non-pathogenic nature that are beneficial to their hosts. Probiotics have been in use for quite a long time as Romans and Greeks, the ancient civilizations developed fermented milk and used it as probiotics, even the bible mentions this sour milk so the concept of probiotics is not entirely new. Probiotics improve the microbial balance of the GI tract. The World Health Organization (WHO) defines probiotics as "Live microbes which confer a health benefit to their host when administered in

adequate amounts. *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, *Lactococcus*, and *Streptococcus* are most commonly used as probiotics.

Bacterial Strains Commonly used as Probiotics

Species of *Lactobacillus* and *Bifidobacterium* are most commonly used as probiotics. The yeast *Saccharomyces boulardii* and specific strains of *Streptococcus*, *Pediococcus*, *Leuconostoc*, *Bacillus*, *Escherichia coli* are also used as probiotics.

Lactobacillus

The genus *Lactobacillus* includes various Gram-positive facultative anaerobic or microaerophilic rod-shaped bacteria. They are a major part of the lactic acid bacteria (LAB) group that can convert hexose sugars to lactic acid. In humans, Lactobacilli are normally present in the vagina and gastrointestinal tract where they inhibit harmful bacteria by making acidic environments. Some Lactobacilli are used for the production of yogurt, cheese, sauerkraut, pickles, sourdough, wine, and other fermented products.

Lactobacilli species are commonly selected as probiotics since they express many crucial properties such as high tolerance to acid and bile, capability to adhere to intestinal surfaces, withstanding low pH of gastric juice, inhibiting potentially pathogenic species, resisting antibiotics, producing exopolysaccharides, and removing cholesterol. Studies have shown that certain strains of Lactobacilli are effective in preventing antibiotic-associated diarrhea, preventing recurrent UTI in adult women, etc. .

Bifidobacterium

Strains of the genus *Bifidobacterium* are also commonly used as probiotics either alone or in a cocktail with other probiotic bacteria. The genus *Bifidobacterium* includes various Gram-positive non-motile anaerobic bacteria. They are endosymbiotic inhabitants of the gastrointestinal tract and vagina of mammals, including humans.

Bifidobacterium species have been proven effective to treat constipation, travelers' diarrhea, antibiotic-associated diarrhea, food allergies, and cholesterol-lowering capacities.

Saccharomyces

S. boulardii has been used extensively as a probiotic, both as a dietary supplement and as a drug. *S. boulardii* is a live yeast and is available in a lyophilized form to treat diarrhea. Administration of *S. boulardii* has shown positive effects for patients with irritable bowel syndrome, recurrent pseudomembranous colitis, preventing and treating relapses of inflammatory bowel disease, and treating moderate symptoms of ulcerative colitis.

Saccharomyces boulardii fungemia secondary to use of the probiotic has been described for critically ill patients.

Streptococcus

S. thermophilus, also known as *Streptococcus salivarius* subsp. *thermophilus* is a gram-positive cocci of the group viridans streptococci. *Streptococcus thermophilus* is used as a starter culture for the production of yogurt alongside *Lactobacillus delbrueckii* subsp. *bulgaricus*).

Streptococcus thermophilus and *Lactobacillus delbrueckii* subsp. *bulgaricus* improve lactose digestion and reduce symptoms related to lactose intolerance.

Genus	Species
<i>Lactobacillus</i> spp	<i>acidophilus</i> , <i>rhannosus</i> , <i>fermentum</i> , <i>johnsonii</i> , <i>lactis</i> , <i>reuteri</i>
<i>Bifidobacterium</i> spp.	<i>breve</i> , <i>infantis</i> , <i>longum</i> , <i>bifidum</i> , <i>lactis</i> , <i>thermophilum</i>
<i>Bacillus</i> spp.	<i>coagulans</i>
<i>Streptococcus</i> spp.	<i>thermophilus</i>
<i>Enterococcus</i> spp.	<i>faecium</i>
<i>Saccharomyces</i> spp	<i>cerevisae</i>

Sources of Probiotics

The sources of probiotics are fermented food, unfermented food, and dietary supplements.

Fermented Food

Fermented food, obtained by the growth and metabolic activity of the cultural strains, contains live microorganisms. Fermented foods (such as yogurt, pickles, and so on) that contain organisms have health benefits. These organisms can survive for the entire duration of their shelf life in the product. They enhance gut microbiota and improve digestive and immune health. The most common probiotics are Lactic acid bacteria (LAB) and Bifidobacterium.

Unfermented Foods

Unfermented foods such as juices, nutrition bars, and so on also contain microorganisms, which can also be considered probiotics.

Dietary supplements

Dietary supplements such as capsules, powders, and so on contain a variety of mixed stains. It is taken as a medicine also. One of the probiotic medicines is bifilac. This medicine helps boost the immunity of the digestive tract, which enhances the ability to absorb nutrients from digested food. It also controls diarrhea and helps to balance the gut microflora, such as bacteria and yeast.

Mechanism of Action of Probiotics

Probiotics perform their function by competing with pathogens for nutrients and receptors for binding thereby making their survival and adherence to gut mucosa difficult. It produces anti-microbial substances which inhibit pathogens growth and promote epithelial barrier function by enhancing mucus production and increasing the expression of tight junction proteins which prevents the translocation of pathogens from intestine into the blood. Probiotics regulate immunity of the host by modulating maturation and function of dendritic cells subsequently increasing the activity of T cells which play important role in immune homeostasis and also regulate the production of neurotransmitters including serotonin, dopamine and gamma aminobutyric acid (GABA).

Applications of Probiotics

Probiotic in Medicine :Therapeutic Applications of Probiotics

Probiotics have diverse therapeutic applications across multiple systems of the body. In gastrointestinal health, they are widely used for the management of disorders such as antibiotic-associated diarrhea, where strains like *Lactobacillus rhamnosus* GG and *Saccharomyces boulardii* have proven effective, as well as in irritable bowel syndrome (IBS), where they help relieve symptoms such as bloating and abdominal discomfort. They also serve as adjunct therapy in inflammatory bowel diseases, including Crohn's disease and ulcerative colitis, and contribute to improved bowel movement in constipation and better lactose digestion in cases of lactose intolerance. In urogenital health, probiotics help restore vaginal flora after antibiotic use and prevent urinary tract infections, with strains such as *Lactobacillus crispatus* and *L. rhamnosus* being especially beneficial for women's health. Probiotics also play a vital role in oral health, where they help reduce dental caries, gingivitis, and halitosis; formulations like probiotic lozenges and toothpastes often use *Streptococcus salivarius* strains. Beyond local effects, probiotics modulate the immune system by enhancing mucosal immunity, stimulating the production of protective antibodies such as IgA, and thereby contributing to reduced risk of allergies and respiratory infections. More recently, attention has turned to their role in mental health through the gut-brain axis, where so-called "psychobiotics" may alleviate symptoms of anxiety, depression, and stress by modulating gut microbiota and influencing neurotransmitter production. Together, these applications highlight the broad therapeutic potential of probiotics in promoting overall health and disease management.

Probiotics in Agriculture

Also known as biofertilizers or plant probiotics, these beneficial microorganisms play a crucial role in enhancing plant growth and improving soil fertility. They perform key

functions such as nitrogen fixation, carried out by bacteria like *Rhizobium* and *Azospirillum*, and phosphate solubilization, mediated by strains of *Bacillus* and *Pseudomonas*. Additionally, they help suppress plant diseases by antagonizing harmful pathogens and produce plant growth-promoting substances, including indole-3-acetic acid (IAA) and siderophores. These biofertilizers are applied through methods such as seed treatment, soil inoculation, and foliar sprays, contributing to improved crop yield and quality. Their use also reduces dependence on chemical fertilizers, promoting eco-friendly and sustainable agricultural practices.

Probiotics in Veterinary Use

Probiotics are widely used in livestock to promote gut health, enhance growth, and improve disease resistance. In poultry, they support digestion, strengthen immunity, and help reduce the reliance on antibiotics. In cattle, probiotics aid rumen fermentation and enhance nutrient absorption, while in swine, they reduce gastrointestinal infections and promote growth. In aquaculture, probiotics improve gut microbiota in fish, leading to higher survival rates. Commonly used probiotic strains across livestock include *Lactobacillus*, *Bacillus*, *Enterococcus*, *Saccharomyces*, and *Streptococcus*. Their use results in improved feed efficiency, decreased mortality, reduced incidence of diseases, and a lower dependence on antibiotics, contributing to healthier and more sustainable livestock production.

Other Applications

In the food industry, probiotics are widely applied for the fortification of dairy products such as yogurt, kefir, and cheese, as well as in probiotic-enriched beverages, cereals, and snacks. They are integral to the development of functional foods and synbiotic products, which combine probiotics with prebiotics to enhance health benefits. In the pharmaceutical and nutraceutical sectors, probiotics are formulated into capsules, powders, and tablets for the prevention and management of gut-related and immune disorders. Additionally, custom probiotic formulations, designed to be strain-specific, are increasingly used to target particular health conditions, reflecting their growing importance in both nutrition and therapeutic interventions.

Conclusion

Probiotics are beneficial live microorganisms that, when consumed in adequate amounts, promote health and well-being, particularly in digestive and immune systems. They have diverse applications across medicine, agriculture, food, and veterinary science, supporting both human and environmental health. Probiotic-rich foods and supplements can serve as natural alternatives to drugs for certain conditions, especially gut-related disorders. However, their effectiveness is strain-specific, and they come with challenges such as viability, safety in vulnerable populations, and lack of standard regulation. With ongoing research and technological advances, probiotics hold great promise as functional ingredients in healthcare and sustainable agriculture.

References

1. Sarita, B. (2025). A comprehensive review of probiotics and human health. *Frontiers in Microbiology*. Frontiers
2. Latif, A. (2023). Probiotics: Mechanism of action, health benefits, and their applications. *Frontiers in Microbiology*.
3. Yue, T. (2025). The role of probiotics, prebiotics, synbiotics, and postbiotics in promoting gut health in livestock and poultry. *MDPI*
4. Gul, S. (2024). Health benefits of probiotics: A comprehensive review. PubMed