

Probiotics in Healthcare: From Gut Health to Systemic Effects - A Narrative Review

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ABSTRACT

Probiotics are live microorganisms that provide health benefits when consumed in sufficient quantities. Their scope has expanded from traditional fermented foods to include supplements with broad therapeutic potential. This article examines probiotics, along with prebiotics and postbiotics, covering their definitions, sources, and key characteristics like strain specificity, dosage (measured in colony-forming units, CFU), and survival in the gut through techniques such as microencapsulation. While probiotics are well-established for managing gastrointestinal conditions like antibiotic-associated diarrhea and irritable bowel syndrome, contemporary research reveals far-reaching systemic benefits. Their influence extends to the gut-brain axis, where they can improve cognitive function, mood, and sleep quality. They also modulate immune function by stimulating protective antibodies and anti-inflammatory pathways and can regulate skin health through the gut-skin axis, benefiting conditions like acne and atopic dermatitis. Despite their promise, practical application faces challenges, including regulatory inconsistencies and the fact that benefits are often strain-specific. This underscores the need for evidence-based guidance. Healthcare professionals, especially pharmacists, play a vital role in advising patients on the appropriate selection and use of probiotics to achieve specific, targeted health outcomes.

Keywords: probiotics, gut-brain axis, cognitive function, sleep, skin health, immunity

INTRODUCTION

Although the term probiotic was not introduced until 1953 by German scientist Werner Kollath, who defined probiotics as “active substances that are essential for a healthy development of life”, the use of probiotics dates back 10,000 years, to when humans first began producing fermented foods and beverages¹. For centuries, probiotics have been an integral part of human nutrition. In recent decades, probiotics have growing recognition, driven by scientific

advances that continue to expand our understanding of their health benefits.

The global probiotics market size was valued at USD 87.7 billion in 2023, with a projected Compound Annual Growth Rate (CAGR) of 14.1% from 2024 to 2030². Once primarily associated with digestive health, probiotics are now scientifically validated for their far-reaching impacts, from strengthening immune defenses and alleviating skin disorders to enhancing cognitive function and potentially mitigating neurodegenerative conditions.

DEFINITION OF RELATED TERMS

Prebiotics

Prebiotic, as defined by the International Scientific Association for Probiotics and Prebiotics (ISAPP) in 2008, is “a selectively fermented ingredient that results in specific changes in the composition and/ or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health”. Probiotics ferment and degrade prebiotics to obtain energy for survival, thereby modulating the composition and function of gut microbiota³. Most prebiotics are carbohydrate-based, primarily oligosaccharides, including fructans, galacto-oligosaccharides and polydextrose. Additionally, dietary bioactives such as polyphenols, carotenoids, and phytosterols, function as prebiotics by selectively nourishing beneficial gut bacteria⁴. Natural sources of prebiotics include asparagus, barley, onion, garlic, seaweed, beans, tomatoes and bananas³. Given their crucial roles in health maintenance, prebiotics are also manufactured industrially on a large scale³.

Probiotics

Although countless microorganisms exist in nature, only a small number qualify as probiotics. The Food and Agriculture Organization of the United Nations and the World Health Organization (FAO/WHO) define probiotics as “live microorganisms that, when administered in adequate amounts, confer a health benefit on the host”, which was reaffirmed by ISAPP in 2014⁵. The definition of probiotics

carries four key implications⁶:

1. Probiotics are microorganisms, which can be bacteria or other microbes. They must be alive when administered.
2. They need to be administered, typically via the oral route or other routes.
3. They must be present in sufficient amounts, meaning there should be at least as many viable microbes in the product at the end of its shelf life as were used in clinical studies.
4. They must confer a health benefit, which should be demonstrated in the target host population.

Postbiotics

In 2019, the ISAPP panel defined a postbiotic as a “preparation of inanimate microorganisms and/or their components that confers a health benefit on the host”⁷. Postbiotics consist of deliberately inactivated microbial cells, with or without their metabolites or cell components, that contribute to proven health benefits. They are generally classified into five main categories: enzymes, short-chain fatty acids, cell wall fragments, exopolysaccharides, and other metabolites, including organic acids and vitamins⁸.

PROBIOTICS & GUT MICROBIOTA

The human gastrointestinal (GI) tract hosts a dynamic and diverse ecosystem of microorganisms. The gut microbiota, a complex community comprising trillions of microbes (approximately 10^{14} bacteria representing 2,172 species), plays a vital role in regulating metabolism and maintaining host homeostasis⁹. This relationship is fundamentally mutualistic. While the human body provides nutrients and a stable environment, the gut microbiota reciprocates by contributing to nutritional processes and preserving the physiological health of the intestinal mucosa¹⁰. Alterations in its composition can cause a metabolic shift, leading to changes in the host's phenotype. The key to gut health is preserving a flexible, well-balanced microbial ecosystem in a stable intestinal environment¹¹. Such imbalances, known as dysbiosis, not only contribute to gastrointestinal disorders but are also strongly associated with dysfunction and diseases in other organ systems, including the brain, skin, lungs, kidneys, endocrine system, heart, and muscles¹¹.

Probiotics help maintain intestinal homeostasis via two primary mechanisms, 1. by promoting the growth of beneficial endogenous microbial populations and 2. through the competitive exclusion between probiotics and pathogenic bacteria for nutrients and ecological space, thereby inhibiting harmful bacterial growth while enhancing colonization of beneficial strains¹¹.

SPECIES OF PROBIOTICS

Probiotics are genetically classified and named according to their genus, species, and strain. The most commonly used microorganisms in probiotic formulations include species from the genera *Bifidobacterium*, *Saccharomyces*, *Streptococcus*, *Enterococcus*, *Escherichia*, and *Bacillus*. Below is a table demonstrating three representative

examples of this classification system :

Genus	Species	Strain
<i>Bifidobacterium</i>	<i>Lactis</i>	DN-173 010
<i>Lactobacillus</i>	Plantarum	DSM 13273
<i>Lactobacillus</i>	rhamnosus	GG

SOURCE OF PROBIOTICS

Historically, dietary probiotics were primarily obtained from fermented foods. They are produced through the metabolic activity of a variety of live microbial cultures. While yogurt often contains probiotic strains from *Bifidobacterium* or *Lactobacillaceae*, other fermented foods with live cultures, such as cheese, kimchi, miso, pickles and apple cider vinegar, do not necessarily contain clinically validated probiotic microorganisms. In recent years, probiotic supplements have gained significant popularity alongside traditional vitamin and mineral supplements. These probiotic formulations are commercially available in diverse delivery forms including capsules, powders, candies, and liquids, each offering various microbial strains and doses to meet different health needs.

PROPERTIES OF PROBIOTICS

Quantity of probiotics

Probiotic content is quantified in colony-forming units (CFU), representing the number of viable cells capable of proliferation and colony formation. The effective dosage varies significantly among different strains and indications, making it impossible to establish a universally recommended dose. Take the treatment of irritable bowel syndrome (IBS) as example, *Bifidobacterium longum subsp. longum* 35624 demonstrates efficacy in alleviating the symptoms of IBS at 100 million CFU/day while the effective dose of other probiotic products is 300–450 billion CFU administered three times daily. Therefore, dosage recommendations should always be guided by clinical studies demonstrating specific health benefits rather than generalized guidelines.

Since probiotics are live microorganisms, they are susceptible to loss of viability during transportation and storage. To compensate for this, manufacturers typically add extra amounts of probiotics to guarantee that the labeled potency is maintained throughout the product's shelf life¹⁴. Hence, the CFU amount indicated on the package should reflect the number available at the end of the product's shelf life, rather than at the time of manufacture. It is also important to note that a higher CFU count does not necessarily correlate with greater health benefits¹².

Probiotics & acidity of gastric juice

To exert their beneficial effects, probiotics must survive the passage through the acidic gastric environment so they can reach the large intestine in adequate amounts to colonize and proliferate¹⁵. However, most probiotics cannot survive in sufficient quantities due to the stomach's low pH¹⁶. Resistance to stomach acid and tolerance to bile salts are two fundamental properties of probiotics, enabling

them to survive in the small intestine with their presence¹⁷. Microencapsulation, the most common protective strategy, involves coating the probiotics with the minuscule capsule¹⁸ that shields them from various physical and chemical stresses (including humidity, heat, pH, and harmful substances¹⁹). Protective matrices such as alginate, chitosan, or cellulose derivatives help shield probiotics from gastric acid and enable their controlled release in the intestines²⁰.

Single- & multi-strain probiotics

The efficacy of probiotics can vary depending on whether they contain a single strain or multiple strains, with each formulation offering distinct advantages. Single-strain probiotics, such as *Lactobacillus rhamnosus* GG or *Saccharomyces boulardii*, have been well-studied for specific conditions, demonstrating targeted benefits such as reducing antibiotic-associated diarrhea²¹. In some cases, multi-strain probiotics may provide broader benefits due to synergistic interactions. For example, a mixture of *L. rhamnosus* GG and *B. lactis* Bb12 was significantly more effective than *L. rhamnosus* GG alone for eradicating *H. pylori*²².

PROBIOTICS AND HEALTH

Probiotics contribute to health maintenance, offering a wide range of benefits that extend far beyond their well-known role in gastrointestinal health. They exert profound effects on multiple physiological systems. As science continues to unravel the complex interactions between probiotics and human physiology, their role in preventive and therapeutic medicine appears to be increasingly significant.

Gut health

The gastrointestinal tract represents the largest microbial reservoir in the human body. The effects of probiotics on intestinal diseases are the most extensively studied. They exert multiple protective mechanisms by preventing pathogenic bacteria from adhering to the intestinal epithelium, stimulating production of inhibitory agents²³, enhancing local immune responses²⁴, and maintaining optimal short-chain fatty acid levels²⁵. Additionally, probiotics modulate immune function by suppressing proinflammatory cytokines²⁵, repairing intestinal permeability²⁶, inhibiting the growth of pathogenic bacteria through direct binding (particularly to gram-negative species)²⁷, and upregulating intestinal electrolyte absorption²⁴. Clinical evidence supports the therapeutic use of probiotics for several gastrointestinal disorders, including:

1. Acute Infectious Diarrhea

Clinical evidence demonstrates that probiotics are effective against acute infectious diarrhea of bacterial origin, though their efficacy against viral diarrhea remains inconsistent. A comprehensive Cochrane review analyzing 63 randomized controlled trials (RCTs) and quasi-RCTs involving 8,014 participants (including infants, children, and adults) reveals that probiotic supplementation reduces the average duration of diarrhea by 25 hours and decreases the likelihood of prolonged diarrhea (lasting for ≥ 4 days) by 59%²⁸.

2. Antibiotic-Associated Diarrhea, *Clostridium difficile* (*C. difficile*) Infection, and *C. difficile*-Associated Diarrhea

Probiotics show clinical efficacy in both preventing and treating antibiotic-associated diarrhea and preventing *C. difficile*-associated diarrhea across all age groups. A Cochrane analysis of 23 pediatric studies (3,938 participants) demonstrates significantly lower incidence rates of antibiotic-associated diarrhea in probiotic-treated groups versus controls²⁹. The studies also reveal a reduced risk of antibiotic-associated diarrhea, including *C. difficile*-associated diarrhea and culture-negative diarrhea, as well as significantly lower stool frequency, higher recovery rates, and a shorter mean duration of diarrhea³⁰.

3. Irritable Bowel Syndrome (IBS) and Functional Abdominal Pain

Evidence supports the moderate efficacy of probiotics for managing IBS symptoms in adults and children, as well as functional abdominal pain in pediatric populations. A guideline by the American College of Gastroenterology incorporating 23 clinical trials (2,575 participants) documents significant probiotic-mediated improvements in global IBS symptoms, bloating, and flatulence compared to placebo³¹. Similarly, pediatric meta-analyses confirm greater treatment success rates with probiotics versus placebo for both IBS and functional abdominal pain³².

4. Constipation

Probiotic interventions demonstrate therapeutic benefits for constipation in both pediatric and adult populations. In children, a small randomized controlled trial (n=59) reveals that Bifidobacterium-enriched yogurt outperformed conventional yogurt in improving defecation frequency while reducing abdominal pain and painful defecation³³. A meta-analysis involving 10 peer-reviewed studies shows that the substantial majority (70%) reports positive results in the treatment of functional and chronic constipation. However, the variability in probiotic strains, dosages, and study designs among the studies necessitates further investigation to establish the optimal regimen³⁴.

Cognitive function & Mood disorder

The enteric nervous system is often described as our “second brain”. The gut-brain axis (GBA) is a bidirectional communication network linking the gut microbiota to the central nervous system via pathways such as the hypothalamic-pituitary-adrenal (HPA) axis, autonomic nervous system (ANS), enteric nervous system (ENS), and central nervous system (CNS), forming a critical element of this axis. It is essential to note that this is an emerging field; the evidence base, while promising, requires replication in larger, more robust studies. Current research reveals that gut microbiota significantly influences this axis, with probiotics demonstrating considerable potential to enhance cognitive function through several interconnected mechanisms as follows:

- 1) Neurotransmitter modulation: Probiotics stimulate the production of gamma-aminobutyric acid (GABA)

and brain-derived neurotrophic factor (BDNF), both are essential for learning (spatial learning, extinction of conditioned fear, object recognition), memory processes and mood regulation. For example, *Lactobacillus rhamnosus* JB-1 has been shown to upregulate GABA receptor expression in the brain, hence reducing stress-induced corticosterone, and improving cognitive performance³⁸.

- 2) Reduction of neuroinflammation: Probiotics can address neuroinflammation, which is strongly associated with cognitive decline, neurodegenerative diseases, and mood regulation. Specific strains, such as *Bifidobacterium breve*, have been shown to decrease levels of pro-inflammatory cytokines (e.g. IL-6, TNF- α) in the hippocampus, thereby protecting against memory impairment³⁹ and mood disorders, including anxiety and depression⁴⁰.
- 3) Short-chain fatty acids (SCFAs) and brain health: SCFAs, particularly butyrate, are produced by probiotics and contribute to brain health by crossing the blood-brain barrier. They promote neuronal growth and neurogenesis, hence strengthen the brain's protective barriers by enhancing the expression of tight junction proteins that guard against neurotoxins⁴¹.

1. Alzheimer's Disease

In a small 12-week study (n=60), Alzheimer's patients receiving probiotics showed statistically significant improvements in Mini-Mental State Examination (MMSE) scores (cognitive assessment score) compared to control groups⁴². Furthermore, probiotic supplementation improved markers of oxidative stress in mild to moderate Alzheimer's cases, as shown by increased serum glutathione (GSH) and decreased levels of 8-hydroxy-2'-deoxyguanosine (8-OHdG) and malondialdehyde (MDA). Another small 12-week study (n=90) shows the additional benefits of better quality of life and greater physical activity among participants⁴³. While preliminary studies on probiotics and Alzheimer's disease show promising results, it is important to note that the findings come from relatively small-scale clinical trials. Until more robust evidence is available, probiotics should be considered an experimental rather than established therapeutic approach for Alzheimer's disease.

2. Mild Cognitive Impairment (MCI)

Two separate small 12-week investigations report that probiotic administration not only enhances cognitive performance but also improves sleep quality and gastrointestinal function in elderly MCI patients (n=42)⁴⁴. Moreover, computerized neurocognitive assessments identified significant improvements in overall cognitive function, with benefits in attention domains, when compared to placebo groups (n=100)⁴⁵. These cognitive enhancements were associated with increased serum BDNF levels and notable increases in *Lactobacillus* populations in the participants' gut microbiota.

3. Anxiety and Depression

Certain probiotic strains, often referred to as

"psychobiotics", appear to modulate neurotransmitter production, reduce inflammation, and improve gut barrier function. All these effects may influence mood and emotional regulation⁴⁶. A systematic review has shown that probiotics, particularly strains of *Lactobacillus* and *Bifidobacterium*, may improve symptoms associated with major depressive disorder by increasing serotonin availability and decreasing levels of inflammatory markers⁴⁷. Similarly, a small randomized controlled trial (n=10) reports that a multi-strain probiotic (containing *L. helveticus* R0052 and *B. longum* R0175) reduces anxiety and improves emotional processing in healthy participants⁴⁸. However, results are not uniform across all studies. A systematic review notes that while some trials show significant benefits, others report minimal effects, possibly due to differences in strain selection, dosage, treatment duration, and individual microbiome variability⁴⁹. For instance, *Lactobacillus rhamnosus* has been associated with reduced anxiety in animal studies but may not have the same effect in human populations³⁸. It is therefore critical to emphasize that probiotics should not be considered a standalone treatment for psychiatric disorders. They are not a replacement for established therapies such as psychotherapy, pharmacotherapy, or clinical management under professional supervision. Despite these promising findings, probiotics should not yet be considered a standalone treatment for anxiety or depression. Future research is required to identify the most effective strains and optimal treatment protocols for maximizing mental health benefits.

Sleep

The growing global prevalence of insomnia has spurred innovation in developing novel sleep support interventions. Current research reveals a clear association between poor sleep quality or quantity and gut microbiome dysbiosis. It is important to acknowledge that this area of research is emerging, and high-quality evidence from large randomized controlled trials (RCTs) remains limited. Probiotics have shown potential in improving sleep quality through various mechanisms, including the modulation of the gut-brain axis, production of sleep-promoting metabolites (interleukin (IL)-1 β , SCFAs, serotonin (5-HT), γ -aminobutyric acid (GABA) and melatonin), and reduction of stress responses and anxiety. Notably, some of the observed sleep benefits may be indirect, resulting from a probiotic-mediated reduction in general anxiety or physiological stress. Clinical evidence highlights specific strains from *Lactobacillus* and *Bifidobacterium* genera as particularly effective in improving sleep. Notable examples include *Lactobacillus casei* Shirota, which reduces morning sleepiness and prolongs sleep duration in academically stressed students, and *Lactobacillus gasseri* (administered as a postbiotic), which produces significant improvements in the Pittsburgh Sleep Quality Index (PSQI) scores, especially among male subjects⁵⁰.

The underlying mechanisms involve neurotransmitter production (e.g., GABA, serotonin), regulation of immune responses (e.g., reducing proinflammatory cytokines), and circadian rhythm regulation through microbial metabolites such as SCFAs and bile acids. For instance, recent studies demonstrate that SCFAs can promote non-rapid eye

movement (NREM) sleep, while certain probiotics appear to enhance relaxation and sleep onset by lowering cortisol levels⁵⁰. Moreover, the Epworth Sleepiness Scale (ESS) showed no statistically significant change after probiotic use, suggesting their selective effects on nighttime sleep quality without causing next-day drowsiness. However, the optimal probiotic strains, effective dosages, and required treatment durations for sleep support have yet to be firmly established.

Immunity

Two major breakthroughs in intestinal microbiology and immunology in recent years are: 1) the discovery that gut microbiota serves as primary modulators of the host's internal environment, and 2) evidence that both the composition and metabolic products of intestinal microorganisms exert substantial influence on the immune response⁵². Probiotics play a crucial role in strengthening both mucosal and systemic immunity. One key pathway involves stimulating the production of secretory immunoglobulin A (sIgA), which are proteolytically resistant antibodies that prevent pathogenic adhesion to the intestinal epithelium. Probiotic strains including *Lactobacillus casei* and *Bifidobacterium breve* have been shown to enhance sIgA production via interactions with gut-associated lymphoid tissue (GALT)¹⁰, thereby reinforcing antimicrobial defenses. While these mechanisms are well-supported by in vitro and animal research, confirming their translation into reliable and predictable effects in humans requires further clinical validation.

Probiotics also exhibit sophisticated immunomodulatory capabilities by simultaneously promoting anti-inflammatory cytokines (such as IL-10) and inhibiting pro-inflammatory mediators (such as TNF- α and IL-6). Specific strains, like *Lactobacillus rhamnosus* GG, demonstrate efficacy in supporting regulatory T-cell (Treg) activity, thereby maintaining immune homeostasis and preventing excessive inflammatory responses¹⁰. Individual variation including genetics, baseline microbiome composition, and immune status can significantly influence the responsiveness to these immunomodulatory effects.

The immunomodulatory effects extend to microbial metabolites, particularly SCFAs, such as butyrate. They are produced by intestinal microorganisms that can enhance the epithelial barrier function by reaching the other organs and acting on antigen-presenting cells, hence reduce the inflammation in related diseases⁵². They also increase antimicrobial peptides, which help fight a wide range of harmful pathogens. The results of multiple studies confirm the beneficial effect of probiotic microorganisms on the balance of the intestinal microbiome and the production of metabolites⁵⁴.

Probiotics have also been found to reduce both the incidence of acute respiratory tract infections and the need for antibiotics⁵⁵. A systematic review of 9 studies shows that the oropharyngeal probiotic *Streptococcus salivarius* K12, which colonizes the oropharyngeal mucosa, may help reduce the occurrence and/or severity of acute otitis media and secretory otitis media in children. Another systematic review of 4 articles (n=1846) reveals that *S. salivarius* K12's can significantly reduce the occurrence of streptococcal

pharyngitis, further highlighting the broad immunological benefits conferred by probiotic supplementation⁵⁷. These collective findings reinforce the crucial relationship between probiotic microorganisms, their metabolic byproducts, and comprehensive immune system regulation.

Skin

Building upon the well-established gut-brain axis, researchers have identified a similar gut-skin axis which connects intestinal microbiota to skin health. When the intestinal microbiota becomes imbalanced, it may lead to autoimmune and inflammatory conditions that affect not only the gastrointestinal tract, but also distant organs, including the skin⁵⁸. It is important to acknowledge that the current evidence, while promising, is primarily based on small-scale, preliminary studies, and larger, high-quality trials are needed to confirm these relationships. Increasing evidence indicates that the intestinal microbiome is closely related to common skin diseases⁵⁹. In addition to oral probiotics, topical probiotic formulations have emerged as effective therapeutic options for various skin conditions. The optimal formulation strategy—oral, topical, or a combination—for specific skin conditions remains an active area of investigation. The following section focuses on the effects of probiotics on the two common skin disorders: atopic dermatitis and acne vulgaris.

1. Atopic dermatitis

Atopic dermatitis, a common chronic inflammatory skin disease, has been strongly linked to alterations in the gut microbiome. Clinical observations reveal that patients with atopic dermatitis typically exhibit reduced populations of intestinal *Bifidobacterium* compared to healthy individuals, with its level inversely correlated with the disease severity⁵². Besides, therapeutic approaches of atopic dermatitis focus on barrier restoration⁶⁰, which can be achieved by topical probiotic formulations. In a small randomized, double-blind split-body clinical trial with patients with atopic dermatitis (n=28), emollients containing *Lactobacillus* is found to suppress the proliferation of *Staphylococcus aureus*, offering mechanical protection and symptomatic relief in patients with atopic dermatitis⁶¹. Oral ingestion of certain probiotic strains has also been shown to improve the skin barrier, enhance skin hydration, and reduce transepidermal water loss. A small randomized, double-blind, placebo-controlled study (n=64) investigating the effects of oral supplementation with *L. paracasei* NCC2461 reveals improvements in both skin sensitivity and skin barrier function in the probiotic group. The probiotic group also shows an increase in serum concentration of TGF- β , a cytokine crucial for maintaining skin integrity, after 29 days, while there is no increase in the placebo group⁶².

2. Acne vulgaris

Acne vulgaris, another common skin disease, shows connections to dysfunction of the gut-skin axis. Probiotic interventions have demonstrated therapeutic potential by modulating systemic immune responses beyond the intestines, extending its effect

to skin health⁶³. Specific strains, such as *Lactococcus* sp. HY449, exhibit direct antimicrobial activity against *P.acnes* through the production of antimicrobial proteins⁶⁰. Increasing evidence suggests that probiotics also modulate the skin's mechanical barrier and increase antimicrobial peptides production. For instance, the lactic acid bacterium, *Streptococcus thermophiles*, promotes the synthesis of ceramide, which helps retain water in the skin and increases certain ceramide sphingolipids, including sphingomyelin. These sphingolipids enhance skin hydration and possess intrinsic antibacterial properties against acne-causing bacteria, such as *Cutibacterium acnes*⁶⁴. Such probiotic approaches offer promising alternatives to conventional acne treatments, which often compromise skin barrier through excessive drying and irritation⁶⁴.

PRECAUTIONS & CONSIDERATIONS

Limitations of probiotics

Despite substantial research supporting the therapeutic benefits of probiotics for various health conditions, neither the European Food Safety Authority (EFSA) nor the U.S. Food and Drug Administration (FDA) has approved any health claims regarding their ability to prevent or treat medical conditions⁶⁵. The principal reasons EFSA has denied approval of probiotic health claims include insufficient characterization, undefined or nonbeneficial claims, lack of relevant human studies, lack of measurable outcomes that reflect direct benefits for humans, and poor quality of the presented studies. An additional challenge is the strain-specific nature of probiotic effects, where benefits demonstrated by one strain cannot be extrapolated to others, even within the same species⁶⁶. Furthermore, the current marketing landscape, where probiotic products are often promoted directly to consumers without clear evidence of clinical efficacy, presents significant regulatory challenges. This practice risks disseminating misleading information and highlights the critical need for healthcare professionals to provide evidence-based guidance on the appropriate use of probiotics¹⁰.

Safety of probiotics

The safety profile of most probiotic strains is well-established through rigorous evaluation systems. The Qualified Presumption of Safety (QPS)⁶⁷ was developed by EFSA as a safety assessment approach for microorganisms intended for use in food or feed chains; it is a list of microbes, including bacteria, yeasts, filamentous fungi, and viruses, deemed safe for use in foods. Most bacterial species used as probiotics have obtained QPS status. In addition, probiotics are described as "generally recognized as safe (GRAS)" by the FDA¹⁰. Since the safety of probiotics is well established in most research, there is no contraindication. However, certain high-risk groups, including immunocompromised individuals, elderly patients, and those with short bowel syndrome, should consult healthcare providers before use⁶⁸, since a systematic review of 17 studies, including 1530 patients with cancer, found 5 cases of probiotic-related bacteremia, fungemia, or positive blood culture⁶⁹.

PHARMACISTS' ROLE IN THE COUNSELLING OF PROBIOTICS

While probiotics can be used in clinical treatments, they are more commonly available as over-the-counter supplements in Hong Kong⁷⁰. Pharmacists can play a significant role in assisting patients to make informed decisions regarding the selection of probiotics products by providing individualized recommendations, as there is no one-size-fits-all approach to supplements. Patients should be reminded that the effectiveness of probiotics can be species, dose, and disease specific⁶⁹. According to ISAPP guidance, probiotic product labels should disclose the all the genus, species, and strain in the product⁶⁶. Pharmacists can help patients choose products with clear strain identification and select strains that address their desired health outcomes. Additionally, pharmacists should remind consumers to use probiotic products before the "use-by" date, as the CFU count may decline over the product's lifespan.

Moreover, the beneficial effects of probiotics may diminish within days to weeks after discontinuation, depending on the strain, dosage, duration of use, and individual factors such as gut microbiota composition. Pharmacists should remind patients that continuous probiotic intake may be necessary for maintaining sustained effects. However, in rare cases, some individuals, known as "persisters", can retain specific strains, such as *Bifidobacterium longum* for at least 166 days⁷².

CONCLUSION

Probiotics have evolved from traditional dietary components to scientifically validated potential therapeutic agents, demonstrating remarkable potential across diverse areas of health. The growing evidence supporting their roles in immune modulation, skin health, and cognitive function suggests that we are only beginning to understand their full therapeutic potential. However, as with any intervention, proper strain selection, dosage and quality control remain crucial for optimal results. As we move forward, probiotics will likely play an increasingly important role in both maintaining wellness and managing disease, offering a natural, safe, and effective complement to conventional medical therapies.

Author's background

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