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Diverse applications of probiotics in health and disease

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Abstract

Probiotics play diverse roles in promoting health and well-being, encompassing gut microbiota balance, digestive health, immune function, gut barrier integrity, metabolic health, and mental well-being. With the beneficial effects of probiotics, individuals may improve their gastrointestinal health, boost immune function, and reduce the risk of various diseases. These probiotics compete with pathogens and support gut and immune homeostasis to help in the prevention and cure of gastrointestinal disease, immune disorders, diabetes, obesity, cancer and allergic disorders, etc. Probiotic-rich foods and supplements into the diet offer a proactive approach to maintaining overall health and optimizing the functioning of the gut. Probiotics help to maintain immune homeostasis and decrease the risk of inflammatory disorders and allergic conditions. Several probiotic strains are available on the market and are being consumed in the form of foods, supplements, or drugs for health benefits. Lactobacilli, Bifidobacteria, and *Bacillus* species are common probiotic strains.

Keywords: Probiotics; Health; Microbiota; *Lactobacillus*; *Bifidobacterium*

1. Introduction

Elie Metchnikoff pioneered the concept of modulating gut microbiota by replacing harmful microbes with beneficial ones[1]. The majority of beneficial microbes are Lactic acid-producing bacteria, including *Lactobacillus* and *Bifidobacterium*. These beneficial microbes (probiotics) represent a fascinating ecosystem nestled within our gastrointestinal tract, comprising a diverse array of microorganisms that play pivotal roles in maintaining our health and well-being. These microorganisms, predominantly bacteria but also including fungi and other organisms, form a dynamic community that interacts with our body in multifaceted ways[2]. Probiotics work by maintaining a delicate balance of different types of microbes in our gut. This balance is essential for keeping our gut healthy and our body functioning well. Some microbes are good for us, while others can cause problems if they outnumber the good ones. These microbes affect various aspects of our health, such as digestion of food, absorption of nutrients, fight off illnesses and promote good health[2, 3].

One of the primary functions of probiotics is to aid in the breakdown of the complex nutrients and its absorption. These microorganisms help break down complex carbohydrates, proteins and fats into simpler forms that can be more easily absorbed by the body. Additionally, probiotics produce enzymes that facilitate the digestion process and enhance nutrient absorption. By promoting efficient digestion, probiotics contribute to overall metabolic health and energy production[2, 4]. Beyond digestion, probiotics also play a vital role in maintaining a robust immune system. The gut is home to a significant portion of our immune cells and probiotics help to regulate immune activities by influencing the development and functioning of these cells. Certain strains of probiotic bacteria have been shown to stimulate the production of antibodies, enhance the function of immune cells, and modulate inflammatory responses. By supporting

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a healthy immune system, probiotics protects against infections and may reduce the risk of chronic inflammatory conditions[5].

Emerging researches have revealed the intricate connection between the gut and brain, often referred to as the gut-brain axis. Probiotics are believed to influence brain function and mental health through this axis with implications for conditions such as anxiety, depression, and cognitive function. The communication between gut microbes and the central nervous system is mediated by various pathways, including the production of neurotransmitters and inflammatory molecules. By modulating these pathways probiotics may have profound effects on mood, behavior, and cognitive function. In addition to their role in maintaining health, probiotics have garnered attention for their potential therapeutic applications in managing various diseases. Clinical studies have demonstrated the efficacy of certain probiotic strains in treating gastrointestinal disorders such as irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and infectious diarrhea. Probiotics may help alleviate symptoms such as abdominal pain, bloating, and diarrhea, while also promoting gut healing and reducing inflammation[6, 7, 8].

Probiotics have shown promising role in supporting metabolic health and mitigating of the risk of metabolic disorders such as obesity and type II diabetes. Studies reported that some probiotic strains can modulate gut hormones involved in appetite regulation, leading to reduced food intake and improved weight management. Probiotics may help in regulating blood sugar levels and improve sensitivity to insulin, key factors in the development of diabetes. The potential applications of probiotics extend beyond gastrointestinal and metabolic health to include dermatological conditions, respiratory infections, and even oral health. Probiotic supplements and fermented foods containing beneficial microbes have been explored for their role in promoting skin health, enhancing immune responses to respiratory infections, and preventing oral health conditions such as dental caries and gum disease.

However, it's essential to recognize that not all probiotics are same in their properties and actions, and their efficacy depends on the strain, dosage, and individual response of the probiotic candidate [9, 10]. Probiotics are not a panacea, and their benefits should be viewed in the context of a holistic approach to health, including diet, lifestyle, and medical management when necessary [11, 12].

2. Common source of probiotics

Probiotics are live microorganisms that confer health benefits when consumed in adequate amounts[13]. These probiotic bacteria and yeasts are naturally present in certain foods and are also found in various dietary supplements. Understanding the sources of probiotics is essential for incorporating these beneficial microorganisms into diet to promote gastrointestinal health and overall well-being[9].

2.1. Human Gut

The human gut serves as a rich source of beneficial microorganisms (probiotics), which contribute to gut health and overall well-being. These beneficial microbes naturally inhabit the gastrointestinal tract, where they play crucial roles in digestion and absorption of nutrient, immune function, and the maintenance of eubiosis. These organisms can be found in various parts of the digestive system, including the stomach, small intestine, and large intestine. The common genera of beneficial bacteria found in the gastrointestinal tract of human include *Lactobacillus*, *Bifidobacterium*, and *Bacillus* among others[14]. These bacteria have been extensively studied for their health-promoting properties and their potential use as probiotic through supplements of functional foods.

The human gut microbiota is highly dynamic and influenced by external factors such as diet, lifestyle, medications, and environmental exposures. Homeostasis of gut microbiota is associated with better health outcomes, while dysbiosis have been linked to various gastrointestinal disorders, metabolic diseases, and immune dysfunctions[15]. Probiotics from the human gut offer several advantages, including potential compatibility with the recipient's existing gut microbiota and increased likelihood of survival and colonization in the gastrointestinal tract[9]. However, the use of human gut-derived probiotics may raise concerns about safety and the transmission of potential pathogens. Therefore, rigorous screening, characterization, and safety assessment are essential steps in the development and utilization of human gut-derived probiotic products[16].

2.2. Fermented Foods

Fermented foods are the natural sources of probiotics, as they undergo a natural fermentation process that promotes growth of beneficial microorganisms. The fermented foods such as curd, yogurt, kefir, sauerkraut, kimchi, miso, tempeh, and kombucha are rich source of probiotics. These traditional foods have been consumed for centuries in various cultures and are prized for their probiotic content and potential health benefits. For instance, yogurt and kefir contain

strains of *Bifidobacterium* and *Lactobacillus*, while fermented vegetables like sauerkraut and kimchi harbour diverse microbial communities that contribute to gut health[17, 18]. Homemade fermented foods are important source of probiotic, prepared using traditional fermentation techniques. Fermented foods prepared at home allow individuals to regulate the ingredients and fermentation process, ensuring that the live probiotic cultures are present. By fermenting foods at home, individuals can customize the flavours and probiotic content to suit their preferences while reaping the health benefits of these probiotic-rich foods[19].

2.3. Dairy Products

Dairy products such as milk, cheese, yogurt, kefir, and certain types of cheese serve as excellent sources of probiotics. These products are consumed directly or processed by fermenting with specific strains of lactic acid bacteria, which convert lactose into lactic acid through fermentation. The resulting acidic environment promotes the growth of probiotic bacteria while inhibiting the growth of harmful bacteria. Yogurt, in particular, is often fortified with probiotic strains such as *Lactobacillus acidophilus*, *Lactobacillus casei*, and *Bifidobacterium bifidum*, making it a convenient and accessible source of probiotics[20].

2.4. Probiotic Supplements

In addition to natural sources, probiotics are also available in the form of dietary supplements. Probiotic supplements typically contain concentrated doses of specific probiotic strains, often in the form of capsules, tablets, or powders. These supplements may be formulated with single strains or combinations of multiple strains, depending on their intended use and target health benefits. Common probiotic strains found in supplements include *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Bifidobacteriumbifidum*, and *Saccharomyces boulardii* etc. Probiotic supplements offer a convenient way to increase probiotic intake, especially for individuals who may not consume fermented foods regularly or who have specific health concerns[21, 22]

2.5. Probiotic-fortified foods and beverages

In recent years, there has been a growing trend toward fortifying foods and beverages with probiotics to enhance their health-promoting properties. Manufacturers may add probiotic strains various products, including dairy products, dairy alternatives (e.g., soy milk, almond milk), cereals, granola bars, juices, and even chocolate. These fortified products provide consumers with additional options for incorporating probiotics into their diet, particularly for those who may have dietary restrictions or preferences that limit their consumption of traditional fermented foods[22, 23].

3. Application of probiotics

Probiotics have potential therapeutic applications and optimizing their use may support the overall health of an individual.

3.1. Gut homeostasis

One of the primary and most important roles of probiotics is to maintain a healthy balance within the gut microbiota, the complex community of microorganisms residing in the gastrointestinal tract. Probiotics help to promote the growth of beneficial bacteria such as Bifidobacteria and Lactobacilli while inhibiting the proliferation of harmful pathogens. By modulating the diversity and composition of the gut microbiota, probiotics contribute to gastrointestinal health, immune function, and metabolic balance [24].

3.2. Digestive Health

Probiotics play a vital role in supporting digestive health by aiding in the breakdown and absorption of nutrients, promoting regular bowel movements, and alleviating symptoms of gastrointestinal disorders. The set of enzymes produced by these beneficial microorganisms assist in the digestion of proteins, carbohydrates, and fats, facilitating nutrient absorption and reducing digestive discomfort. Probiotics also help maintain bowel regularity by encouraging the growth of beneficial bacteria and inhibiting the growth of pathogenic organisms, thus preventing conditions such as constipation, diarrhea, and irritable bowel syndrome (IBS) [25].

3.3. Immune function

Probiotics exert immunomodulatory effects that enhance the immune system and promote immune tolerance. These beneficial microorganisms interact with immune cells in gut-associated lymphoid tissue (GALT), stimulating regulatory T cells and anti-inflammatory cytokines production while suppressing pro-inflammatory responses. By modulating immune function, probiotics help to maintain immune homeostasis, reduce the chance of infections, and alleviate

symptoms of inflammatory conditions like inflammatory bowel disease (IBD) and allergic reactions[11, 26]. Multiple studies investigating the impact of probiotics on immune function concluded that probiotic supplementation was associated with enhanced immune responses, reduced incidence of infections[27, 28]. The prevalence of immune-related disorders underscores the potential of probiotics as a preventive and therapeutic strategy. Several studies reported the effects of probiotics on various immune parameters, including cytokine levels, immune cell activity, and antibody production[29].

3.4. Gut barrier integrity

Probiotics contribute to the maintenance of gut barrier integrity, which plays a critical role in preventing the translocation of harmful substances from the gut lumen into systemic circulation. These beneficial microorganisms reinforce the gut barrier by promoting the production of mucin, a protective layer that lines the intestinal epithelium, and by regulating the of tight junction protein expression that control intestinal permeability. By enhancing gut barrier function, probiotics reduce the risk of leaky gut syndrome and associated inflammatory responses[29, 30].

3.5. Metabolic health

Emerging research suggests that probiotics may play a role in supporting metabolic health and reducing the risk of metabolic disorders such as obesity and type 2 diabetes. Certain probiotic strains have been shown to influence energy metabolism, appetite regulation, and insulin sensitivity, potentially contributing to improved weight management and blood sugar control. Probiotics can produce short-chain fatty acids (SCFAs) through the fermentation of dietary fibre, which have beneficial effects on metabolism, immune function, and gut health[30].

3.6. Mental well-being

There are growing evidences to suggest that probiotics may influence mental well-being and cognitive function through the gut-brain axis, a bidirectional communication pathway between the gut and the brain. Probiotics can modulate neurotransmitter production, reduce systemic inflammation, and influence stress responses, thereby exerting positive effects on mood, behavior, and cognitive function. Although research is needed to elucidate the mechanisms underlying these effects, preliminary studies suggest that probiotics may have potential therapeutic applications in managing mood disorders such as anxiety and depression[31].

3.7. Urinary tract infection

Probiotics can compete with and inhibit the growth of pathogens like *Escherichia coli* which are common causes of UTIs. By colonizing the urogenital tract, probiotics may prevent the adhesion and colonization of uro-pathogens, reducing the risk of infection. Modulating Immune Response: Probiotics have been shown to modulate the immune response in the urinary tract, enhancing the body's natural defences against UTIs. They can stimulate antimicrobial peptides and cytokines production, which help fight off invading pathogens and promote tissue repair. UTIs are often associated with imbalance of the urogenital microbiota. Probiotics can restore this balance by replenishing beneficial bacteria and maintaining microbial homeostasis. This may help prevent the overgrowth of pathogens and reduce the recurrence of UTIs[32].

Studies proposed that probiotics may enhance the efficacy of antibiotics in treating UTIs. By restoring microbial balance, probiotics can improve the efficiency of antibiotic therapy and reduce chance of recurrent infections[33]. Probiotics reduces UTI symptoms and frequency of recurrent infections, particularly in susceptible populations such as women and elderly individuals. Studies have shown that regular consumption of certain probiotic strains, such as *Lactobacillus rhamnosus* and *Lactobacillus reuteri*, may reduce the incidence of UTIs by promoting urinary tract health and bolstering the body's natural defenses. Oral probiotic supplements, probiotic-rich foods like yogurt, kefir, and fermented vegetables may also confer benefits for UTI prevention and management. These foods contain live cultures of beneficial bacteria that can colonize the gut and potentially migrate to the urogenital tract, where they exert their protective effects [32]. The probiotics offer promising potential for UTI management, individual responses may vary, and not all probiotic strains may be equally effective. Moreover, probiotics may use as part of a comprehensive approach that includes proper hygiene practices, adequate hydration, and appropriate medical treatment when necessary[33].

3.8. Bacterial vaginalis

The normal bacteria found in the vagina serve a protective role by utilizing glycogen from vaginal epithelial cells. It is influenced by oestrogen levels. Lactobacilli convert this glycogen into lactic acid, helping to maintain an acidic vaginal pH. An abnormal pH level above 4.2 can occur due to various factors such as injury, low oestrogen levels, menstruation etc. In healthy women, the vaginal microbiota is typically dominated by Lactobacilli species[34]. Antimicrobial treatments

for urogenital infections may not always be entirely effective, and issues can arise due to bacterial resistance, yeast infections, recurrent infections, and side effects associated with their use. The use of antimicrobial therapy in the vagina can disrupt the natural balance of microorganisms, making it more susceptible to colonization by pathogens. This disruption increases the risk of recurrent infections. Therefore, considering the use of probiotics to restore the population of beneficial microbes is a potential strategy to reduce the risk of re-infection[35].

3.9. Obesity

Probiotics have been studied for their potential role in obesity management and prevention. Probiotic strains may influence body weight and fat metabolism through various mechanisms. Probiotics may affect appetite-regulating hormones such as leptin and ghrelin, leading to reduced food intake and decreased appetite. This may contribute in management of weight by promoting feelings of fullness and satiety[36]. Probiotics can alter the diversity and abundance of gut microbiota, which may influence energy metabolism and fat storage. By promoting beneficial bacteria and inhibiting harmful bacteria, probiotics may help maintain a healthy gut environment conducive to weight regulation[24]. Chronic low-grade inflammation is associated with obesity and metabolic disorders. Probiotics have anti-inflammatory properties and may help mitigate inflammation in the gut and systemic circulation, thereby improving metabolic health and reducing the risk of obesity-related complications[37]. Regulation of Lipid Metabolism: Some probiotic strains have shown to regulate lipid metabolism by increasing the breakdown of dietary fats, inhibiting fat absorption, and promoting the excretion of cholesterol. These effects may contribute to the prevention of weight gain and the management of obesity[38]. Probiotics may enhance insulin sensitivity and glucose metabolism, leading to better blood sugar control and reduced risk of insulin resistance, a hallmark of obesity and type 2 diabetes[39]. Probiotics should be used as part of a comprehensive approach to obesity management, including a balanced diet, regular physical activity, and lifestyle modifications[37, 40]. Consulting with a healthcare professional is recommended before starting any probiotic regimen for weight management purposes

3.10. Hypocholesterolaemia

Probiotics have been investigated for their potential role in managing hypocholesterolaemia, or low cholesterol levels. Certain probiotic strains may influence cholesterol metabolism and contribute to maintaining healthy cholesterol levels through several mechanisms. Probiotics may modulate the activity of enzymes involved in cholesterol synthesis in the liver, leading to a reduction in cholesterol production. By inhibiting the synthesis of cholesterol, probiotics may help lower blood cholesterol levels in individuals with hypercholesterolemia. Probiotics can influence the metabolism of bile acids, which play a crucial role in cholesterol absorption and excretion. By promoting the conversion of cholesterol into bile acids and enhancing bile acid excretion, probiotics may help lower circulating cholesterol levels[41]. Some probiotic strains have been shown to bind to dietary cholesterol in the intestines, preventing its absorption into the bloodstream. By sequestering cholesterol in the gut lumen, probiotics may reduce cholesterol absorption and promote its excretion in the faeces. Probiotics can alter the composition and function of the microbiota of the gut, which may indirectly influence cholesterol metabolism. By promoting the growth of beneficial bacteria and inhibiting the growth of harmful bacteria, probiotics may create a gut environment that is conducive to maintaining healthy cholesterol levels. Chronic low-grade inflammation is associated with dyslipidaemia and cardiovascular disease. Probiotics have anti-inflammatory properties and may help reduce systemic inflammation, which can contribute to improvements in lipid profiles and overall cardiovascular health[42]. Probiotics should be used as part of a comprehensive approach to lipid management, including dietary modifications, exercise, and lifestyle interventions. Individuals with hypocholesterolaemia should not rely on probiotic supplementation regimen as it is a dietary supplement only and not a treatment. The individual should consult doctor and undergo proper treatment.

3.11. Oral health

Probiotics have emerged as promising agents for promoting oral health and preventing various oral diseases. These beneficial microorganisms, primarily bacteria such as *Lactobacillus* and *Bifidobacterium*, exert their effects through several mechanisms within the oral cavity. One of the key roles of probiotics in oral health is their ability of inhibiting the growth of pathogenic bacteria that contribute to dental caries, periodontal disease, and other oral infections. Probiotic bacteria produce antimicrobial substances such as organic acids, hydrogen peroxide, and bacteriocins which create an unfavourable environment for the growth of pathogens like *Streptococcus mutants* and *Porphyromonasgingivalis*. The competition for nutrients and adhesion sites, help probiotics to prevent the colonization and proliferation of pathogenic bacteria on the surfaces of teeth and gums. It support the maintenance of a balanced oral microbiota by promoting the growth of beneficial bacteria and inhibiting the overgrowth of harmful species. By modulating the microbial composition of dental plaque and saliva, probiotics contribute to a healthier oral environment and reduce the chance of oral diseases. Probiotics also have anti-inflammatory properties that can benefit oral health by reducing inflammation and promoting tissue healing. Studies have shown that probiotic supplementation can

decrease gingival inflammation and improve periodontal parameters in individuals with gum disease[43]. Additionally, probiotics may help alleviate symptoms of oral thrush (oral candidiasis) by inhibiting the growth of *Candida albicans*.

4. Most common probiotics microorganisms

The common probiotic candidates belong to several genera of bacteria and yeasts, each with specific strains that have been extensively studied for their health-promoting properties. These probiotic organisms are commonly found in fermented foods, dietary supplements, and probiotic-fortified products. Understanding the characteristics and benefits of these common probiotic microorganisms is essential for selecting appropriate probiotic strains to support gut health and overall well-being[44, 22].

4.1. Lactobacillus

Lactobacillus is one of the most well-known genera of probiotic bacteria, comprising a diverse group of species that inhabit various niches within the human body, including the gastrointestinal tract, oral cavity, and genital tract. Some of the most common Lactobacillus species used as probiotics include *Lactobacillus acidophilus, Lactobacillus rhamnosus, Lactobacillus casei, and Lactobacillus plantarum*. These strains are known for their ability to colonize the intestine, promote gut microbiota balance, and support digestive health. Lactobacillus species produce lactic acid as a metabolic byproduct, creating an acidic environment that inhibits the growth of pathogenic bacteria and contributes to gut barrier integrity [45, 46].

4.2. Bifidobacterium

Bifidobacterium is another genus of probiotic bacteria that is commonly found in the human gastrointestinal tract. Bifidobacteria are considered beneficial for gut health due to their ability to ferment dietary fibre, produce short-chain fatty acids (SCFAs), and modulate immune function. Some of the most commonly used Bifidobacterium species include *Bifidobacterium bifidum, Bifidobacterium longum, and Bifidobacterium breve*. These strains have been studied for their roles in promoting intestinal health, alleviating symptoms of gastrointestinal disorders, and supporting immune function. Bifidobacteria are Gram-positive, non-motile, rod-shaped bacteria that are primarily anaerobic, meaning they thrive in environments with little to no oxygen. These beneficial microorganisms play a vital role in maintaining gut health and promoting overall well-being. The major function of Bifidobacteria is their positive impact on the immune system. These bacteria help regulate immune responses in the gut, promoting a balanced and healthy immune system. It plays a role in controlling intestinal pH, helping to maintain the optimal acidic environment necessary for digestive processes and inhibiting the growth of harmful bacteria.

Bifidobacteria are also known for their ability to produce bacteriocins and bacteriocin-like inhibitory compounds[47]. These substances have antimicrobial properties, allowing Bifidobacteria to inhibit the growth of pathogenic bacteria and maintain a healthy balance of microorganisms in the gut. By producing these compounds, bifidobacteria help protect against gastrointestinal infections and other related disorders. Research has shown that individuals with lower levels of bifidobacteria in their gut microbiota may have a higher risk of developing diarrhoea and allergies. To address this imbalance, Bifidobacteria are often added to probiotic supplements, infant formulas, drinks, yoghurts, and various other food products. By consuming these products, individuals can replenish and maintain healthy levels of Bifidobacteria in their gut, thereby supporting digestive health and reducing the possibility of gastrointestinal issues and allergic reactions[48, 49].

4.3. Bacillus species

Some of *Bacillus* species also used as probiotics including *Bacillus coagulans*, *Bacillus clausii, Bacillus licheniformis, Bacillus polyfermenticus, and Bacillus subtilis*. These probiotics are chosen based on their safety profile, including considerations such as antibiotic resistance, toxigenic potential, and production of biogenic amines. They contain antimicrobial substances like bacteriocin, short-chain fatty acids, and organic acids[50, 7]. *Bacillus clausii* strains are used primarily for their immune-modulatory and antimicrobial properties. Fermented soybean paste containing *Bacillus licheniformis* has demonstrated anti-obesity and anti-diabetic properties. *Bacillus polyfermenticus* strain has demonstrated cholesterol-reducing and antioxidant activities. *Bacillus subtilis* have been investigated for their antimicrobial, antiviral, and anticancer effects and used as commercial probiotics[51, 52, 7].

Bacillus coagulans strain is notable for being plasmid-linked, heat-stable, and exhibiting both bactericidal and bacteriolytic activities. Studies have shown that it can reduce blood lipid levels in humans. *B. coagulans* enhances the efficient utilization of ingested foods primarily through its production of various enzymes. *B. coagulans* RCS3 secretes β-galactosidase, which breaks down lactose in milk into glucose and galactose. This process improves milk digestibility

and effectively reduces lactose intolerance symptoms[52]. The *B. coagulans* strain has shown the ability to produce enzymes that break down proteins and carbohydrates into smaller peptides and amino acids. This process enhances metabolism in the upper section of the small intestine, leading to a healthier intestinal environment in the colon and a reduction in toxic metabolites. In addition to producing digestive enzymes, *B. coagulans* can generate metabolites like diacetyl, short-chain fatty acids (SCFAs), and vitamins[53]. It also stimulates intestinal peristalsis, diminishes the production of harmful substances like amines, and enhances the metabolic environment of the intestines. This aids in improving regular bowel movements, preventing toxin build-up, and maintaining overall health of the gut[54].

4.4. Saccharomyces boulardii

Saccharomyces boulardii as a non-pathogenic yeast which has been studied extensively for its probiotic properties. Unlike bacterial probiotics *S. boulardii* is naturally resistant to gastric acid and bile salts, allowing it to survive passage through the stomach and colonizes in the intestine temporarily. *S. boulardii*help restore eubiosis, reduce the possibility of antibiotic-associated diarrhea, and alleviate symptoms of inflammatory bowel disease (IBD). *S. boulardii* may have antifungal properties and help prevent the overgrowth of Candida yeast in the gut[55].

4.5. Streptococcus thermophilus

Streptococcus thermophilus is a lactic acid-producing bacterium that is frequently used in the production of yogurt and other fermented dairy products. While *S. thermophilus* is not traditionally considered a probiotic species due to its transient nature in the gastrointestinal tract and it confer health benefits when consumed in adequate amounts. *S. thermophilus* helps improve lactose digestion in individuals with lactose intolerance and may support gut health by contributing to the production of lactic acid and other metabolites[56].

5. Conclusion

Probiotic are beneficial and the effects of probiotics are strains specific which may attribute to increased intestinal permeability, normal restoration of unbalanced microbiota, improvement of the intestine's immunological barrier functions and alleviation of the intestinal inflammatory response. There are adequate evidences on benefit of few probiotic strains in different health condition. However, large-scale clinical studies are prerequisite for different probiotics strains to claim any preventive and therapeutic application.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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