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Role of Probiotics and probiotic beverages on human health

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ABSTRACT

Probiotics are under considerable research, as the concept holds promise for human health and well-being, and corresponding commercial opportunities. Protection of consumers requires health claims to be confirmed with sufficient scientific evidence. Overall scientific demonstration of probiotic effects requires defining a healthy microbiota and interactions between microbiota and host, and the difficulty to characterize probiotic effectiveness in health and disease. Recent developments of high-throughput sequencing technology and the consequent progresses of metagenomics represent a new approach for the future of probiotics research. This study is an attempt to understand the role of probiotics on human health.

1. Introduction

Vergin first introduced the term “probiotics”, when he compared in his paper “Anti- and Probiotika”, the detrimental effects of antibiotics and other antimicrobial substances on the gut microbial population with factors “probiotika” favourable to the gut microflora[1]. Then probiotics were defined as non-pathogenic microorganisms when ingested, exert a positive influence on host health or physiology[2]. Now, the definition of Food and Agriculture Organisation of the United Nations/World Health Organisation (FAO/WHO 2001) for probiotics is “Live microorganisms, which when administered in adequate amounts, confer a health benefit on the host”. Microorganisms that are probiotics (Table 1) in humans include yeast[3], bacilli[4], *Escherichia coli*[5], enterococci[6], and the more commonly used bifidobacteria and lactic acid bacteria, such as lactobacilli, lactococci and streptococci[7].

A variety of probiotic agents have been studied as single agents or as combination therapies. Examples of such strains include lactobacilli, bifidobacteria, saccharomyces, Escherichia coli and streptococci. Considerable differences exist in the bioavailability, biological activities, doses and composition among probiotic preparations. Moreover, most studies have not been reproduced or confirmed.

1.1 Health benefits of probiotics

Probiotics may seem new to the food and supplement industry, but they have been with us from our first breath. During a delivery through the birth canal, a newborn picks up bacteria from his/her mother. These good bacteria are not transmitted when a Cesarean section is performed and have been shown to be the reason why some infants born by Cesarean section have allergies, less than optimal immune systems, and lower levels of gut microflora. Probiotics are believed to protect us in two ways. The first is the role that they play in our digestive tract.

Our digestive tract is a complex system that needs a healthy balance between the good and bad bacteria but poor food choices, emotional stress, lack of sleep, antibiotic overuse, other drugs, and environmental influences can all shift the balance in favor of the bad bacteria. An imbalance has been associated with diarrhea, urinary tract infections, muscle pain, and fatigue.

When the digestive tract is healthy, it filters out and eliminates things that can damage it, such as harmful bacteria, toxins, chemicals, and other waste products. On the flip side, it takes in the things that our body needs (nutrients from food and water) and absorbs and helps deliver them to the cells where they are needed.

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The other way that probiotics help is the impact that they have on our immune system. Some believe that this role is the most important. Our immune system is our protection against germs. But when it fails to function properly we suffer from autoimmune disorders, allergic reactions, and infections (Skin and vaginal infections). Besides of these harmful effects we can protect ourself by maintaining the correct balance from birth.

1.2 Potential Mechanisms

Probiotics, such as lactic acid bacteria, are active bacterial cultures with unique characteristics that allow them to survive in the gastrointestinal tract and compete with other enteric microorganisms. Thus, they help to maintain the natural balance of the microbiota and overall health**[8, 9].**

Additionally, probiotics may promote immunomodulation by attaching to gut epithelial tissue, interacting with the immune system and producing antimicrobial substances**[8, 9].** Dairy lactobacilli, as part of a regular diet, may also modulate innate immune responses**[10,11]**. Furthermore, probiotics may suppress the growth of bacteria that convert procarcinogens into carcinogens**[12]**.

1.3 Types of probiotics

Probiotic products contain bacteria and/or yeasts that assist in restoring the balance in our gut. Up until the 1960s, the gut microfloras that they were able to identify were *clostridia, lactobacilli, enterococci*, and *Escherichia coli*. Since then, innovative techniques have discovered many more bacteria.

There are several different kinds of probiotics, and their health benefits are determined by the job that they do in your gut. Probiotics must be identified by their genus, species, and strain level. Here is a list of probiotics and their possible health benefits.

Table 1. Microorganisms considered as probiotics**[13-34]**

Lactobacillus	***Bifidobacterium***	**Other lactic acid bacteria**	**Non-lactic acid bacteria**
L. acidophilus	*B.adolescentis*	*Enterococcus facecalis*	*Escherichia coli Nissle 1917*
L. casei	*B. bifi dum*	*Lactococcus lactis*	*Propionibacterium freudenreichii*
L. crispatus	*B. breve*	*Leuconostoc mesenteroides*	*Saccharomyces cerevisiae*
L. delbrueckii subsp. bulgaricus	*B. infantis*	*Pediococcus acidolactici*	*Saccharomyces boulardii*
L. gallinarum	*B. lactis*	*Streptococcus thermophilus*	
L. gasseri	*B. longum*	*Sporolactobacillus inulinus*	
L. johnsonii			
L. paracasei			
L. plantarum			
L. reuteri			
L. rhamnosus			

Lactobacillus

There are more than 50 species of lactobacilli. They are naturally found in the digestive, urinary, and genital systems. Foods that are fermented, like yogurt, and dietary supplements also contain these bacteria. *Lactobacillus*has been used for treating and preventing a wide variety of diseases and conditions.

Some of the lactobacilli found in foods and supplements are *Lactobacillus acidophilus*, *L. acidophilus* DDS-1, *Lactobacillus blugaricus*, *Lactobacillus rhamnosus* GG, *Lactobacillus plantarium*, *Lactobacillus reuteri*, *Lactobacillus salivarius*, *Lactobacillus casei*, *Lactobacillus johnsonii*, and *Lactobacillus gasseri*.

More research is needed regarding probiotics and their potential health benefits before any definitive claims can be made about their effects. However, studies have shown some benefits linked to *Lactobacillus* and treating and/or preventing yeast infections, urinary tract infection, irritable bowel syndrome, antibiotic-related diarrhea, traveler's diarrhea, diarrhea resulting

from *Clostridium difficile*, treating lactose intolerance, skin disorders (fever blisters, eczema, acne, and canker sores), and prevention of respiratory infections. More specifically, results from some of the studies are as follows:

- *Lactobacillus* GG was given to children 5 to 14 years of age with irritable bowel syndrome over eight weeks' time. They were given 3 billion cells twice per day. This reduced the frequency and severity of abdominal pain.
- *Lactobacillus* GG was given to children taking antibiotics and there was a decrease in reported diarrhea.
- *Lactobacillus casei*, *Lactobacillus bulgarius*, and *Streptococcus thermophilus* given twice daily during antibiotic treatment and for a week later decreased the risk of diarrhea in hospitalized adults.
- *Lactobacillus* GG-containing milk was given to children 1 to 6 years of age who attended day care. They got fewer or less severe lung infections than those who did not drink it.
- *Lactobacillus gasseri* and *Lactobacillus rhamnosus* vaginal capsules lengthened the time in between bacterial vaginosis infections.
- *Lactobacillus* GG reduced the risk of traveler's diarrhea by 47% in a study with 245 people who traveled to 14 worldwide geographic regions.

Bifidobacteria

There are approximately 30 species of bifidobacteria. The make up approximately 90% of the healthy bacteria in the colon. They appear in the intestinal tract within days of birth, especially in breastfed infants.

Some of the bifidobacteria used as probiotics are *Bifodbacterium bifidum*, *Bifodbacterium lactis*, *Bifodbacterium longum*, *Bifodbacterium breve*, *Bifodbacterium infantis*, *Bifodbacterium thermophilum*, and *Bifodbacterium pseudolongum*.

As with all probiotics, more research is needed to prove a definitive benefit, but studies have shown that bifidobacteria can help with IBS, dental cavities, improved blood lipids, and glucose tolerance.

Bifidobacterium infantis 35624 was given to 362 patients with irritable bowel syndrome in a four-week study. They showed improvement in the symptoms of abdominal pain, bloating, bowel dysfunction, incomplete evacuation, straining, and the passage of gas.

Salivary levels of bifidobacteria are associated with dental cavities in adults and children.

Bifidobacterium lactis Bb12 is reported to have beneficial effects on metabolism, including lowered serum LDL-cholesterol in people with type 2 diabetes, increased HDL in adult women, and improved glucose tolerance during pregnancy.

Saccharomyces boulardii

This is also known as *S. bo*ulardii and is the only yeast probiotic. Some studies have shown that it is effective in preventing and treating diarrhea associated with the use of antibiotics and traveler's diarrhea. It has also been reported to prevent the reoccurrence of *Clostridium difficile*, to treat acne, and to reduce side effects of treatment for Helicobacter pylori.

Streptococcus thermophilus

This produces large quantities of the enzyme lactase, making it effective, according to some reports, in the prevention of lactose intolerance.

Enterococcus faecium

This is normally found in the intestinal tract of humans and animals.
a. *E. faecium* SF68b. *E . faecium* M-74

Leuconostoc

This has been used extensively in food processing throughout human history, and ingestion of foods containing live bacteria, dead bacteria, and metabolites of these microorganisms has taken place for a long time.

Research has demonstrated that nutrition plays a crucial role in the prevention of chronic diseases, as most of them can be related to diet. Functional food enters the concept of considering food not only necessary for living but also as a source of mental and physical well-being, contributing to the prevention and reducing of risk factors for several diseases or enhancing certain physiological functions. Dairy products form the major part of functional products. To understand their success it is important to realise that milk is a natural and highly nutritive part of a balanced daily diet. Developing functionality in dairy-based products simply means modifying and/or enriching the healthy natural characteristics of the original base. Milk and some other dairy products were recognized as important foods as early as 4000 B.C. The Roman historian Plinio recommended the use of fermented milk for treating gastrointestinal infections. The French paediatrician Tissier proposed in the early 1900s that bifidobacteria could be effective in preventing infections in infants, as they were the predominant component of the intestinal microflora in breast-fed infants. Then Metchnikoff suggested that consumption of fermented milk could reverse the putrefactive effects of the gut microflora. This concept has developed particularly over the past two decades through trend scientific evidence based on placebocontrolled clinical trials showing that particular strains have associated health benefits.

Nowadays dairy products are excellent media to generate an array of products that fit to current consumer demand for functional food. Fermented dairy products enriched with probiotic bacteria have developed into one of the most successful parts of functional foods. The food industry is especially active in studying probiotics because the gastrointestinal tract is one of the richest zones of biodiversity within the body with at least 450 known species of microorganisms commonly found there.

1.4 Product considerations

Probiotics and prebiotics are marketed as health, or functional, foods whereby they are ingested for their purported positive advantages in the digestive tract and/or systemic areas such as the liver, vagina or bloodstream. Unlike new drugs or pharmaceuticals, which are screened intensively for safety and effectiveness, probiotics and prebiotics are less rigorously assessed. It is therefore relatively easy to launch a new product, and legislation against such products is loose. Nevertheless, consumers should be provided with an accurate assessment of physiological, microbial and safety aspects. Several criteria for the appropriate use of probiotics and prebiotics exist and may be summarised as follows. They should:

- Exert a proven beneficial effect on the consumer, preferably with a mechanistic explanation of how this occurred;
- Be non-pathogenic, non-toxic and free of adverse side effects;
- Maintain stability in the product;
- Contain a large number of viable cells (for probiotics);
- Survive well in the GI tract (the best products should be resistant to gastric acid, small gut secretions and have a good ability to influence bacteria already in the gut);
- Have good sensory and mouthfeel properties;
- Preferably be isolated from the same species as the intended use; and
- Have accurate product labelling and content.

Much effort has concentrated on identifying probiotic bacteria and characterising their beneficial credentials. It is generally considered that probiotic bacteria must possess certain properties. The probiotic must survive passage through the upper regions of the GI tract, and persist in the colon. There must be no adverse host response to the bacterium, its components or metabolic end-products. The probiotic should be antagonistic to mutagenic or pathogenic organisms in the gut, and must be genetically stable.

1.5 Fermented dairy products

Typical probiotics include lactic acid bacteria such as *Lactobacillus* and *Bifidobacterium*. These strains are widely used in the fermentation of dairy products, such as yogurt, cheese and kefir. Fermented dairy products with active bacterial cultures are therefore one of the most common sources of probiotics. These types of probiotic-containing milk products may be beneficial for a number of gastrointestinal and digestive conditions**[8,9].**

Table 2: Benefits of fermented dairy products

S. No.	Types of infections	Studies	References
1.	***Helicobacter pylori Infection***	A total of 10 eligible studies, which included 963 adults and children, were assessed. It was found that fermented milk-based probiotic preparations reduce *Helicobacter pylori* infection rates by approximately 5% to 15%.	**[35]**
2.		The study concluded that intestinal microbiota balance can be maintained and humoral and cellular immunity can be stimulated in children who regularly consume yogurt.	**[36]**
3.	**Irritable Bowel Syndrome**	A majority of the clinical trials reviewed showed that lactic acid bacteria alleviate abdominal pain and discomfort. Both single- and multi-centre studies have shown that lactic acid bacteria may improve abdominal bloating and distension.	**[37]**
4.	**Inflammatory Bowel Disease**	Probiotics could have beneficial effects on inflammatory bowel disease, but the evidence is limited. According to a systematic review and meta-analysis, the effects could differ depending on disease subtype and probiotic strain. In addition, findings from a cohort study of middle-aged women living in France indicate that milk products are a protein source that does not increase the risk of inflammatory bowel disease.	**[38,39]**

5.	**Antibiotic-Associated Diarrhea**	Evidence demonstrates that probiotics are associated with reduced antibiotic-associated diarrhea. In a meta-analysis of 82 randomized controlled trials, a statistically significant association was found between the administration of probiotics and the reduction of antibiotic-associated diarrhea. Various studies included in the meta-analysis consisted of interventions with probiotic milk products, which showed that probiotic milk products may be efficacious in preventing antibiotic-associated diarrhea.	**[40]**
6.	**Constipation**	A 2013 meta-analysis of randomized controlled trials indicated that short-term probiotic supplementation reduces intestinal transit time. Greater effects were observed among adults who were older or constipated. Certain probiotic strains, such as strains of *Bifidobacterium lactis*, appear to be more efficacious.	**[41]**
7.	**Lactose Intolerance**	In an evidence-based report on lactose intolerance and health published in 2010, a systematic review of the literature indicated that there was insufficient evidence to determine the effectiveness of yogurt and probiotics in alleviating the symptoms of lactose intolerance. However, many people who have difficulty digesting milk find that they can digest yogurt. This is because beneficial bacteria in yogurt have lactase activity and thus help in lactose digestion.	**[42,43]**
8.	**Gastric Cancer**	It has been postulated that probiotics may help in gastric cancer prevention, but the evidence so far is mainly based on experimental in-vitro data. For instance, a study was conducted on fermented milk containing *Propionibacterium freudenreichii* as microbiota, and it was demonstrated that this probiotic fermented milk had pro-apoptotic effects on human gastric cancer cells.	**[44]**

2. Conclusion

The lack of effectiveness of modern drug therapy counteracts the rapid increase in antibiotic resistant micro-organisms. Lacks of effective antimicrobials in developing countries- were they are needed resulted in the increased demand of effective drug therapy. Evidence suggests that probiotic products enhance digestive and overall health by improving gut microbiota and promoting immunity. These products may be beneficial in *Helicobacter pylori* infection, irritable bowel syndrome and various other types of infections and could prevent antibiotic-associated diarrhea. These prophylactic approaches not only used in the prevention of disease, but also can be applied as sole treatment or as adjuncts.

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