

Probiotics and Health Benefits

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ABSTRACT

Recently, the use of probiotics by human beings through different delivery routes is increased. These are those microorganisms that produce positive health benefits to the host. Different species of probiotics are used in human food matrices, but the commonly used probiotics are related to Bifido-bacteria and Lactobacillus genus. The health benefits attributed to probiotic consumption are investigated in numerous human and animal studies. These benefits are the improvement of metabolic disorders like control of diarrhea, improvement in lactose intolerance, prevention of colon cancer, treatment of *H. pylori*; decrement in blood cholesterol, alleviation in sensitivity and so forth. etc... The mentioned health benefits are species species-dependent. These microorganisms produce the benefits through several mechanisms such as competitive exclusion of pathogens and colonization resistance, normalization of altered microbiota, Anti Anti-proliferative effect, competition for nutrients, production of inhibitory substances, production of short chain fatty acids, and degradation of toxin receptors, immune effects, and regulation of intestinal transit. In this article, information and the results of recently conducted research concerning probiotics, its properties and mechanism of action, and health benefits of probiotics are gathered and discussed.

Keywords- Probiotics; Properties of Probiotics; Mechanism of Action; Health Benefits.

I. INTRODUCTION

Probiotics, which are human-friendly microbes, have gained popularity over the decades for their vital health benefits, and their importance is well-known today. The word probiotic is derived from a Greek word meaning life (Sarao and Arora, 2017) or a combination of Latin (pro = benefit) and Greek (bios = life). Probiotics have been defined differently by different scientists since their introduction (Lee and Salminen, 2009) but the most comprehensive definition was given by the Food and Agriculture Organization of the United Nations (FAO, 2002). This definition was further explained by Hill and his colleagues, who defined probiotics as living microorganisms that, after sufficient entry into the human body, produce a health benefit in the host human (Hill et al., 2014). Different types of probiotics are used in food items, especially fermented foods for health benefits, which have different health benefits, but Lactobacillus and Bifidobacterium types are

more commonly used than other probiotics (Arihara, 2014). In order for probiotics to have health benefits in the host human, the number must be more than a certain amount, depending on the type of probiotic. As part of food numbers of health benefits are associated with the use of probiotics. These health benefits vary depending on the sex, type, and even the strain of the probiotic. These benefits include boosting the immune system, improving bowel health, preventing cancer, lowering serum cholesterol and other benefits (Kumari et al., 2020). In addition, of this the probiotics also has have a significant effect and are used to treat food allergies, neurological function, inflammation (Roobab et al., 2020), diabetes, and Helicobacter infection repairing (Shafi et al., 2014) and to prevent and treat oral infections (Chugh et al., 2020). These microbes demonstrate the above above-mentioned health benefits through various mechanisms. These mechanisms may be used by more probiotics and some may be specific to a single strain. The mechanisms which most commonly used by probiotics are: Competitive removal of pathogens and resistance to colonization, normalization of altered microbiota, anti-proliferative effects, competition for nutrients, production of inhibitory substances (bacteriocins, organic acids, hydrogen peroxide), production of short-chain fatty acids, destruction of toxins, immune effects, and intestinal transmission. Organization (Cremon et al., 2018; Kumar Bajaj et al., 2015). On the other hand, the mechanisms used by certain species include vitamin production, enzymatic activity, bile salt metabolism, and improving intestinal barriers (Cremon et al., 2018).

II. RESULTS AND DISCUSSION

Characteristics of probiotics

In order for a microbe to be called a probiotic, it must have a number of characteristics. The definition given by Hill et al. (2014) suggests that probiotics should be alive, adequate and have a health benefit to humans when consumed. In addition, probiotics must be safe and have a known composition for the expected dose (Sanders et al., 2018). In addition to the above features, there should be some other features based on their specific use as shown in table 1. For example, Probiotics must have a safe, GRAS (generally recognized as safe) condition and a long history of use in food. These microbes must be nonpathogenic,

successfully attach to colon cells and colonize, and show resistance to antimicrobial substances but must not be able to transmit this resistance to other bacteria. The release of probiotics into the intestinal mucosa is important for the regulation of the immune system, the protection of pathogens, and the elimination of pathogens from the digestive system. Probiotics should also be technologically appropriate for use in food to survive before and after human consumption. In addition, these microbes must be resistant to digestive enzymes (Erkmen and Bozoglu, 2016).

Table 1: Ideal properties of probiotics

1	GRAS status.
2	Documented health benefits on humans.
3	Antimutagenic and anticarcinogenic properties.
4	Nonpathogenic.
5	Tolerance to antimicrobial substances.
6	Able to grow and colonize in intestines.
7	Adherence to the intestinal mucosa.
8	Ability to reduce pathogen adhesion on the intestinal mucosa.
9	Antagonistic and antimicrobial activity against pathogenic bacteria.
10	Immune stimulation without proinflammatory effect.
11	Acid tolerance and ability to survive the acidic

conditions in the stomach.

12	Human gastric juice tolerance.
13	Bile salt tolerance.
14	Desired metabolic activity.
15	Good sensory properties.
16	Retain viability during food processing, storage, and following consumption.

Health benefits of probiotics

Health benefits associated with the use of probiotics have been extensively studied by various researchers through human and animal studies (Daliri and Lee, 2015). Each probiotic has its own unique benefits and the general health, benefits of probiotics cannot be applied to the entire population of probiotics because those health benefits range from one genus to another, from one species to another, and even from one strain to another are different. Therefore, the health benefits caused by one species may not be mentioned for another, or in other words, a probiotic may not reflect all the proposed health benefits (Kumar Bajaj et al., 2015). The health benefits associated with probiotics are described in Figure 1. These health benefits are demonstrated by probiotics through a variety of mechanisms that may be combined or specific to the type or strain (Cremon et al., 2018; Kumar Bajaj et al., 2015).

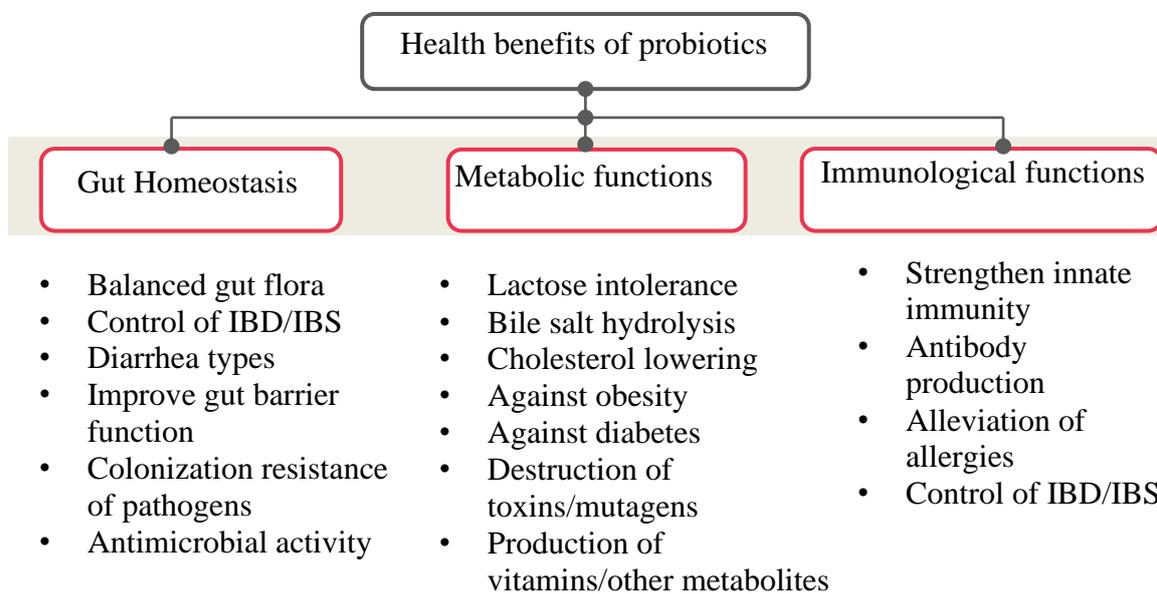


Figure 1. Health benefits associated with probiotic consumption (Kumar Bajaj et al, 2015)

Anti-pathogenic effects

Anti-pathogenic effects of probiotics have been extensively studied and still require further study. It demonstrates its anti-pathogenic effects by producing anti-pathogenic substances such as ethanol, organic acids, di acetyl, acetyl aldehyde, hydrogen peroxide and peptides. These inhibitory substances make the

environment unsuitable for pathogens. Bifidobacterium produce acetic and lactic acid in a ratio of 2: 3 molar. *Lactobacillus acidophilus* and *Lactobacillus* causative lactic acid are produced as the general final product of fermentation (Nagpal et al., 2012). Tejero-Sariñena et al. (2006) studied the anti-pathogenic effects of probiotics against *Salmonella typhimurium* and *Clostridium*

difficile in an in vitro model. Based on the results of their study, there was a significant reduction in the number of *Salmonella typhimurium* and *Clostridium difficile* in the presence of specific probiotics compared to the control group. Among the groups of probiotics, two strains, *Lactobacillus casei* NCIMB 30185 (PXN 37) and *Bifidobacterium brevis* NCIMB 30180 (PXN 25), had higher levels of *Salmonella typhimurium* and cholesterol diphtheria than other probiotics. Verdenelli et al. (2014) and his colleagues conducted a study to determine antimicrobial effects of various strains of *Lactobacillus* against *Candida* strains. The researchers concluded that all the strains of *Lactobacillus* showed anti-pathogenic properties against *Candida* strains, but that these effects were strain dependent. Furthermore, the results showed that only *Lactobacillus ramanosae* IMC 501 and *Lactobacillus paracasei* IMC 502 of the strains studied were capable of producing hydrogen peroxide, an anti-pathogenic substance.

Elimination of lactose intolerance

Lactose intolerance is a metabolic disorder caused by low production of the lactase enzyme (which converts lactose sugar into glucose and glucose in milk and milk products) (Kechagia et al., 2013). As a result of this disorder, the contents of the intestines become acidic and create an excessive osmotic load, which results in abdominal pain, diarrhea, and flatulence. Some lactic acid bacteria such as *Lactobacillus*, *Bifidobacterium* and *Streptococcus* can reduce the symptoms of lactose intolerance because these bacteria have the ability to consume lactose and are commonly added to dairy products to increase the digestibility of lactose present in these products (Fung et al., 2011). For example, a number of researchers have studied the effects of lactose intolerance on yogurt containing *Lactobacillus acidophilus* and *Bifidobacterium bifidum* probiotics in patients with lactose intolerance. The results of their study showed a significant reduction in the symptoms of hydrogen and lactose intolerance in the experimental groups compared to the control group. He adds that the use of probiotics during lactose intolerance is a good choice (Masoumi et al., 2021).

Anti-diarrheal effects

Diarrhea is the occurrence of thin or liquid stools 3 or more times a day. After pneumonia, diarrhea, especially acute infectious diarrhea, is the leading cause of hospitalization, infection, and death (Shafi et al., 2014). Potential mechanisms by which probiotics fight diarrhea include competing with pathogens for nutrients, lowering lumen pH and producing bacteriocins, and increasing mucus production (Dastoor et al., 2018). The use of probiotics (*Lactobacillus* species) has many beneficial effects against this global problem. These microbes can also be used to treat other gastrointestinal and periodontal diseases (Shafi et al., 2014). Guo et al. (2019) reported that probiotics played a moderate role in preventing antibiotic-related diarrhea. Also, based on their findings, higher doses of probiotics (more than 5

billion CFU / day) are needed to demonstrate this effect. Another meta-analysis performed on children who were given the antibiotic showed that *Bacillus*, *Bifidobacterium*, *Lactobacillus*, *Lactobacillus* species, *Lactobacillus cremoris*, *Saccharomyces*, and *Streptococcus* species were the only probiotics. 5 Billion CFU / day dose should prevent antibiotic-related diarrhea (Johnston et al., 2011). However, there is no general consensus on the effect of probiotics as some studies have not found beneficial effects of probiotics for the prevention of diarrhea in children (Olek et al., 2017; Freedman et al., 2018; Schnadower et al., 2018).

Anti-inflammatory effects

Inflammatory bowel disease (IBD) is the most common inflammatory disease of the colon. The term is synonymous with Crohn's disease (CD) in which all parts of the digestive tract, such as the mucosa, subcutaneous mucosa, and cirrhosis, are affected, and ulcerative colitis (UC), which affects the mucosa and submucosa of the colon (Sharif et al., 2018). There are still many reports that lactic acid bacteria, some of which are probiotics, have been used to treat IBD. They demonstrate their aforementioned effects through various mechanisms such as regulation of intestinal microbiota, enhancing intestinal inhibitory functions, reducing oxidative stress, and improving the host immune system (LeBlanc and LeBlanc, 2016). According to an experimental study performed on 81 patients with UC disease. Based on the results of this study, a combination of different strain-containing probiotics, including *Lactobacillus rhamnosus* NCIMB 30174, *Lactobacillus plantarum* NCIMB 30173, *Lactobacillus acidophilus* NCIMB 30175, and *Enterococcus phylloxera* reduce the symptoms of the disease (Bjarnason et al., 2019). Another study has shown that the use of *Bifidobacteria* for the treatment of active UC has been shown to be satisfactory. However, to further study these effects, further experimental research is needed to determine the type and dosage of probiotics to produce the effect (Asto et al., 2019).

Helicobacter pylori infection

The use of probiotics as a strategy to eradicate *H. pylori* has been tested. In the in vitro model, lactic acid bacteria and some strains are effective in inhibiting the growth of *Helicobacter pylori*. However, one of these strains is not effective in eradicating *H. pylori* infection through specific yeasts. On the other hand, some clinical studies have shown the effectiveness of the use of different strains of probiotics along with the standard treatment of antibiotics (Goderska et al. 2018).

Oral health

Dental caries and periodontal are two common oral diseases caused by bacteria. When the amount of beneficial microbes in the mouth becomes irregular, pathogenic microbes cause various oral diseases such as tooth decay, periodontitis, and bad breath. The use of probiotics can be an effective way to manage the oral microflora and control oral conditions. Probiotics that

are used and marketed for oral health include *Lactobacillus* and *Bifidobacterium* species (Daliri and Lee, 2015). Caglar et al. (2018) reported that the use of probiotic ice cream containing *Bifidobacterium bifidum* Bb-12 had significantly reduced the number of mutans streptococci associated with tooth decay. The reason for this decrement maybe that; probiotics attach themselves to the oral mucosa and dental tissues and eventually compete with oral pathogens. In another randomized clinical trial, researchers examined the effect of probiotics on the pH of their mouths and the number of *Streptococcus mutans* in 60 volunteers between the ages of 20 and 25. The results of the study showed that short-term use of probiotic probes raises the pH and decreases the number of *Streptococcus mutans* (Srivastava et al., 2016).

Anti-cancer effects

According to the World Health Organization's Cancer Fact Sheet (WHO, 2017), cancer is one of the deadliest diseases. Around the world until 2012 it has caused approximately 14 million infections and 2.8 million deaths. 70% deaths of these statistics were reported from the Asia, Africa and the Americas (Vidya and Thiruneelakandan, 2015). For the treatment of this disease, researchers are working to find a drug that has the least side effects. In an in vitro study, *Lactobacillus fermentum* NCIMB-5221 and -8829 caused by the production of short-chain fatty acids (ferulic acid) to affect colon-rectum cancer cells and extent to normal growth of colon epithelial cells. Therefore, these probiotics can be considered as good biotherapeutic agents for colon health and prevention of colon-rectum cancer (Kahouli et al., 2015). Another study, which looked at the effects of two antibiotic cell extracts on colon cancer cells, showed that the extracts of probiotic cells (*Lactobacillus acidophilus* LA102 and *Lactobacillus casei* LC232) Caco-2 and HRT-18 has a strong cytotoxic effect against colon-rectums cells lines (Awaisheh et al., 2016).

Cholesterol lowering effects

Different models are used to reduce blood cholesterol levels such as nutrition management, change in habits such as exercising and taking medication. There is a cure for high cholesterol. Although these drugs are effective in lowering cholesterol levels, they are expensive on the one hand and have side effects on the other. Therefore, the use of probiotics can be a good strategy due to their natural and safe properties and no side effects. Blood cholesterol-lowering effects have been demonstrated by a variety of probiotics, but the most effective probiotics belong to the family *Lactobacillus* and *Bifidobacterium* (Homayouni et al., 2012). In a study conducted on mice with high cholesterol, a mixture of probiotics (*Bifidobacterium langum*, *Bifidobacterium lactis*, *Bifidobacterium breve*, *Lactobacillus reuteri*, , *Lactobacillus plantarum*) Giving us a mixture of probiotics resulted in a significant reduction in their serum total cholesterol, triglyceride,

LDL-cholesterol levels while a significant increase in HDL cholesterol was observed (Kim et al., 2017). Other researchers also found that giving *Lactobacillus fermentum* PD2 and PH5 to mice fed a high-cholesterol diet significantly reduced the concentrations of total cholesterol, LDL cholesterol, and triglycerides in their blood serum (Thakkar et al., 2019). According to a meta-analysis, the use of probiotics improves fat metabolism by reducing aggregate and LDL cholesterol concentrations (Cho and Kim, 2015).

Anti-allergic effects

The increase in the incidence of allergic diseases caused by immune disorders is a serious economic and social burden to the world (Akelma and Topcu, 2016). Recently, significant advances have been made regarding the beneficial role of probiotics in the prevention and management of allergic diseases. In vitro studies of certain probiotics such as *Lactobacillus plantarum* L67 have been shown to play a significant role in the prevention of allergy-related disorders by producing interleukin-2 and interferon- γ in their hosts (Song et al., 2016). In another study, *Lactobacillus plantarum* 06CC2 had a significant role in reducing the sensitivity symptoms of mice that were sensitive to egg albumin as well as serum total immunoglobulin E, egg albumin specific immunoglobulin E, and histamine. It has also been found that *Lactobacillus plantarum* 06CC2 significantly increases the secretion of interferon- γ and interloquine-4 in mouse cells, which is responsible for reducing sensitivity symptoms (Takeda et al., 2014).

III. CONCLUSIONS

Probiotics are living microbes that cause health benefits after being ingested by humans. Some of these benefits are common to all probiotics but some are caused by specific probiotics, so relevant probiotics should be consumed for the expected health benefits. This means that different types of probiotics should be taken while consuming probiotics to increase the level of health benefits. It is also important to take a certain number of probiotics in order to have the mentioned health benefits as taking less than the recommended number of probiotics does not lead to the mentioned benefits. In total, the intake of probiotics improves digestive system disorders (lactose intolerance, diarrhea, colon cancer, etc.), lowers blood cholesterol levels and prevents pathogens and other beneficial effects. Further experimental research and clinical trials are needed to prove the health benefits of different species of probiotics.

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