

# Probiotics: Health Benefits and Side Effects

**Kuntal Kalra**

Department of Biotechnology,  
Faculty of Engineering and Technology,  
Manav Rachna International University,  
Email: kuntal.fet@mriu.edu.in

**Shilpa Chapangaokar**

Department of Biotechnology,  
Faculty of Engineering and Technology,  
Manav Rachna International University,  
Email: shilpas.fet@mriu.edu.in

***Abstract:** Probiotics are live microbial food supplements or components of bacteria, which have been shown to have beneficial effects on human health. Microbial cultures have been used for thousands of years in food and alcoholic fermentations, and they have been shown to prevent and cure a variety of diseases. These beneficial microorganisms have been named as 'Probiotics'. The beneficial effects are due to change in the composition of the gut microbiota. There is currently an enormous evidence for the therapeutic use of probiotics in infectious diarrhea in children, the possible benefit in other gastrointestinal infections; prevention of postoperative bacterial translocation, irritable bowel syndrome and inflammatory bowel disease continues to emerge. This study deals with the possible benefits and side effects of Probiotics.*

***Keywords:** probiotic, prebiotic, health food, gut flora, lactobacillus, synbiotic*

## 1. INTRODUCTION

The concept of Probiotics was first studied and documented by the Nobel prize winner Russian scientist Elie Metchnikoff in his book *The prolongation of life* (1908) [1]. He suggested that the long healthy life of Bulgarian peasants resulted from their consumption of fermented milk products. These fermented milk products are a source of microflora that inhabits the gut and elicit a healthy response on the host. Some years later in 1917 during an outbreak of shigellosis, German professor Alfred Nissle isolated a strain of *Escherichia coli* from the faeces of a soldier who was not affected by the disease. Methods of treating infectious diseases were needed at that time when antibiotics were not yet available, and Nissle used the *Escherichia coli* Nissle 1917 strain in acute gastrointestinal infectious salmonellosis and shigellosis [2].

The gastrointestinal tract of an adult human being is filled with an enormous number of helpful bacteria called probiotic bacteria. They are called probiotic bacteria because the term "probiotic" means "for life," as opposed to the term "antibiotic" which means "against life." Our bodies are actually designed to have symbiotic relationships with these probiotic bacteria. They help us digest our food, kill harmful microorganisms and are responsible for proper digestion and priming the gastrointestinal immune system. There is now a mounting scientific evidence that these microbial flora is vital for maintenance of health of an individual also these friendly microorganisms might be

used as prophylactic and for treatment of various diseases.

Probiotics are commercially available in foods and dietary supplements (for example, capsules, tablets, and powders) and in some other forms as well. Examples of foods containing probiotics are yogurt, fermented and unfermented milk, miso, tempeh, and some juices and soy beverages. In probiotic foods and supplements, the bacteria may have been present originally or added during preparation. Most probiotics are bacteria similar to those naturally found in people's guts, especially in those of breastfed infants (who have natural protection against many diseases). Probiotics are not the same thing as prebiotics – the nondigestible food ingredients that selectively stimulate the growth and/or activity of beneficial microorganisms already in people's colons are known as prebiotics. When probiotics and prebiotics are mixed together, they form a synbiotics (Table -1).

**Table 1: Terminology**

Probiotic	A live microbial food ingredient which is beneficial to health
Prebiotic	A non digestible food ingredient which beneficially affects the host by selectively stimulating the growth and activity of one or limited number of bacteria in the colon having the potential to improve health
Synbiotic	A mixture of Probiotics and prebiotics which beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract, and thus improving host health and well being



For organisms to be considered as Probiotics, the following criteria need to be fulfilled:

- (1) It should be isolated from the same species as its intended host
- (2) It should have a demonstrable beneficial effect on the host
- (3) It should be non-pathogenic
- (4) It should be able to survive transit through the gastrointestinal tract
- (5) On storage, large number of viable bacteria must be able to survive prolonged periods

In recent years, there has been an upsurge in research in Probiotics. The data on health benefit of Probiotics has accelerated a commercial interest in the probiotic food concept. Many Probiotic products have come in the market and these products have becoming popular. Fermented dairy products have emerged as the most important and popular probiotics (Table 2).

## 2. SOURCE OF PROBIOTICS

Human gut is inhabited with a diverse non-pathogenic microflora that has been proved to be beneficial for the human health. Major functions of the gut microbiota include metabolic activities that result in

salvage of energy and absorbable nutrients, trophic effects on the intestinal epithelium and enhancement of innate immunity[3-4]. It has been estimated that at least 500 different microbial species exist in the Gastro Intestinal Tract although on a quantitative basis about 20 genera probably predominate. These include *Bacteroides*, *Lactobacillus*, *Clostridium*, *Fusobacterium*, *Bifidobacterium*, *Eubacterium*, *Peptococcus*, *Peptostreptococcus*, *Escherichia*, and *Veillonella*. The *Bifidobacteria* and *Lactobacilli* mainly constitute the beneficial microflora.

### 2.1 Probiotics – mechanism of action

Mechanisms for the benefits of probiotics are not understood completely. However, as a general rule, this includes [5].

- Adherence and colonization of the gut
- Suppression of growth or epithelial invasion by pathogenic bacteria and production of antimicrobial substances
- Improvement of intestinal barrier function
- Controlled transfer of dietary antigens
- Stimulation of mucosal and systemic host immunity as shown in Figure 1.

Table 2: List of some Probiotics available in Market

S. No	Type of food	Microorganism	Manufacturer
1	Yogurt	<i>Streptococcus thermophilus</i> <i>Lactobacillus acidophilus</i> or <i>Lactobacillus bulgaricus</i>	Stonyfield farm, Mother dairy
2	Flavoured yogurt	<i>Lactobacillus casei</i> Shirota	Yacult
3	Kefir	<i>Lactobacillus kefir</i> <i>Leuconostoc</i> , <i>Lactococcus</i> , yeast	Lifeway kefir
4	Fruit juice	<i>Lactobacillus plantarum</i> 299v	Next Foods
5	Sauerkraut (fermented cabbage)	<i>Lactobacillus plantarum</i> .	Great Lakes Kraut
6	Cereals with probiotics	<i>Lactobacillus acidophilus</i>	Kashi
7	Whole grains & live active cultures	<i>Lactobacillus bulgaricus</i> , <i>Streptococcus thermophilus</i> , <i>Lactobacillus acidophilus</i> and <i>Bifidobacterium bifidum</i> .	Vive
8	Chocolates	<i>Lactobacillus acidophilus</i> and <i>Lactobacillus casei</i>	Attune



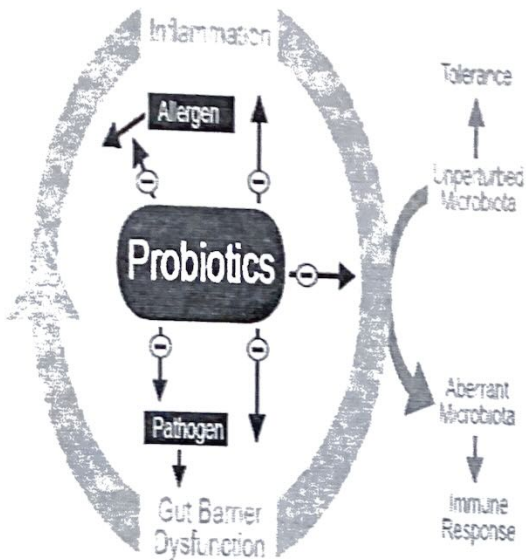


Fig. 1: Mechanisms by which the Probiotics affect human body

### 3. HEALTH CARE BENEFITS OF PROBIOTICS

An enormous evidence of healthcare benefit of Probiotics has been accumulated in the recent times. It has to be noted that these benefits are not general, benefit of all the Probiotics are associated with specific strains of microbes. The following discussion gives a comprehensive discussion of the potential effects of Probiotics:

#### 3.1 Diarrheal Diseases

Infective diarrhea caused by an infection of the digestive system by a bacterium, virus, or parasite. The diarrhea is usually viral in origin, and is mostly caused by Norovirus, Rotavirus, Adenovirus, or Astrovirus. Rotavirus is the leading cause of serious infantile diarrhea worldwide and rapid oral rehydration is the primary treatment. Results of the role of probiotics have been summarized in at least three systematic reviews, all of which found an overall reduction in the duration of diarrhea by about 17 to 30 hours [6-8].

Probiotics can prevent or ameliorate diarrhea through their effects on the immune system. Moreover, probiotics might prevent infection because they compete with pathogenic viruses or bacteria for binding sites on epithelial cells [9]. Competitive blockage of receptor sites in which lactobacilli bind to receptors, enhance immune response by increasing the antibody secretory IgA and decreasing viral shedding, and lactobacilli produce substances that inactivate the viral particles [10].

#### 3.2 Inflammatory Bowel Disease

Inflammatory bowel disease (IBD) is a group of inflammatory conditions of the colon and small intestine. The major types of IBD are Crohn's disease and ulcerative colitis. The causes of such diseases are unknown, but it has been hypothesized that an intolerance to the normal flora (bacteria) in the gut leads to inflammation and resulting pathology. Several controlled clinical trials have shown that high levels of certain probiotic strains viz. *Escherichia coli* (Nissle), *Bifidobacteria* and *L acidophilus* can extend the disease-free remission period. Ingestion of probiotic bacteria has the potential to stabilize the immunological barrier in the gut mucosa by reducing the generation of local proinflammatory cytokines. There are studies on the use of probiotics in inflammatory bowel disease (IBD) [11-15]. Another probiotic bacterium, *Lactobacillus plantarum* 299v, was also found to be effective in reducing IBS symptoms.<sup>[40]</sup> Additionally, a probiotic formulation, VSL#3, was found to be safe in treating ulcerative colitis, though efficacy in the study was uncertain.<sup>[41]</sup>

#### 3.3 Lactose Intolerance

Intolerance is the inability to metabolize lactose because of a lack of the required enzyme lactase in the digestive system. Lactic acid bacteria actively convert lactose into lactic acid therefore ingestion of certain active strains may help lactose intolerant individuals tolerate more lactose than what they would have otherwise [16]. It is well documented that most nonpathogenic bacteria like *Lactobacillus* and *Streptococcus thermophilus* produce lactase, which hydrolyses the lactose in dairy products to glucose and galactose. Thus, it can be hypothesized that would seem that ingestion of probiotics can exert their lactase activity in vivo in the gut lumen, thus facilitating digestion and alleviating intolerance. This has been well shown in both adults and children [17-18].

#### 3.4 Constipation

Constipation is common especially in elderly people. Probiotics have been shown to increase the bowel movements or decrease the intestinal transit time [19]. Presently lactulose is most widely used laxative which is a prebiotic. Lactulose is not attacked by human disaccharidases. However *bifidobacteria* that inhabit colon, catabolise it to smaller molecules, creating an osmotic effect and leading to alleviation of constipation.



### 3.5 Prevention of colon cancer

In general, cancer is caused by mutation or abnormal activation of genes that control cell growth and division. These mutations occur due to exposure to hazardous chemicals, retrovirus infections, genetic abnormalities etc.

Lactic acid bacteria have been shown to protect against colon cancer in rodents, however human data is limited and conflicting [21]. Most human trials have found that the strains tested may exert anti-carcinogenic effects by decreasing the activity of an enzyme called  $\beta$ -glucuronidase [21]. (which can generate carcinogens in the digestive system). Lower rates of colon cancer among higher consumers of fermented dairy products have been observed in one population study.

It has been hypothesized that probiotic cultures might decrease the exposure to chemical carcinogens by (a) detoxifying ingested carcinogens [22]. (b) altering the environment of the intestine and thereby decreasing populations or metabolic activities of bacteria that may generate carcinogenic compounds; (c) producing metabolic products (e.g., butyrate) which improve apoptosis or programmed cell death, (d) producing compounds that inhibit the growth of tumor cells; or (e) stimulating the immune system to better defend against cancer cell proliferation .

### 3.6 Improving immune function and preventing infections

Probiotic therapies help in preventing secondary infections, which is a common complication of antibiotic therapy. They may protect against pathogens by means of competitive inhibition (i.e., by competing for growth) and by boosting the immune system. Lactic acid bacteria improve immune function by increasing the number of IgA-producing plasma cells, increasing or improving phagocytosis as well as increasing the proportion of T lymphocytes and Natural Killer cells [23]. Clinical trials have demonstrated that probiotics may decrease the incidence of respiratory tract infections [24] and dental caries in children [25].

### 3.7 Allergy

Sanitary living environments and the consumption of processed foods have limited the number of microbes in the diet. It has been hypothesized that the exposure of infants to microbes before the age of six months helps the immune system mature to better tolerate

allergens later in life. This hypothesis is based on observations that lower allergy incidence is associated with environments that have greater numbers of microbes, such as day care centers, farms, or in homes with siblings or pets.

Probiotics have the potential to modify the structure of potential antigens, reduce their immunogenicity, reduce intestinal permeability and the generation of proinflammatory cytokines in patients with allergic disorders. There are a number of studies that evaluated probiotics in allergic conditions including rhinitis, atopic dermatitis and food allergy [26-27]. These studies demonstrate promising results in children.

## 4. SIDE - EFFECTS

As of now, there have been no reports regarding severe health complications after administration of probiotics. In normal healthy persons, probiotics when taken in recommended doses do not cause any significant side effect. In rare cases, they may lead to mild digestive problems like flatulence, bloating, diarrhea and abdominal pain. If Probiotics are taken in excess amount, there are chances of developing infections that require medical attentions.

Categories of people that have conditions like food allergies, sensitivity to fermented foods, or the milk derivatives should use Probiotics with caution. Intestinal microflora can contribute to the processing of food antigens in the gut resulting in food hypersensitivity, of which atopic disease is a manifestation. Probiotics should not be used as a replacement option for prescribed medications. In order to prevent any health complications it is always advisable to consult a qualified physician before using Probiotics. A cold chain has to be maintained for the transportation and storage of Probiotics. The Probiotics if not refrigerated may lose their potency.

In case of people having underlying disease or immuno-compromised patients are at a risk of developing infection after the use of Probiotics. Symptoms such as bloody stools, skin rash and fever are indications of intestinal infection. In addition, Probiotics may disturb the normal metabolic processes and autoimmune responses of the body. According to medical studies conducted, there is a possibility that Probiotics may interact with immunosuppressive drugs, leading to life-threatening conditions. Hence, those who are on immunosuppressive medications should strictly avoid Probiotics. Probiotics' safety has not been



thoroughly studied scientifically, however. More information is especially needed on how safe they are for young children, elderly people, and people with compromised immune systems.

## REFERENCES

1. Metchnikoff, E. 1907. *Essais optimistes*. Paris. The prolongation of life. Optimistic studies. Translated and edited by P. Chalmers Mitchell. London: Heinemann, 1907.
2. W Kruis, P Frič, J Pokrotnieks, M Lukáš, B Fixa, M Kaščák, M A Kamm, J Weismueller, C Beglinger, M Stolte, C Wolff, and J Schulze Maintaining remission of ulcerative colitis with the probiotic *Escherichia coli* Nissle 1917 is as effective as with standard mesalazine. *Gut* 2004;53:1617-1623 doi:10.1136/gut.2003.037747
3. Guarner F, Malagelada JR. Gut flora in health and disease. *Lancet* 2003; 361:512-9.
4. Backhed F, Ding H, Wang T, Hooper LV, Koh GY, Nagy A et al. The gut microbiota as an environmental factor that regulates fat storage. *Proc Natl Sci U S A* 2004; 101:15718-23.
5. Sartor RB. Therapeutic manipulation of the enteric microflora in inflammatory bowel diseases: Antibiotics, probiotics and prebiotics. *Gastroenterology* 2004; 126:1620.
6. Allen SJ, Okoko B, Martinez E, Gregorio G, Dans LF. Probiotics for treating infectious diarrhoea. *Cochrane Database Syst Rev*. 2004; 2:CD003048
7. Szajewska H, Mrukowicz JZ. Probiotics in the treatment and prevention of acute infectious diarrhea in infants and children: a systematic review of published randomized, double-blind, placebo- controlled trials. *J Pediatr Gastroenterol Nutr* 2001; 33 Suppl 2:S17.
8. Van Niel CW, Feudtner C, Garrison MM, Christakis DA. *Lactobacillus* therapy for acute infectious diarrhea in children: a meta-analysis. *Pediatrics* 2002; 109:678.
9. Parvez S., Malik K.A., Ah Kang S. and Kim H.Y. Probiotics and their fermented food products are beneficial for health. *Journal of Applied Microbiology* 100: 6: 1171-1185.
10. Huang JS, Bousvaros A, Lee JW, Diaz A, Davidson EJ. Efficacy of probiotic use in acute diarrhea in children. A meta-analysis. *Dig Dis Sci* 2002; 47: 2625-34.
11. Rembacken BJ, Snelling AM, Hawkey PM, Chalmers DM, Axon AT. Nonpathogenic *Escherichia coli* versus mesalazine for the treatment of ulcerative colitis: a randomized trial. *Lancet* 1999; 354:635-9.
12. Kruis W, Schutz E, Fric P, Fixa B, Judmaier G, Stolte M. Double-blind comparison of an oral *Escherichia coli* preparation and mesalazine in maintaining remission of ulcerative colitis. *Aliment Pharmacol Ther* 1997; 11: 853-8.
13. Ishikawa H, Akedo I, Umesaki Y, Tanaka R, Imaoka A, Otani T. Randomized controlled trial of the effect of bifidobacteria-fermented milk on ulcerative colitis. *J Am Coll Nutr* 2003; 22: 56-63.
14. Venturi A, Gionchetti P, Rizzello F, Johansson R, Zucconi E, Brigidi P et al. Impact on the composition of the faecal flora by a new probiotic preparation: preliminary data on maintenance treatment of patients with ulcerative colitis. *Aliment Pharmacol Ther* 1999; 13: 1103-8.
15. Malchow HA. Crohn's disease and *Escherichia coli*. A new approach in therapy to maintain remission of colonic Crohn's disease? *J Clin Gastroenterol* 1997; 25: 653-8.
16. Sanders ME (February 2000). "Considerations for use of probiotic bacteria to modulate human health". *The Journal of Nutrition* 130 (2S Suppl): 384S-390S. PMID 10721912. <http://jn.nutrition.org/cgi/pmidlookup?view=long&pmid=10721912>
17. Saltzman JR, Russell RM, Golner B, Barakat S, Dallal GE, Goldin BR. A randomized trial of *Lactobacillus acidophilus* BG2FO4 to treat lactose intolerance. *Am J Clin Nutr* 1999; 69:140-6.
18. Shermak MA, Saavedra JM, Jackson TL, Huang SS, Bayless TM, Perman JA. Effect of yogurt on symptoms and hydrogen production in lactose-malabsorbing children. *Am J Clin Nutr* 1995; 62:1003-6
19. Koebnick C, Wagner I, Leitzmann P, Stern U, Zunft HJ. Probiotic beverage containing *Lactobacillus casei* Shirota improves gastrointestinal symptoms in patients with chronic constipation. *Can J Gastroenterol* 2003; 17:655-9
20. Ouwehand AC, Salminen S, Isolauri E (August 2002). "Probiotics: an overview of beneficial effects". *Antonie Van Leeuwenhoek* 82 (1-4): 279-89.
21. Brady LJ, Gallaher DD, Busta FF (February 2000). "The role of probiotic cultures in the prevention of colon cancer". *The Journal of Nutrition* 130 (2S Suppl): 410S-414S. PMID 10721916. <http://jn.nutrition.org/cgi/pmidlookup?view=long&pmid=10721916>
22. Wollowski I, Rechkemmer G, Pool-Zobel BL (February 2001). "Protective role of probiotics and prebiotics in colon cancer". *The American Journal of Clinical Nutrition* 73 (2 Suppl): 451S-455S.
23. Reid G, Jass J, Sebulsky MT, McCormick JK (October 2003). "Potential uses of probiotics in clinical practice". *Clin. Microbiol. Rev.* 16 (4): 658-72.
24. Hatakka K, Savilahti E, Pönkä A, et al. (June 2001). "Effect of long term consumption of probiotic milk on infections in children attending day care centres: double blind, randomised trial". *BMJ* 322 (7298): 1327. doi:10.1136/bmj.322.7298.1327. PMID 11387176.
25. Näse L, Hatakka K, Savilahti E, et al. (2001). "Effect of long-term consumption of a probiotic bacterium, *Lactobacillus rhamnosus* GG, in milk on dental caries and caries risk in children". *Caries Research* 35 (6): 412-20. doi:10.1159/000047484. PMID 11799281.
26. Miraglia del Giudice M, De Luca MG. The role of probiotics in the clinical management of food allergy and atopic dermatitis. *J Clin Gastroenterol* 2004; 38:S84-5
27. Isolauri E, Arvola T, Sutas Y, Moilanen E, Salminen S. Probiotics in the management of atopic eczema. *Clin Exp Allergy* 2000; 30: 1604-10.

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