



## EFFECT OF PROBIOTIC MICROORGANISMS ON GUT AND OVERALL HEALTH: A REVIEW

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### ABSTRACT

Probiotic microorganisms are useful by manifold mechanisms in improving overall health. They exert their beneficial effects on both gut and extraintestinal organs. These things are of tremendous interest to the world of scientific workers and researchers who are avidly interested in probiotics. Comprehensive reviews and meta-analyses on these aspects are lacking.

**KEYWORDS:** Probiotic, Curd, Mucroorganisms.

### INTRODUCTION

Probiotics are live microorganisms which, when ingested in adequate amounts, offer some health benefits to the host. Probiotics exert numerous beneficial effects on gut health as well as overall health. They have been reviewed here.

### MATERIALS AND METHODS

Literature search using MeSH (Medical Subject headings) terms were used to search and access scientific information about probiotics and their beneficial applications in improving intestinal health. Careful scrutiny of scientific articles was done and the meta-analysis was prepared.

### Definition of probiotic microorganisms

Probiotics are live microorganisms which when ingested in small amounts, imparts some health benefits to the host. On the other hand, prebiotics are those foods that lead to abundance of probiotic bacteria in the gut. A prebiotic is defined as a "selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well-being and health". Prebiotics must be resistant to digestion and must be able to get fermented by colonic bacteria. Common Prebiotics include oats, inulin, garlic and fruits, which are rich in FOS (Fructooligosaccharides) and GOS (Galactooligosaccharides). In- vitro culture of human fecal bacteria has shown that FOS selectively stimulates

growth of *Bifidobacterium* spp. while maintaining pathogens like clostridia at a low level. Thus prebiotics help in overall good growth and multiplication of probiotic bacteria in gut.

Commonly used probiotics are bacteria but they may be yeasts also.

### Common probiotic microbial strains can be enlisted as follows

- a. Bacteria:- *Bifidobacterium* spp., *Lactococcus* spp., *Lactobacillus* spp. and *Bacillus clausus* are common probiotic bacterial strains. Of these, *Bifidobacterium* spp., a Gram positive branched anaerobic bacillus, is the first bacterial strain to colonize human gut because it comes from mother's milk.<sup>[1]</sup>
- b. Yeasts:- *Saccharomyces cerevisiae* var. *boulardii* is a very good probiotic yeast strain. There will be no development of antibacterial resistance in this yeast even after rampant oral antibiotic usage, unlike *Lactobacillus* spp.

In our experience, *Lactobacillus* spp. and *Lactococcus* spp. are commonest bacterial probiotic strains available in loose yogurt while *Bacillus clausus* and *Lactobacillus* are common probiotic bacterial strains available in the market. As per data of NIH of U.S. Government, the seven commonest genera of microorganisms most frequently used in probiotic formulations are *Lactobacillus*, *Bifidobacterium*, *Saccharomyces*,

*Streptococcus*, *Enterococcus*, *Escherichia* and *Bacillus* spp.<sup>[2]</sup>

An image of a commercial natural probiotic is shown in figure no. 1 below.

#### Direct effects of probiotics on gut health, with mechanisms

A. Helps in maintaining epithelial integrity of gut: Probiotic bacteria produce SCFA or Short chain fatty acids (like Butyric acid) which help in nourishment of the epithelial cells of gut. The most common SCFA are acetic acid, propionic acid and butyric acid (in a 3:1:1 molar ratio), and they make up 90%–95% of SCFAs seen in the human colon.<sup>[3]</sup> SCFAs promote the integrity and permeability of the gut barrier in many ways. These molecules, mainly consisting of butyrate, increase the concentration of tight junctions, like claudin-1, zonula occludens-1 and occludin via mechanisms like the upregulation of genes which encode for these proteins.



**Fig 1: Natural curd/ yogurt.**

B. Helps dislodge pathogenic bacteria from gut: Lactobacilli can displace gut pathogens like *Escherichia coli* and disallow them from binding to the enterocytes with the help of their pili.

C. Helps synthesize Vitamin B12 and Vitamin K: Lactobacilli synthesize these vitamins in gut.<sup>[4]</sup> This is important because humans lack the biosynthetic capacity for most vitamins and these must thus be provided exogenously. Although vitamins can be found in a variety of foods, deficiencies still occur, mainly due to malnutrition due to insufficient food intake and also because of poor eating habits. Fermented milks with high levels of B-group vitamins (like folate and riboflavin) can be produced by LAB-promoted and presumably bifidobacteria-promoted biosynthesis, too. Furthermore, certain strains of LAB produce the complex vitamin cobalamin (or vitamin B<sub>12</sub>).

So, it can be seen from the above findings that probiotic bacteria help in thriving of enterocytes and produce vitamins.

#### Effect of probiotics on other parameters of health, with mechanisms

- Insulin sensitivity:** Healthy bacteria in gut improve insulin sensitivity. Dysbiosis or alteration of normal microbial flora of gut hampers this. Probiotics and prebiotics appear to be a promising approach to improve insulin sensitivity by favourably modifying the composition of the gut microbiota, reducing intestinal endotoxin concentrations and mitigating energy harvest. SCFA produced by probiotics may also have anti-lipolytic activities in adipocytes and improve insulin sensitivity via GLUT4 through the up-regulation of 5'-AMP-activated protein kinase signalling in muscle and liver tissues.<sup>[5]</sup>
- Immune system:** Probiotics help maintain immune tolerance. Probiotic bacteria can interact and stimulate intestinal immune cells as well as commensal microbial flora to modulate specific immune functions and immune homeostasis.<sup>[6]</sup>
- Headache:** Probiotic bacteria act on the gut-brain axis and helps reduce severity of migraine attacks. The use of probiotic supplements significantly affects the severity and frequency of migraine headaches compared to placebo.
- Allergy and asthma:** Probiotics can promote the expansion of type-1 immune response, downregulate IgE production, dampen airway inflammation, and reinforce immune defence against respiratory infections. So they can help control bronchial asthma, as found by Ciprandi and coworkers.<sup>[7]</sup>
- Atopic dermatitis:** Numerous studies and meta-analyses show that exposure to probiotics during pregnancy and early infancy may reduce the risk of developing atopic dermatitis in children. For instance, a meta-analysis published in the year 2018 included 27 randomized controlled trials (RCTs) and 1 controlled cohort study in 6,907 infants and children exposed to probiotics in utero for 2 weeks to 7 months (via maternal oral supplementation) and/or by oral administration to the infants after birth for 2 to 13 months. Between age 6 months and 9 years, probiotic treatment with single strains or mixtures of bacteria that included *Lactobacillus*, *Bifidobacterium*, and *Propionibacterium* strains significantly brought down the risk of atopic dermatitis from 34.7% in the control group to 28.5% in the probiotic group.<sup>[2]</sup>
- Antibiotic-associated diarrhoea (AAD):** Both LGG (*Lactobacillus rhamnosus* GG) and *Saccharomyces boulardii* have been shown to reduce the risk of AAD. In a systematic review and meta-analysis of 12 RCTs with a total of 1,499 children and adults, treatment with LGG (4 x 10<sup>8</sup> to 12 x 10<sup>10</sup> CFU) compared with placebo or no additional treatment for 10 days to 3 months reduced the risk of AAD in

patients treated with antibiotics from 22.4% to 12.3%.<sup>[9]</sup>

- g. **Mood:-** Numerous studies have demonstrated that probiotic bacterial strains can produce dopamine and serotonin, positively influencing mood. These probiotics, which affect mood either directly or indirectly, are often referred to as psychobiotics. Research indicates that products or supplements rich in live bacterial cultures, such as *Bifidobacterium bifidum*, *Bifidobacterium lactis*, *Lactobacillus acidophilus*, *Lactobacillus salivarius*, *Lactobacillus brevis*, *Lactobacillus casei*, and *Lactobacillus lactis*, can enhance overall well-being and alleviate symptoms of depression after approximately 3 to 4 weeks of use. The extent of these benefits may vary depending on the initial severity of the patient's psychological symptoms.<sup>[10]</sup> However, probiotics may not be a major source of Serotonin in the body.

Apart from this, Several studies have also found that some strains and combinations of probiotics can ameliorate some of the non-motor symptoms of Parkinson's disease. These include constipation and other gastrointestinal problems, disrupted sleep, anxiety and fatigue.

Hence probiotics have beneficial effects on extraintestinal systems also.

#### Discussion about individual bacteria

##### i) *Bifidobacteria*

Numerous reports have emphasized the critical role of bifidobacteria in maintaining intestinal homeostasis, modulating both local and systemic immune responses, and offering protection against inflammatory diseases and infections. Furthermore, certain species of bifidobacteria have the ability to transform various dietary compounds into health-promoting bioactive molecules, like conjugated linoleic acid and specific vitamins. This bacterium also exerts anti-inflammatory, anti-tumour, disease-resistant, and immune-stimulating effects on the human body.<sup>[9]</sup> These beneficial effects underscore the importance of bifidobacteria in supporting overall health and well-being.

ii) *Lactobacillus sp.:-* It releases lactacin and inhibits pathogenic gut bacteria like *Escherichia coli*. *Lactobacillus* is among the most important GRAS food lactic acid bacteria. There are nearly 140 species at present, mostly of industrial importance. Being part of the natural flora of a number of food products like raw milk, fermented dairy products, fruits, vegetables, meat products, they also act as starters for a multitude of fermented food products either to enhance the quality or to add health benefits.

iii) *Lactococcus spp.:-* Due to its historical application in food fermentation, *Lactococcus lactis* is classified as "generally recognized as safe" (GRAS). It has been proposed as a possible vehicle to deliver therapeutic molecules in the gastrointestinal tract. Anti-inflammatory properties have been found in some natural *L.*

*lactis* isolates, whereas the ability to modulate the intestinal microbiota has been documented in a *L. lactis* strain which was obtained from a fermented milk product.<sup>[11]</sup>

#### Yeast-based probiotics

i) *Sachharomyces cerevisiae* var. *boulardii:-* It helps in AAD (Antibiotic associated diarrhoea) and IBD. It also helps in digestion by providing digestive enzymes.

It can also reduce the probability of Traveler's diarrhoea by 10%. This yeast is also used to treat other gastrointestinal disorders, like inflammatory bowel disease (IBD) and *Helicobacter pylori* infections.<sup>[12]</sup> It also has anti-inflammatory, antibacterial, antiviral, and antioxidant properties.

#### DISCUSSION

The health benefits of beneficial bacteria have been recognized since ancient times. Historical records, including Persian scriptures and the Old Testament, suggest that lactic acid-producing bacteria were valued for their health benefits. For instance, it is hinted that Abraham's consumption of sour milk contributed to his health and longevity.<sup>[5]</sup> More and more health benefits of probiotics will be unravelled with time.

#### CONCLUSION

##### Legends

AMP:- Adenosine monophosphate

CFU:- Colony Forming units.

LAB:- Lactic acid bacteria.

SCFA- Short chain fatty acids.

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