# Nutritional and Health Benefits Of Prebiotics, Probiotics and Synbiotics-A Review

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## ABSTRACT

In the last few decades, a lot of study has been done on the health benefits that prebiotics, probiotics, and synbiotics offer. Functional foods are food supplements that have been shown to change, adapt, and restore the body's natural gut flora. They also support the intestinal environment's efficient operations. The probiotic strains *Bifidobacterium, Lactobacilli, S. boulardii, and B. coagulans* that are most frequently utilized. The most widely utilized prebiotics include fructans, inulin, GOS, FOS and XOS. These fibres are known as synbiotics when they are combined with probiotics to increase the viability of the probiotics. The focus of the current review is on the components and functions of probiotics, prebiotics, and synbiotics in human health.

Additionally, numerous health benefits including immune-modulation, cancer prevention, inflammatory bowel disease, etc.are also covered.

***Keywords- Prebiotics, Probiotics, Synbiotics, cancer prevention***

## INTRODUCTION

*"The first wealth is health."*— Ralph Waldo Emerson

The basic principle of modern health is the famous R.W. Emerson quotation among awared population. Eli Metchnikoff, a Russian Nobel laureate, was the first to identify the advantageous effects of certain bacteria on the human gastrointestinal tract. The *Theory of Longevity* by Metchnikoff was afterwards linked to prolonged youth and a healthy old age, which were primarily witnessed among Balkan peasants at the time who consumed cultured milks **(Kaufmann 2008).** Since then, researchers have continued to explore how certain food minerals and ingredients can improve health or fight off chronic diseases. The study conducted in this field has shown a plethora of new products that have an abundance of health benefits and these products are known as functional foods **(Webb GP 2011).**

The idea of "functional foods" emphasizes that, in addition to being necessary for survival, food also helps prevent and lower risk factors for a number of diseases and can improve some important physiological processes. The body receives the necessary amounts of vitamins, lipids, proteins, carbohydrates, and other nutrients from functional foods **(Cencic and Chingwaru 2010).**

## PREBIOTICS

According to **(DeVrese & Schrezenmeir 2008),** prebiotics, which are largely fibres and non-digestible dietary components, preferentially stimulate the growth and/or activity of some genera of microorganisms in the colon, typically *lactobacilli* and *bifido bacteria*. A prebiotic should have the following qualities:

1. Resistance to the effects of stomach acids, bile salts, and other hydrolyzing enzymes in the intestine.
2. The upper gastrointestinal tract shouldn't absorb it. 3) Be simply able to ferment by gut microorganisms. **(Kuo 2013).**

According to the FAO/WHO, Prebiotics are non-viable food components that offer the host health benefits through modifying the microbiota. In terms of their origin, fermentation characteristics, and dosage requirements for health effects, prebiotics constitute a diverse collection of carbohydrate compounds. Breast milk, soybeans, inulin sources such as chicory roots, etc.), raw oats, unrefined wheat, unrefined barley, non-digestible carbohydrates, and in particular non-digestible oligosaccharides are some of the sources of prebiotics. Only bifidogenic, non-digestible oligosaccharides—in particular, inulin, its hydrolysis product

oligofructose, and (trans) galacto-oligosaccharides (GOS)—fulfill all prebiotic classification specifications **(Pokusaeva et al. 2011).**

Prebiotics like inulin and pectin have been shown to provide a number of health advantages, including a decrease in the duration and frequency of diarrhea, relief from inflammation and other intestinal bowel problem symptoms, and preventive benefits against colon cancer **(Pena 2007).** They have also been associated in reducing various cardiovascular disease risk factors, improving the bioavailability and uptake of minerals, and increasing satiety and weight reduction to combat obesity **(Pokusaeva et al. 2011).** Table 1.1 lists some of the key oligosaccharide characteristics as well as the names of the most popular prebiotics **(Swennen et al. 2006).**

**Table 1.1 Properties of Prebiotics**

| Desirable qualities | Properties of oligosaccharides |
|---|---|
| Active at low dosage | Selectively and efficiently metabolized by *Bifido bacterium and / or Lactobacillus sp.* |
| Lack of side effects | Selectively and efficiently metabolized by beneficial bacteria without producing gas |
| Persistence through the colon | Preferably high molecular weight |
| Varying viscosity | Available in different molecular weights and linkages |
| Acceptable storage and processing stability | Possess 1–6 linkages and pyranosyl sugar rings |
| Ability to control micro-flora modulation | Selectively metabolized by restricted microbial species. |
| Varying sweetness | Varying monosaccharide composition |

**PROBIOTICS**

The word "*probiotics,*" which means "for life" in Greek, is used to describe live, non-pathogenic organisms and the advantageous effects on their hosts. Vergin initially used the word "probiotics" when he was researching the damaging effects of antibiotics and other microbial agents on the population of bacteria in the gut. He noticed that probiotika was good for the gut flora. Lilly and Stillwell later defined probiotic as “a product formed when one microbe promotes the growth of another microbe". This word was subsequently defined by Fuller as "non-pathogenic microorganisms that, when ingested, exert a positive influence on the host's health or physiology."

According to the most recent definition proposed jointly by FDA and WHO, states that “probiotic is a living organism which if provided to a host in sufficient quantities, improves host's health.

Probiotic bacteria such as *Lactobacillus rhamnosus, Lactobacillus reuteri, bifido bacteria, lacto bacillus acidophilus-group, bacillus coagulans, Escherichia coli strain Nissle 1917,* some *enterococci,* particularly *Enterococcus faecium SF68,* and the yeast *Saccharomyces boulardii* are most widely used. These probiotics can be added alone or in combination to foods, especially fermented milk products. Probiotics are constantly evolving, with new genera and strains appearing as a result of more advanced and specialized research activities.

When compared to the 180 research articles published between 1980 and 2000, more than 5700 research articles were published between 2000 and 2014 on probiotic Lactobacillus, demonstrating the exponential growth of research on probiotics, particularly Lactobacilli, over the past two decades **(Probiotic Lactobacillus PubMed 2014).**

The advantages of various plant and bacterial sources as prebiotics and probiotics have recently come into emphasis. Table 1.2 lists some of the qualities of a novel prebiotics and probiotics. This field of study is expected to be an active research area **(Saulnier et al. 2009).**

**Table 1.2-Some novel prebiotics and probiotics**

| Novel Prebiotics | | Novel Probiotics |
|---|---|---|
| **Prebiotic** | **Source** | |
| A low-molecular-weight polysaccharide | Agar and alginate of seaweed Gelidium CC2253 | *F. prausnitzi* |
| Ulvan | Green algae-Ulvarigida | |
| ß-glucans | Pleurotus sp. (pleuran) mushrooms | |
| Inulin-type fructans | Roots of traditional Chinese medicine Morindaofficinalis or Indian mulberry | *L. plantarum* |
| Oligosaccharide | White and red-flesh pitayas (dragonfruit) | |
| Oligosaccharide | Yacon root | |

FAO and WHO have jointly proposed guidelines in order to develop a systematic approach for effective evaluation of probiotics in foods to support the health claims and benefits, Fig. 1.1 shows some of the prerequisites of the optimal probiotic organism.

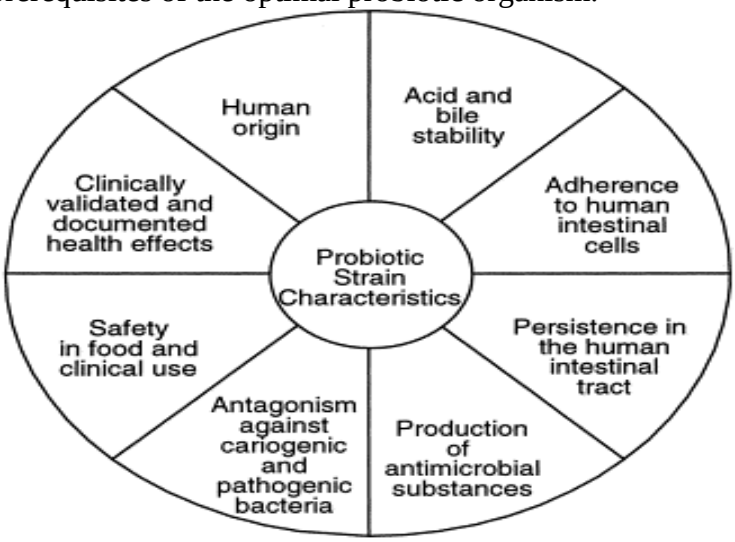


**Fig 1.1 Probiotic strain characteristics**

The FAO/WHO guidelines should be used to evaluate probiotics in food. The subsequent guidelines make it essential to perform the following activities-

1. Strain recognition.
2. The functional characterization of the strain(s) for probiotic qualities and safety.
3. Human research that confirm the health benefits.
4. Labelling of efficacy claims and content that is genuine and not fraudulent for shelf life.

**SYNBIOTICS**

When Gibson first proposed the idea of prebiotics, he hypothesized about the potential advantages of combining prebiotics and probiotics to create what he called Synbiotics **(DeVrese and Schrezenmeir 2008)**. By targeting the growth and/or metabolism of one or a small number of bacteria that promote health, a synbiotic product positively influences the host and enhances the survival and implantation of live microbial dietary supplements in the gastrointestinal tract. The term "synbiotics" ought to be employed for products in which the prebiotic compound(s) specifically favour the probiotic organism(s) because it alludes to synergism **(Cencic and Chingwaru 2010).** Synbiotics have been developed to help probiotics survive any possible issues. The justification for using synbiotics appears to be supported by observations

demonstrating an enhancement in the probiotic bacteria's survival during transit through the upper digestive tract. A more successful colon implantation as well as a growth-stimulating action of probiotics and ubiquitous bacteriais facilitated by intestinal homeostasis and a healthy body **(Pena 2007).** The main prebiotics utilized are oligosaccharides such fructooligosaccharide (FOS), xyloseoligosaccharide (XOS), and gorgonzola oligosaccharide (GOS), inulin, and prebiotics from natural sources like chicory and yacon roots, among others.

Probiotic strains used in synbiotics formulations include *Lacbobacilli, Bifidobacteria spp., S. boulardii, B. coagulans.* Humans are said to benefit from consuming synbiotics due to:

1. Higher levels of lactobacilli and bifido bacteria and a balanced gut micro-biota,
2. Improved liver function in cirrhotic patients,
3. Improved immune-modulating ability,
4. Prevention of bacterial translocation and lower rates of nosocomial infections in surgical patients, etc **(Zhang et al. 2010).**

## POTENTIAL HEALTH ADVANTAGES OF PREBIOTICS, PROBIOTICS AND SYNBIOTICS

The most significant and well-established health benefits of probiotics are their ability to prevent diarrhoea, constipation, modify the conjugation of bile salts, increase antibacterial activity, and function as an anti-inflammatory. Additionally, they aid in the production of minerals and increase their bioavailability. Some probiotics are also known to have antioxidant effects in intact or lysates. Probiotics have also been effective at reducing the signs and symptoms of allergies, cancer, AIDS, lung infections, and urinary tract infections. The positive benefits on ageing, fatigue, autism, osteoporosis, obesity, and type 2 diabetes have been reported infrequently **(Harish and Varghese 2006).**

As illustrated below, several processes are believed to be linked to the positive effects of probiotics-

1. Synthesis of inhibitory compounds such as H2O2, bacteriocins, organic acids, etc.
2. Preventing pathogenic microorganisms from attaching to surfaces.
3. Competition for nourishment with harmful microorganisms.
4. Toxin receptors are blocked and toxins are broken down.
5. Controlling immunological reactions.

## PROSPECTIVE AREAS FOR RESEARCH IN THE FIELD OF PROBIOTICS

1. Focused research efforts are being made to determine how probiotics affect diseases including atherosclerosis and myocardial infarction that affect the cardiovascular system **(Loscalzo 2011).**
2. The working hypothesis of neuro-gastro-enterologist Dr. Gershon postulates the presence of an enteric nervous system, as well as its participation in the physiology of the gut and other related gut illnesses **(Gershon 1998).** Understanding the function of Microbial endocrinology can help us address the afore-mentioned notion. Probiotics synthesize and react to neuro-active substances **(Roshchina 2010).**

## FORMULATION OF PROBIOTICS IS A CHALLENGE

Today, there are issues with the misuse of the word "probiotic" and a lack of understanding of the significance of strain and dose specificity. When produced as nutritional supplements rather than pharmaceuticals, probiotics are subject to less regulatory scrutiny because the manufacturer is not required to provide evidence to support claims of the efficacy or safety of foods and nutraceutical supplements. This is a major factor in the majority of commercial products having inadequate or no efficacy and safety information. Applying the new knowledge produced by basic scientists in the field of intestinal flora is a problem for professionals working on the medical aspect of functional foods and prebiotics, probiotics, synbiotics, and novel foods. The development of better probiotic formulations will be aided by a deeper knowledge of the complicated molecular processes behind probiotics' effectiveness.

Delivering insufficient amounts of probiotics to the lower gastrointestinal tract, particularly the acidic environment of the stomach, is one of the drawbacks and intrinsic flaws of commercial probiotic products and corrective measures **(Pathak 2011).** As a result, a more accurate target delivery mechanism and the right dosage must be developed. There is still need for improvement, including the following:

1. The probiotic formulation should deliver live, active probiotic cells even after prolonged storage.
2. Evaluation techniques must be developed to ensure that the formulation genuinely contains clinically tested, live probiotic microorganisms **(Both et al. 2012).**

## RESEARCH ON PROBIOTICS IS LIMITED

We only have little knowledge of the mechanisms underlying the positive effects of prebiotics, synbiotics, and other probiotics. The requirement for molecular identification of probiotics for the development of health claims is made more difficult by incomplete data regarding the probiotic doses necessary for certain clinical effects. Understanding the immunological pathways through which probiotics are able to exert their positive benefits still relies largely on direct data. The probiotic interactions between the probiotic strains in formulations like #VSL-3, which combine several different probiotic strains, have not been researched. It is important to comprehend the interactions between the microbiota, the host, and the prebiotic component in organized clinical trials and validation studies with large sample sizes **(Boyle et al. 2006).**

There is a lack of published literature in the field of manufacturing processes and subsequent formulation, and much work needs to be done to boost strain survival during formulation and storage.

## CHALLENGED ROLES OF PROBIOTICS AND PREBIOTICS

Probiotics rarely have negative effects; however digestive discomfort like bloating is the most frequent adverse effect. According to **Szajewska et al. 2010**, *S. boulardii and Lactobacillus GG* have been shown to hasten the development of health issues in a number of immune-compromised patients. Due to their compromised immune systems, pregnant women, neonates, and the elderly are at an increased risk of acquiring a probiotic infection. Vancomycin resistance is a natural trait of certain Lactobacillus strains, which raises questions about whether this resistance can spread to further harmful organisms in the gut environment **(Saulnier et al. 2009).** Hydrogen and carbon dioxide are produced during the fermentation of FOS in the colon, which might make people feel uncomfortable. Prebiotics, particularly oligosaccharides like FOS and GOS, can induce large amounts of flatulence and gastrointestinal pain when consumed in excess **(Niittynen et al. 2007).**

## CONCLUSION

The overall systemic impacts that probiotics, prebiotics, and synbiotics have on the host's health, metabolism, and immune system have been discussed in this study.

Synbiotics, Prebiotics, and Probiotics all have a systemic impact on the host's immune system, metabolism, and general health. In order to maintain a strong synergy between the two and maximize the positive benefits, prebiotic use by probiotics should be necessary for synbiotic selection. Scientists would be able to develop more good functional foods to promote host health by figuring out the underlying mechanisms of prebiosis and probiosis. A fascinating approach for the prevention and treatment of some serious diseases is the potential of prebiotic components of food and probiotic bacteria to affect the composition of the microbiota. Recent technological developments have made it possible to deeply scan and analyse the unexpected diversity of bacteria in the GIT, which should be able to avoid diseases and make it easier to maintain better health.

In several publications, use of probiotics by humans has been reported, whereas prebiotics and synbiotics have received far less attention. Furthermore, appropriately planned large-scale clinical trials are required to clearly establish and support the health claims presented. It would

be extremely valuable to be able to target particular organisms in the large intestine for specific health-improving purposes.

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