

The Components of Microbiome-Driven Nutraceuticals to Transform Gut Health

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The provided article focuses on the definition and the components of microbiome-targeted nutraceuticals. The phrase "microbiome" refers to microorganisms (microbiota) that coexist in the human body, specifically in the gut. The words "nutrition" and "pharmaceutics" are combined to form the phrase "nutraceutical." The phrase implies foods distinguished from herbal items, dietary supplements (nutrients), certain diets, and processed meals like cereals, soups, and drinks utilized as medicines. Microbiome-targeted nutraceuticals are supplements that affect the gut microbiota to enhance health and have a detrimental impact on diseases. Microbiome-targeted nutraceuticals interact directly with the microbiota to promote the growth of good bacteria, improve their functioning and inhibit the activity of harmful bacteria. They contain components viz., fibre, essential fatty acids, polyphenols, probiotics, prebiotics, synbiotics and postbiotics.

1. Dietary fibre

Dietary fibre is a non-digestible carbohydrate, also termed as roughage. Dietary fibre can profoundly affect the microbiome's diversity and composition by providing a broad variety of substrates for fermentation that are carried out by particular microbial species required to break down these complex carbohydrates. It serves as a prebiotic and promotes the growth of healthy bacteria. The end product is SCFAs (Short Chain Fatty acids) mainly, acetate, propionate and butyrate that plays a vital role in maintaining gut health. β -glucan found in barley and oats, Psyllium husk and pectin found in fruits are the common examples of dietary fibre.

2. Essential fatty acids

Polyunsaturated fats, also referred to as essential fatty acids (EFAs) are vital for preserving health. They need to be acquired from the diet as the body lacks the ability to produce them naturally. Omega-3 Fatty Acids and Omega-6 Fatty Acids play a crucial role in various biological processes. Their intake must be proportionate in order to promote gut health and microbiota composition as it lowers gut inflammation and immune system dysregulation and

also promotes the growth of good bacteria that form SCFAs.

3. Polyphenols

Polyphenols are referred to as a group of substances that stimulates the proliferation and functioning of the beneficial bacteria in the digestive tract. They support the growth of positive bacteria and also help in the elimination of harmful bacteria that hinder gut health. The studies have shown that the intake of polyphenols has led to an increase in the production of SCFAs (Edwards *et al.*, 2017).

Polyphenols facilitate the microbial diversity of the gut (Wang *et al.*, 2022). Improved immune system functionality, more metabolic health, and a lower risk of disease are all associated with a diverse microbiome. They have antioxidant and anti-inflammatory properties that maintains gut barrier integrity. They help in reducing inflammation and oxidative stress to maintain a healthy intestinal gut and lining which, in turn, could lead to intestinal permeability. Catechins in green tea, resveratrol in grapes and red wine, curcumin in turmeric and lignanin in nuts are the main sources of polyphenols. Fig. 1 to represents functions of polyphenols as microbiome-targeted nutraceutical.

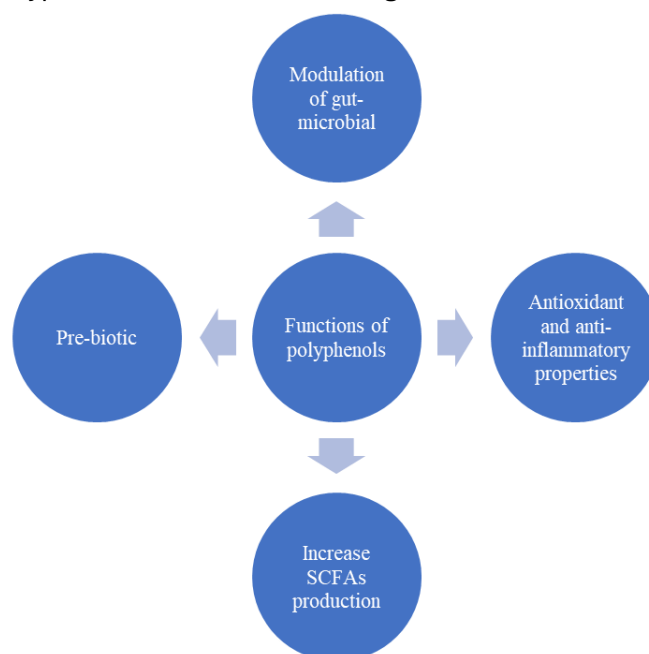


Fig. 1. Functions of polyphenols as microbiome-targeted nutraceutical



Fig. 2. Source of polyphenol

Source: <https://askthescientists.com/resveratrol/>

4. Probiotics

Probiotics are live bacteria that enhance the gut microbiota when synthesized in sufficient quantities. They are a crucial component of microbiome-targeted nutraceuticals as they support a healthy microbiome, balance gut microbial diversity, and improve overall digestive and immune system health. Probiotics helps in the production of SCFA, mainly butyrate. Butyrate has anti-inflammatory properties and controls the immune system and gut integrity.

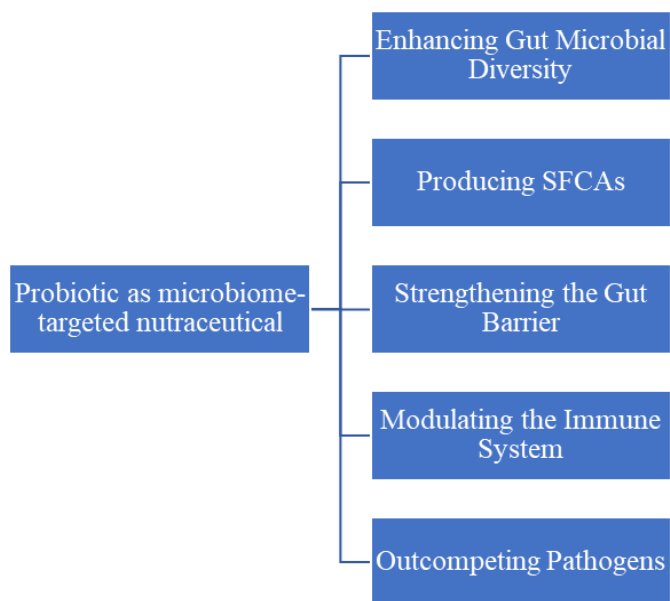


Fig. 3. Probiotics as microbiome-targeted nutraceutical

Probiotics help to restore the gut barrier by reducing the risk of leaky gut and inflammation both of which can weaken the intestinal barrier. Probiotics can affect the innate and adaptive immune systems, assisting in the regulation of immune responses and

minimizing the risk of hyperactive immunological responses that may result in autoimmunity and inflammation. They also produce bacteriocins and organic acids that restrict the growth of harmful bacteria in the gut. Fig.3 summarizes the use of probiotics as microbiome-targeted nutraceuticals.

5. Pre-biotics

Prebiotics are the high-fibre food that feeds good bacteria to the gut. They help in maintaining microbial equilibrium and enhance the intestinal and immune barrier against harmful bacteria. Prebiotics can improve various aspects of metabolic health viz., blood sugar regulation, lipid metabolism, and weight management. Prebiotics have an impact on mood, stress reactions, and cognitive function by affecting the gut-brain axis, a communication channel between the gut and the brain. Certain prebiotics, such as Galactooligosaccharides (GOS), can lower anxiety and depressive symptoms, presumably by encouraging the development of particular microorganisms that generate neuroactive substances. Resistant Starch, Fructooligosaccharides and inulin are a few examples of pre-biotics. Fig. 4 represents pre-biotics as microbiome-targeted nutraceuticals.

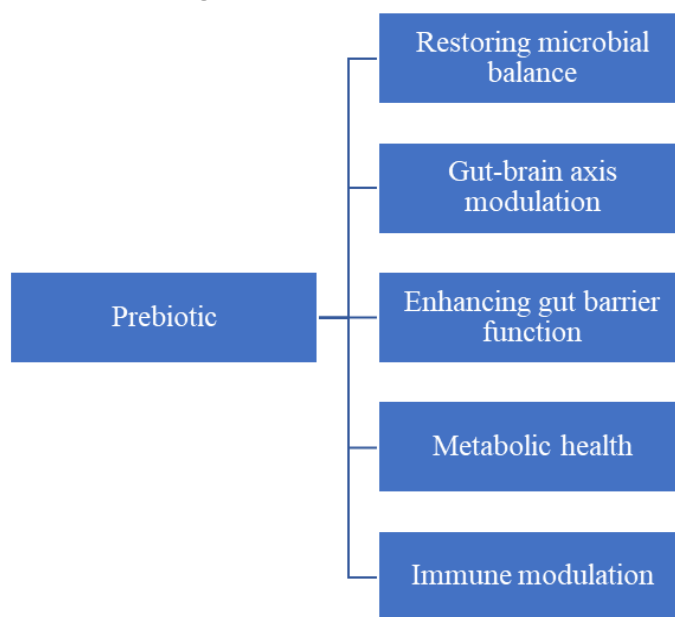


Fig. 4. Pre-biotic as microbiome-targeted nutraceutical

Spirulina as pre-biotic and probiotic

Spirulina is one of nature's most powerful superfood. It is suggested as the greatest supplement due to its distinct qualities and abundance of vitamins and minerals. Spirulina contains several bioactive components that could stimulate the growth of

beneficial gut bacteria, thus qualifying it as a potential prebiotic. The polysaccharides and other minerals included in spirulina, like phycocyanin, have a "probiotic-like" effect on gut health via regulating the microbiome. Fig 5 depicts the natural cultivation of spirulina.

Fig. 5. Natural cultivation of Spirulina



(Source: Turpin ex Gomont, 1892)

6. Synbiotic

Synbiotics are the combination of probiotics and prebiotics that enhances the health of the gut microbiome and, therefore, are regarded as very effective microbiome-targeted nutraceuticals.

Synbiotics can help the growth and activity of good bacteria in the gut by combining probiotics and prebiotics in an effective way simultaneously. This helps to improve immunological function, metabolic health, digestive health, and even mental health through the gut-brain axis. Example: For Digestive Health Synbiotic:

- Probiotics: *Bifidobacterium lactis* HN019 (helpful for bowel regularity) and *Lactobacillus plantarum* (supports gut barrier integrity).
- Prebiotics: Resistant starch (a fibre that resists digestion in the small intestine and feeds beneficial bacteria in the colon) or Acacia gum (a prebiotic fibre that improves gut microbiota diversity).

7. Post-biotics

Postbiotics are the byproducts of microbial fermentation that have a direct biological impact on the host. They can be SFCAs, proteins, bacterial cell wall components and vitamins. They assist in strengthening

the intestinal barrier and have a positive impact on immune, mental and metabolic health.

A promising new area in microbiome-targeted nutraceuticals is represented by postbiotics. Without the use of live microbes, postbiotics provide a means of enhancing immune function, metabolic health, gut health, and even mental well-being by utilizing the metabolic products generated by probiotics. Postbiotics could be a key element of treatments that target the microbiome. For example, Supplements containing butyrate (as a postbiotic): Gut bacteria make butyrate when they ferment fibre. As butyrate strengthens the gut lining and lowers inflammation, using it as a supplement can immediately improve gut health.

Conclusion

The host's nutritional and health state is significantly affected by the gut microbiota through immune and metabolic function regulation. Microbiome-targeted nutraceuticals make use of the intricate relationship between gut microbiota and general health, offering a way to improve health. Utilizing probiotics, prebiotics, synbiotics, polyphenols, and postbiotics provides novel approaches to immune response modulation, gut health maintenance, and the prevention of numerous metabolic and inflammatory disorders. However, further research is required about the mechanism of components for meeting the therapeutic targets in the future.

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