

Glucan as prebiotic or probiotic?

Editorial

Tremendous changes in lifestyle and eating habits are causing significant and often irreversible changes leading to manifold multiplication of various health problems. There has been, roughly since World War II, an apparent decrease in the prevalence of traditional infectious diseases, with the concomitant increase in immune-related disorders, such as irritable bowel disease, type 1 diabetes and various allergic diseases. One reason might be the reduction of exposure to microbes, which subsequently resulted in an undereducated immune system. In addition, the rise in food products composed of highly refined ingredients has led to the decreased consumption of micronutrients, which might be relevant to immune maturation. Immune modulation via dietary strategies might hold promise as well as for maintaining immune homeostasis in the healthy population. The question “which food components impact the functions of the immune system” is simple-all do. Protein malnutrition affects all parts of the immune system. The concept of dietary components being of paramount importance to immune functions is also tangible in the formulation of immunonutritional food. Other than “immunonutrition,” pro- and prebiotics represent typical products with demonstrated Immunomodulatory claims. A number of beneficial health-related effects have been claimed for the pro-pre-biotic category, including effects against antibiotic-associated or traveler’s diarrhea, improved stools, as well as wide array of immunity-related health claims.

Proactive action is therefore widely used. Functional foods are often defined as foods that contain some health-promoting components. Sometimes we can find them as designer food, medicinal food, nutraceuticals, or therapeutic food. Within this type of food, probiotics are the small but rapidly expanding area. More than 100 years ago, the idea of probiotics was promoted by Metchnikoff, who later won the Nobel Prize. Metchnikoff linked health and longevity to ingestion of bacteria present in yogurt. Numerous dietary factors are critical for the evolution of the microbiome in the large intestine. Several recent studies have shown that numerous diseases are triggered by changes in bacterial communities in the gut. However, this relation is bi-directional, as some types of bacteria in the gut will actually be beneficial. The gut is not just a simple barrier preventing the invasion of bacteria, but is actively involved in the maintenance of a rich and healthy community of gut bacteria. Gastrointestinal problems often develop after receiving heavy doses of antibiotics, because the gut bacteria are affected.

Prebiotics are non-digestible food ingredients that help to stimulate the growth and activity of bacteria in the digestive system. The whole idea was introduced in 1995 by Gibson et al.¹ The second term, sometimes mixed with the term “prebiotics,” is probiotics. It might be of interest that the term “probiotic” was initially used as an antonym of the term “antibiotics” and its translation from Greek means “for life.”

Probiotics

Probiotic refers to viable microorganisms that promote or support a beneficial balance of the autochthonous microbial population of the gastrointestinal tract. These are live microorganisms that are beneficial

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to the organism. It is important to remember that these bacteria are nonpathogenic microorganisms. A number of genera of bacteria and yeast are used as probiotics, including *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Bifidobacterium*, *Saccharomyces* and *Enterococcus*. The most common probiotics are lactic acid bacteria (*Lactobacillus acidophilus*) and bifidobacteria (*Bifidobacterium lactis*). These bacteria are usually consumed as part of fermented food with added live cultures. The use of yogurt is the most common example. It is important to note that the conditions in most food are not optimal for long-term survival of bacteria; therefore we have to remember the fact that the presence of bacteria is mentioned on the label does not necessarily reflect reality. The nutraceuticals potential and bioactive properties of polysaccharides including glucan have been investigated in depth during the last decades. For detailed information, see a comprehensive review by Sharma et al.²

Probiotics can reduce diarrheal incidence, lactose intolerance, lower serum cholesterol, stimulate immunity, control infections and via maintaining a healthy intestinal balance protect against colon and bladder cancer. Given the well-established health effects of glucan, it is not surprising that a combination of glucan with probiotics was studied. Using a fish model, a recent study demonstrated strong synergy in stimulation of immune system between glucan and probiotic strain *Shewanella putrefaciens*.³ The direct studies of the probiotic effects of glucans produced by lactic acid bacteria showed that these polysaccharides are not only a safe food additive, but also have unique properties that might facilitate its application in the food industry as a viscosifying and gelling agent. A detailed study testing prebiotic activity of glucans with nine probiotic strains of *Lactobacillus*, *Bifidobacterium* and *Enterococcus* shows strong prebiotic activities, strongly dependent of types of glucan and strain specificity.⁴

Food enhanced with barley-derived glucans significantly enhanced probiotic performance of beneficial bacteria. The main reasons for these effects are that they are highly fermentable by intestinal microbiota and enhance growth rate and lactic acid production of microbes in the human intestine. In addition, glucans have positive effects on bacterial adhesion to enterocyte cells.⁵

Prebiotics

Based on the scientific literature, the most studied prebiotics are oligosaccharides, primarily fructooligosaccharides (oligofructose and inulin) and galactooligosaccharides. Despite significant effort, the

single molecule responsible for these effects has not been found and saccharidic chains of 2-64 (sometimes 9-64) saccharide molecules are considered to be the most active. These short chains seem to be smaller than regular, often- insoluble glucan. However, we must remember that our body will, slowly but steadily, transform even the largest glucans into small, soluble fragments. Inulin is digested mainly by caecal microbiota after passing through small intestine.

Despite the fact that numerous foods contain prebiotics, we cannot call them prebiotics, as no food is a prebiotic. As more and more attention has been focused on prebiotics, it is not surprising that scientists also considered glucan. Not surprisingly, most of these observations were published quite recently. Generally, glucans in the gastrointestinal tract serve as a substrate for microbial fermentation and selectively stimulate the growth and activity of a small number of beneficial bacteria.

A study on fish showed that using glucan as a probiotic supporting the activity of *Lactobacillus* significantly lowered mortality from *Aeromonas* challenges.⁶ However, more has been done on the prebiotic front. An interesting study showed that the addition of glucan and starch during cold storage strongly increased survival of bifidobacteria strains in yogurt, most probably due to the protective effects on bifidobacteria stress by low temperature.⁷ Another glucan with high prebiotic properties was isolated from *Lactobacillus plantarum*.⁸ Similar effects were obtained when shrimp was used as an experimental model. The situation in calves is similar: feeding with tylosin and glucan as prebiotics has positive effects on selected humoral immunological parameters, including the total protein and gamma globulin concentration.⁹

Prebiotic potential of glucan was also tested on humans. A randomized, double-blind, placebo-controlled clinical study was aimed to evaluate the *in vivo* prebiotic potential of glucan. Fifty-two healthy volunteers were assigned to consume a glucan or placebo daily for 30 days. In volunteers over 50 years of age, glucan induced a strong bifidogenic effect and increase of bifidobacteria. The authors of this study concluded that the daily intake of a glucan was not only well-tolerated, but demonstrated strong bifidogenic properties in older, healthy volunteers consuming their usual food.¹⁰

A more detailed study compared a prebiotic activity with a structure of glucan. Nine probiotic strains of bacteria were used, with two structurally different versions of the same glucan. These probiotics showed different growth characteristics based on the types of glucan used, showing that these effects are not restricted to only one type of glucan. Readers seeking more details about different glucans as prebiotics should read an excellent review written by Synytsya.⁴ It should be noted that the beneficial effects of glucan on microflora were considered high enough to result in a clinical trial of beta glucan in polypectomized patients which is currently under way in Greece.

Conclusion

From all these effects, it is not surprising that there is widespread consensus among scientists that β -glucans are classified as prebiotics.¹¹ The most active glucans are cereal glucans, owing to their ability to pass undigested through the gastrointestinal tract.

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Conflict of interest

The author declares no conflict of interest.

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