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REVIEW ARTICLE

Prebiotics: A Brief Review

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ABSTRACT

Although antibiotics have proven beneficial against various diseases and improve human beings' overall health, excessive use of antibiotics may lead to an imbalance between the beneficial and harmful microorganisms, making our body more susceptible to infections. Antibiotic resistance is the second major concern. Prebiotic supplementation has gained interest in recent years to improve gastrointestinal health and immune function. Probiotic, prebiotics, and a combination of the two have evolved as good alternatives to antibiotics in case of gut health. Many potential prebiotics has been assessed, but only a few, including inulin, GOS, and FOS, have been validated utilizing human studies, while some are under trials for their beneficial effects on human health. So, the review aims to briefly explore the concept of prebiotics, their interaction with probiotics, and their effects on human health.

Keywords: Fructans, Inulin, Lactulose, Prebiotics, Probiotics.

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INTRODUCTION

Glenn Gibson introduced the concept of prebiotics and Marcel Roberfroid in 1995.[1] Pro and Prebiotics are known to improve the health status in the host (animal) by reducing the pathogen load through a better resistance to pathogenic bacteria colonization and enhanced host mucosa immunity.[2,3] prebiotics are known to encompass primarily short and long-chain fructans [Fructo-oligosaccharides (FOS) and inulin], lactulose, and galactooligosaccharides. When added in small quantities (5–20 g/day) into a diet, these compounds stimulate the growth of lactobacilli and bifidobacteria.[4] These bacteria have known beneficial effects majorly for gut health, but studies have shown their beneficial effects for other organ systems and the oral cavity. During recent years relationship between pre and probiotics has been an area of increasing interest, with both having beneficial effects on overall health. Considering the health benefits of prebiotics, they have emerged to be fascinating candidates for promoting human health conditions in association or as a replacement to probiotics.[5]

PREBIOTICS VS PROBIOTICS

Prebiotics

Prebiotic were first described as " non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health".[5] The definition was elaborated in 1995 by Gibson and Roberfroid.[6] The FAO Technical Meeting on Prebiotics in 2007 defined "prebiotics" as "a non-viable food component that confers a health benefit on the host associated with the modulation of microflora."[7] In 2017, ISAPP [International Scientific Association of Probiotics and Prebiotics] identified prebiotics as "a substrate that is selectively utilized by host microorganisms, conferring a health benefit".[6]

Probiotics

Probiotics are living microorganisms, principally bacteria that are safe for human consumption and, when ingested in sufficient quantities, have beneficial effects on human

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health beyond basic nutrition. They were defined by Fuller (1989) as 'A live microbial food supplement which beneficially affects the host animal by improving its microbial balance.[8] These microbes have distinct viability and have been known to provide various health benefits when given in sufficient doses. Different probiotics bacterial strains include *Aerococcus*, *Enterococcus*, *Lactobacillus*, *Vagococcus, Leuconostoc*, *Streptococcus*, *Carnobacterium*, *Tetragenococcus* etc. are grouped into LAB, i.e., probiotic lactic acid bacteria.[9]

TYPES OF PREBIOTICS

The prebiotics mostly consist of dietary fibers and oligosaccharides. Various compounds have been tested to determine their function as prebiotics. Some commonly used prebiotics are FOS [Fructo-oligosaccharides], Galactooligosaccharides , MOS [Mannan-oligosaccharides], Inulin, Lactulose, XOS [Xylo-oligosaccharides].[10] Prebiotics are naturally found in certain fruits like bananas, asparagus, garlic, tomato, and wheat.[6] Galactooligosaccharides, fructooligosaccharides, and trans-galactooligosaccharides are the most common prebiotics. Prebiotic fermentation occurring in the gut produces short-chain fatty acids, including butyric acid, propionic acid, and lactic acid, and these products are known to have multiple effects on the human body. This can be explained with the help of an example. Propionate affects T helper 2 in the airways and macrophages and dendritic cells in the bone marrows.[11,12] Short-chain fatty acids decrease the pH of the colon. Peptidoglycan is another prebiotics fermentation product that can stimulate the innate immune system against pathogenic microorganisms. The structure of prebiotics and the bacterial composition of gut determine the fermentation products.[13,14] The effects of prebiotics on human health are mediated by microorganisms' degradation products. For example, butyrate influences intestinal epithelial development.[15]

The MOS is thought to act by agglutination through the interaction of mannose-sensitive lectins, which are located on cell wall surface of specific gram-negative bacteria. MOS are also known for preventing colonization of harmful bacteria by competing for the attachment site in the digestive tract.[16,17]

Inulin is prebiotic which is neither digested nor absorbed in the small intestine, but it is quickly and selectively fermented by bacteria in further parts of the alimentary tract stimulating the proliferation of Lactobacillus and Bifidobacterium.[10]

There is little evidence regarding the action of Galactooligosaccharides on the GI system.

Galacto oligosaccharides are known to be metabolized by numerous bacteria that possess β-galactosidase, which are able to digest them. Due to this reason, β-GOS, because of their specific bond, are more selective than plants' GOS (α-GOS) for specific bacterial growth, particularly the Bifidobacterium species, as demonstrated in vitro.[18,19] Interestingly, it has been demonstrated that a β-GOS mixture plays a role in modulating immune function.[20]

Lactulose administration is patient and dose-dependent; not all subjects have the same beneficial response to lactulose administration and the microbiota composition before the beginning of the consumption could influence the bifidogenic effect of the lactulose.[21]

PRE REQUISITES OF PREBIOTICS[5,10,22,23]

Criteria for classifying a food ingredient as a prebiotic can be summed up as follows

- Should neither be hydrolyzed mammalian enzymes nor tissues
- Should not be absorbed in the gastrointestinal tract
- Should be resistance to acidic pH of the stomach
- Should be fermented by intestinal microflora
- This compound can selectively stimulate the growth and/or activity of the intestinal bacteria and this process should improve the host's health.
- Improve luminal or systemic aspects of the host defense system.
- Have an overall positive influence on the wellbeing of the host

ROLE IN HUMAN HEALTH

All prebiotics are fibers, whereas not all dietary fibers have prebiotic effects.[6] Recently, research has focused on the use of prebiotics and dietary fibers, since many of these polysaccharides can be metabolized by intestinal microbiota, which leads to the production of short-chain fatty acids. The metabolites of prebiotic fermentation also show anti-inflammatory and immunomodulatory capabilities, suggesting an interesting role in treating several pathological conditions.[20] Paradoxically, prebiotics may have a detrimental effect on lipid profile by producing some SCFAs, such as acetate. Acetate can be converted to acetyl-CoA, a substrate to synthesize fatty acids in hepatocytes[24] other effects include infection control on the skin[25] and optimizing healthy oral microflora.[26] There are clinical trials on the impact of prebiotics dietary fibers on the absorption of minerals, such as calcium, but the results are conflicting.[5] When used in combinations, prebiotics are probiotics that are known to be very beneficial for human health. Prebiotics selectively stimulate the growth of probiotics,

which is dose and strain-dependent. Prebiotics serve as a selective growth substrate for the probiotic strain during fermentation, storage, or its passage through the gut.[22] These two combinations implant live microbial dietary supplements and create a congenial environment for their survival in gut flora. Thereby, this environment in gut flora improves healthy microbial balance. So, the combination of prebiotics and probiotics may have an additive and synergistic effect in providing better oral health conditions.[6] Consuming prebiotics can improve immunity functions by increasing the population of protective microorganisms. Animal and human studies have shown that prebiotics can decrease the population of harmful bacteria by Lactobacilli and Bifidobacteria.[27,28,29]

In terms of oral hygiene, the prebiotics (e.g., glucomannans) provide the health benefits mechanistically by providing a carbon source selectively for the mouth friendly bacteria, where these bacteria more effectively hydrolyze the carbohydrates enzymatically and use the sugar residues for metabolism and growth, then the pathogenic organisms reduce the presence of cariogenic bacteria and also reduces their sugar residues – especially mannose. Prebiotics also help stimulate the immune system topically due to the production of chemical/ physiological messengers that draw fibroblasts to the wound site and contribute to the healing process and stimulate the production of collagen at wound sites.[30]

SIDE EFFECTS

Prebiotics are assumed to lack life-threatening or severe side effects. No serious side effects after the consumption of most prebiotics have been reported in the literature to date. Intestinal enzymes cannot break down oligosaccharides and polysaccharides, so they are transported to the colon for fermentation by the gut microbiota. Therefore, most side effects of prebiotics are related to their osmotic functions.[5] Hence, the only side effects of prebiotics are bloating, flatulence, diarrhea, and cramps. The length of prebiotic chains plays a pivotal role in influencing the development of side effects.[20] Prebiotics with shorter chain lengths is known to have more side effects.[5]

Few studies have stressed the fact that as potential alternatives or adjunctive therapies (synbiotics) to probiotics,[31] prebiotics may have similar safety concerns majority of which include risk of bacteremia, sepsis, or endocarditis, especially in patients with prominent immuno-deficiency (e.g., HIV, cancer, transplant), severe malnutrition or incompetent intestinal epithelial barrier (e.g., severe diarrhea, NEC).[32]

CONCLUSION

Prebiotics in combination with probiotics has been known to have a remarkable influence on human health. They are also known to show antioxidant activity and enhance immunity, and there is no harmful effect like antibiotic resistance and antibiotic residue. This makes them attractive agents that may help improve the quality of human life against various diseases other than the gut infections. Many studies highlight various positive effects of prebiotics, but there is a need for accurately designed long-term clinical and genomics studies to confirm these health benefits.

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