Prebiotics and Inflammatory Bowel Disease

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KEYWORDS

• Inflammatory bowel disease • Ulcerative colitis • Crohn disease • Prebiotics • Fiber

KEY POINTS

- Inflammatory bowel disease risk factors include poor diet, and corresponding low intake of dietary fiber, specifically prebiotics, which is fermented by the gut microbiota.
- Dietary fibers, many of which are potential prebiotics, have hundreds to thousands of unique chemical structures that may promote bacteria or bacterial groups to provide beneficial health effects.
- In vitro and in vivo animal models provide some support for the use of prebiotics for inflammatory bowel disease through inflammation reduction.
- Studies using prebiotics in patients with inflammatory bowel disease are limited and focus on only a select few prebiotic substances.

INTRODUCTION

Prebiotics are fermentable carbohydrates that vary greatly in chemical structure, giving rise to digestion by specific gut microbiota and eliciting discrete beneficial functions. Although hundreds to thousands of fermentable dietary fibers, which are potential prebiotic substances, exist in nature, use of prebiotics in research is often limited to a few distinct structural types. Research centered on prebiotic interventions to beneficially modify the gut milieu is increasing and includes modifying microbiota, improving intestinal barrier function, and producing beneficial metabolites for both local and systemic health benefit. Despite increasing use, limited data exist for prebiotic benefit for certain conditions, including inflammatory bowel disease (IBD). This

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article reviews prebiotic types and the various ways in which they modify the gastrointestinal tract related to IBD. The use of select prebiotics in IBD is described in detail, highlighting their potential effectiveness, as well as the lack of evidence, for their clinical use. Recommendations for future research are made.

PREBIOTICS: DEFINITION AND STRUCTURE

The term prebiotics has, over time, undergone some changes in its definition, although it still adheres to the concept of carbohydrates that make their way to the large intestine where they are fermented and promote beneficial bacteria.[1] At the time of the original definition in the 1990s, a focus was put on oligosaccharides, and larger soluble fibers, because it was found that certain of such carbohydrates promoted 2 genera of beneficial bacteria, namely *Bifidobacterium* and *Lactobacillus*.[2] The term prebiotics became synonymous with oligosaccharides, such as fructooligosaccharides (FOS) and galactooligosaccharides (GOS), as they were accepted in the scientific, although not necessarily the regulatory, community to promote a healthy colon through the favoring of these bacteria. It was true, too, that other dietary carbohydrates promote 1 or both of *Bifidobacterium* spp and *Lactobacillus* spp, and in the scientific literature examples can be found that also are claimed as prebiotic, such as resistant starch and β-glucans. However, as more was learned regarding other relevant beneficial colonic bacteria and the importance of maintaining a favorable gut ecosystem for health, it has become apparent that the concept of prebiotics has a broader, and perhaps more complicated, role in gut health.

Prebiotics are found within the larger class of carbohydrates known as dietary fiber. These carbohydrates include all plant carbohydrates taken in the diet, plus lignin, and although fibers can be broken down into various subfractions, in the current discussion fiber may best be divided into fermentable and nonfermentable fibers. Because prebiotics are all fermentable, a case could be made for a beneficial effect of all fermentable fibers and that they promote beneficial bacteria. Hence, the concept of prebiotics could potentially take in many types of fermentable fibers comprising both oligosaccharides and polysaccharides. In contrast, nonfermentable fibers are recognized for their water-holding property and laxation capacity, although it is not known whether nonfermentable fibers could also induce an environment in the colon in which beneficial bacteria might flourish.

Perhaps what is not well recognized by scientists and clinicians specializing in gastrointestinal health and the gut microbiome is the broad and complex range of dietary fiber chemical and physical structures that exist (see the review by Hamaker and Tuncil,[3] 2014). All dietary fibers, and therefore prebiotics, are composed of 1 or more sugar units (eg, glucose, fructose, galactose, arabinose) or sugar acids (eg, galacturonic and glucuronic acid) that are linked via glycosidic bonds. Although dietary fibers are chemically and physically classified in various ways, for the purpose of the current discussion related to IBD, it is perhaps useful to think of them as (1) plant cell wall polysaccharides of the cereals (mostly composed of cellulose, arabinoxylans, β-glucans, but also small amounts of pectin and even inulin in wheat), legumes (cellulose, pectin, galactans), tubers (cellulose, pectin), and fruits and vegetables (mostly composed of cellulose, pectins, xyloglucans); (2) plant storage oligosaccharides and polysaccharides, such as starch (those entering the large intestines being resistant starch) and inulin; (3) plant exudates (eg, gum arabic); and (4) animal-based carbohydrates (eg, galactooligosaccharides, chitin/chitosan). As discussed here, most prebiotics used in human studies for patients with IBD are in the oligosaccharide and inulin classes: classes 2 and 4, respectively. Plant polysaccharides can have complicated chemical structures (**Fig. 1** for the example of pectin),[3] which gut bacteria can use through specialized abilities to access and metabolize certain structural components.