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Functional Properties of Prebiotics

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ABSTRACT

Prebiotic are called Colonic foods which encourage the growth of favourable bacteria. Some of the known prebiotics include lactulose, lactitol and oligosaccharides. The benefits and functionality of probiotics can be improved by careful selection on the right prebiotic called synbiotic application . Lactulose a synthetic disaccharide is fermented by the colonic microflora resulting in changes in bacterial composition and metabolic activities of the colonic flora. Tagatose alters the composition and population of colonic microflora. Inulin and oligofructose are preferentially fermented by bifido bacteria creating a by-product of short-chain fatty acids. Prebiotics act in several ways to help prevent pathogen colonization and translocation. Insoluble dietary fibre (e.g.cellulose) reduces gut transit time and increases faecal volume, while it might get metabolised by the intestinal microflora. However , soluble dietary fibre gets highly metabolised by the gut microflora and results in: a) acidification of the intestinal content, b) production of short chain fatty acids (SCFA) and gases and c) increase in faecal bacterial mass and faecal volume (Roberfroid, 2007). Specific oligosaccharides and polysaccharides are metabolised by Lactobaccillus and Bifidobaterium, resulting in an increase in their numbers and beneficial activity in the gut. Prebiotics are also useful for their application in food science. Type of sugar moieties and the molecular weight of the prebiotic molecule, determine their selective or non-selective fermentation by the intestinal microflora. The oligosaccharides could prevent attachment of pathogenic bacteria to the intestinal enterocytes by blocking the bacterial lectins. They represent an opportunity for the fortification of the indigenous microflora with its beneficial members through functional diet.

Keywords: Functional foods, prebiotics, inulin, oligosaccharides

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INTRODUCTION

Functional foods are described as foods that provide health-benefits beyond its traditional nutrients. The term functional foods was first introduced in Japan in the mid-1980s and refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious. The tenet “Let food be thy medicine and medicine be thy food,” espoused by Hippocrates nearly 2,500 years ago, is currently receiving renewed interest (Claire,1998)[1]

Prebiotic was defined by Gibson and Roberfroid ,(1995)[2] as “a 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.” Synbiotics combine the properties of both probiotics and prebiotics. Prebiotics are not digested by human enzymes and therefore have a low caloric value and are efficiently used for their non-digestibility fibre-like properties, mainly stool bulking. (Kleessen et al., 1997; Den Hond et al., 2000)[3,4]. In other words they are *Colonic foods* encourage the growth of favourable bacteria. Some of food ingredients known to be prebiotics include lactulose, lactitol oligofructose oligosaccharides (GOS), tagatose, isomaltooligosaccharides, polydextrose, and digestive resistant maltodextrin.

The benefits and functionality of probiotics are dependent on their viability, growth, and metabolic activity, which can be improved by careful selection on the right prebiotic called synbiotic application .

By increasing the amount of prebiotics in the diet, it is possible to increase and maintain healthy bacterial gut flora in the host .To increase the probiotic efficacy in certain processed products like cereals, beverages and infant formulas they can be fortified with prebiotics during manufacturing process . In addition, a number of other suitable food components including nonspecific substrates, plants and their extracts, metabolites of microorganisms and polyunsaturated fatty acids may also be important in probiotic efficacy. From the three principal macronutrients of foods (i.e. proteins, carbohydrates and fats) only carbohydrates are currently represented in the prebiotic consent.

Lactulose is a synthetic disaccharide composed of galactose and fructose ((1,4)- galactosido-fructose). Lactulose is not metabolized or absorbed in the human small intestine. Once in the caecum, lactulose is fermented by the colonic microflora resulting in changes in bacterial composition and metabolic activities of the colonic flora. After ingestion of a large dose of lactulose ranged 20-60 g/day (Berge Henegouwen et al, 1987)[4], there has been an increase of bifidobacterial counts (Ballongue et al, 1997)[5]

The effect of lactitol on the intestinal flora has been extensively studied both in vitro and in vivo. Tagatose alters the composition and population of colonic microflora. Digestive resistant maltodextrin (DRM) has been shown to increase fecal concentrations of beneficial bacter (Flicklinger et al., 2000)[7].

The ingestion of the mother's colostrum and mature milk can be considered an extended maternal influence over the extra-uterine environment. Apart from the nutrients that breast milk provides, it also contains important compounds that boost the infant's immune system (slgA, lactoferrin, growth factors and cytokines). Moreover, breast milk contains prebiotic oligosaccharides that promote numbers of beneficial commensal bacteria in the gut (e.g. bifidobacteria and lactobacilli) and inhibit the attachment of pathogens to glycol conjugates on the intestinal surface – the first step in pathogen invasion.

Studies in preterm and term infants have shown that addition of prebiotics to infant formulas results in in-creased bifidobacteria and lactobacilli counts, as well as intestinal pH and metabolite profiles (short chain fatty acids, lactic acid), that are similar to those of breast-fed infants. In addition, studies have shown that supplementing infants' diets with inulin and oligofructose lowered the prevalence of sickness and related symptoms implying immune modulating effects. These studies provide evidence supporting the use of inulin and oligofructose as prebiotics in the defence against pathogens.

Prebiotics can act in several ways to help prevent pathogen colonization and translocation; (1) selective stimulation of commensal lactic acid bacteria allows them to efficiently compete for nutrients and ecological niches ensuring that pathogens cannot form stable viable communities (2) end-products of lactic acid bacterial fermentation of prebiotics act as an additional nutrient source for mucosal cells (3) lactic acid bacteria secrete organic acids and antibacterial proteins (bacteriocins) which inhibit pathogen growth (4) through the innate cross talk between commensal bacterial and the GALT, prebiotics have modulating properties on the immune system of the host.

Inulin and oligofructose are preferentially fermented by bifido bacteria creating a by-product of short-chain fatty acids (SCFA). SCFA act as a nutrient supply for bacteria and, more importantly, for the cells involved in the mucosa-blood barrier. In vitro studies have shown that SCFA improve barrier function and have muco-protective effects (Van Loo et al ,1995)[8]. In this way, inulin and oligofructose can improve intestinal wall strength.

Research on chronic inflammatory bowel diseases, e.g. ulcerative colitis (UC), Crohn's and pouchitis, has demonstrated clear bifidogenic effects after treatment with inulin and oligofructose. It is likely that the pathogenesis of chronic GI conditions creates imbalances in the gut flora.

Prebiotics as Bioactive nutrients

Non digestible carbohydrates or dietary fibre are either insoluble or soluble. Insoluble dietary fibre (e.g.cellulose) reduces gut transit time and increases faecal volume, while it might get metabolised by the intestinal microflora. However , soluble dietary fibre gets highly metabolised by the gut microflora and results in: a) acidification of the intestinal content, b) production of short chain fatty acids (SCFA) and gases and c) increase in faecal bacterial mass and faecal volume (Roberfroid, 2007)[9].

Non-digestible carbohydrates are specific oligosaccharides and polysaccharides that can be selectively metabolised by the "beneficial" bacteria belonging to the genera of Lactobaccillus and Bifidobaterium, thus resulting in an increase in their numbers and activity in the gut.

Physicochemical characteristics and properties

The physicochemical composition of the prebiotic carbohydrates is important not only for their effects in gastrointestinal physiology and function but also for their application in food science.

Factors such as the type of sugar moieties that make the building blocks, the type of glycosidic linkages present, the structural arrangement and the molecular weight of the prebiotic molecule, determine their selective or non-selective fermentation by the intestinal microflora. (Olano-Martin et al., 2000)[10.]

Simple sugars and oligosaccharides are known to be potent inhibitors of bacterial adhesion to epithelial cells by acting as receptor analogues to mucosal adhesion molecules . Human milk oligosaccharides lacto-N-tetraose and lacto-N-neotetraose act as cell surface receptors for *Streptococcus pneumoniae*, fucosylated oligosaccharides are receptors for E.coli and sialated oligosaccharides are recognised receptor sites for influenza viruses A,B and C, *Campylobacter pylori* and *Mycoplasma pnemoniae* (Kunz and Rudloff, 1993)[11].Prebiotics contribute to less energy production since they are not digested in the upper gut but get fermented in the colon. In healthy humans fructo oligosaccharides were found to have an energy value of 9.5 kJ/g (i.e. about half that of sucrose (Molis et al., 1996)[12].

Some prebiotic oligosaccharides could prevent attachment of pathogenic bacteria to the intestinal enterocytes by blocking the bacterial lectins, thus acting as anti-adhesive (Kunz, 1998)[13]. Enhancement of the beneficial microflora results in stimulation of host's immune system while inhibition of pathogens occurs as a result of competition for growth substrates and production of antimicrobial compounds, lactate and SCFA, (Schley and Field, 2002)[14],

Therefore, prebiotics represent an opportunity for the fortification of the indigenous microflora with its beneficial members through diet. This is of relevance to food safety since consumption of foods that have prebiotic ingredients could improve resistance to gastrointestinal infection.

Legislation and safety issues linked with the use of prebiotics in foods

Food products that contain prebiotics must comply with the general legislation that govern the labelling requirements and claims for foods. Although all aspects of food labelling are to a very great extent harmonised by European legislation, there is currently no consistent legal framework regarding claims and particularly health claims within the European Union (Gibson et al., 2000)[15].

This poses a serious drawback for the marketing of functional food products that relies heavily on claims linking consumption of the products with enhanced physiological functions or reduction of disease risk. Japan is the only country in the world that has, since 1991, developed a legal framework that permits the commercialisation of selected functional foods under the term FOSHU "Food for Specified Health Use".

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