CIBTech Journal of Microbiology ISSN: 2319-3867 (Online)
An Online International Journal Available at http://www.cibtech.org/cjm.htm
2013 Vol. 2 (2) April-June, pp.10-14/Patel et al.
Review Article

ISOMALTOOLIGOSACCARIDE: A PREBIOTIC COMPOUND BENEFICIAL FOR HEALTH

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ABSTRACT
Prebiotics are food ingredients that are good for the health. The prebiotics stimulate the growth of healthy bacteria such as *Bifidobacterium* and *Lactobacillus* in the gut and increase resistance to invade pathogens, any dietary component that reaches the colon intact is a potential prebiotic; however, much of the interest in the development of prebiotics is aimed at nondigestible oligosaccharides such IMO. Imo produce from starch. IMO supplemented diets resulted in significantly higher cecal bifidobacteria compared to the control diet. Isomaltooligosaccharides (IMO) stimulate growth of *Bifidobacterium* and *Lactobacillus.* Besides their beneficial effects on the intestinal tract and metabolism, IMOs have gained interest as food additives because they can replace partially or totally, liquid sugar syrups, giving new functionalities to the product. Indeed, IMOs are about half as sweet as saccharose and therefore can be used to produce different sweetness profiles. They have been identified as good humectants with low viscosity and water activity but highmoisture retaining capacity.

Key Words: *Prebiotic, Bifido Bacteria, Isomaltooligosaccaride, Short Chain Fatty Acid (SCFA).*

INTRODUCTION
Prebiotics
A prebiotic can be defined as 'a nondigestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one, or limited number of, bacteria in the colon that can improve the host health' (Gibson *et al.,* 1995). 'A prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/ or activity in the gastrointestinal microbiota that confers benefits upon host well-being and health'. The key ideas in both this and the earlier definition are 'selective' and 'benefit to improve the host health' (Chockchaisawasdeea *et al.,* 2012). Not all dietary carbohydrates are prebiotics, and clear criteria need to be established for classifying a food ingredient as a prebiotic. These criteria are: 1) resistance to gastric acidity, to hydrolysis by mammalian enzymes, and to gastrointestinal absorption; 2) fermentation by intestinal microflora; and 3) selective stimulation of the growth and/or activity of those intestinal bacteria that contribute to health and well-being (Marcel, 2007).
An alternative approach is the consumption of food ingredients known as prebiotic (Macfarlane *et al.,* 2006). The usual target species for such a dietary intervention are bifidobacteria and lactobacilli. Many studies have now confrimed that prebiotics are a valid approach to the dietary manipulation of the colonic microflora (Macfarlane *et al.,* 2006). The two requirements of a prebiotic are that it is not hydrolyzed in the small intestine and that it is selectively fermented in the colon by certain beneficial members of the colonic microbiota (*Bifidobacterium* and *Lactobacillus* genera) (Cho *et al.,* 2007). Many studies have now confirmed that prebiotics are a valid approach to the dietary manipulation of the colonic microflora (Gibson *et al.,* 1995).
In recent years, the market for probiotics and prebiotics as functional foods and dietary supplements is positioned for growth due to increased consumer awareness of the relationship between diet and health. Prebiotics beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria (healthy bacteria), while limiting the ability of harmful bacteria to multiply and thrive in the colon, thus improving the host's health (Phakkhateem *et al.,* 2000).

'Optimal' gut microflora can improve the intestinal microbial balance, Increase the resistance to pathogenic bacteria, Stimulate the immune response, Reduce the risk of cancer, improve calcium absorption, and Alleviate lactose intolerance. Prebiotics are foods or nutrients defined as nondigestible or low-digestible food ingredients that benefit the host organisms by selectively stimulating the growth or activity of one or a limited number of probiotic bacteria in the intestine (Cho *et al*., 2007). Prebiotics may be utilized as a dietary intervention to restore the gut microflora balance in elderly population, thus indirectly providing them with antipathogenic protection. (Phakkhateema *et al.*, 2000).

Isomalto Oligosaccaride

Isomaltooligosaccharides which are known as prebiotic branched oligosaccharides have been synthesized from starch (Premsuda *et al.*, 2012). Branched oligosaccharides (BOS) are one of the major prebiotic carbohydrates, including isomaltose, panose, isopanose, branched maltotetraose, and branched isomaltopentaose (Cho *et al.*, 2007). BOS are produced using a two-stage reactor system having two different enzymes (Seifert *et al.*, 2007). IMO are composed of glucose monomers linked by α-1, 6 (and rarely α-1,4) glucosidic linkages. IMO is produced from starch by the action of three separate enzymes. Firstly, starch is hydrolysed to maltooligosaccharides by α-amylase (EC 3.2.1.1) and pullulanase (EC 3.2.1.41). After that, α-glucosidase (EC 3.2.1.20) is added to catalyze a transfer reaction that convert the α-1, 4 linked maltooligosaccharide into α-1, 6 linked IMO (Panesar *et al.*, 2011). Immobilized α-amylase (E.C.3.2.1.1) liquefies starch in the first stage, and then the liquefied starch is processed by both β-amylase (E.C.3.2.1.2) and α-glucosidase (E.C.3.2.1.20) in a second stage. The transglucosidase activity of α-glucosidase is mainly involved in the production of BOS (Cho *et al.*, 2007). Moreover, branched IMOs produced with dextransucrase, known as glucooligosaccharides (GOSs) , oligodextran produced by controlled-hydrolysis of dextran , and non-reducing IMO-alditols produced via dextransucrase catalyzed glucosylation of alditols such as glucitol, mannitol, maltitol, or Isomalto are also considered as IMOs (Goffin *et al.*,2011).

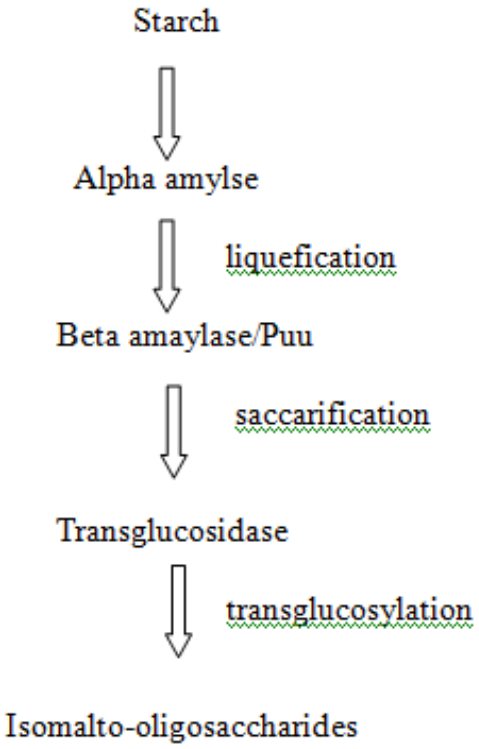

Figure 1: Isomalto-oligosaccharides are manufactured from starch

The major concern in classifying IMOs as prebiotics is that only IMOs with high degrees of polymerisation, i.e. isomaltotetraose and larger oligomers, are considered indigestible. Nevertheless, IMOs are widely used in various foods and drinks as sweeteners; they have 40% of the sweetness of sucrose and a calorific value of 2.8–3.2 kcal g (Chockchaisawasdeea e*t al.,* 2012). IMOs are found naturally in various fermented foods such as miso, sake, or soy sauce but also in honey (Gooffin *et al.,* 2011). Isomalto-oligosaccharides have a great potential to improve the physiochemical quality of many foods as anti-fading agent for food pigments, as food antioxidant and as a sweetener. In addition, these oligosaccharides have physiological functions such as the improvement of intestinal microflora based on the selective proliferation of bifidobacteria stimulation (Saman *et al.,* 2012).Indeed, IMOs are about half as sweet as saccharose and therefore can be used to produce different sweetness profiles. They can also be added to beer as nonfermentable sugar syrups to regulate sweetness and mouth feel. They have been identified as good humectants with low viscosity and water activity but high moisture retaining capacity (Goffin *et al.,* 2011).

IMOs are low-digestibility glucosyl "ALOs" (Anomalously Linked Oligosaccharides) considered as prebiotics and anticariogenic agents. (Goffin *et al.,* 2011).Biological effects of IMO on defecation frequency and blood lipid levels have been shown in young adults and experimental rodents (Goffin *et al.,* 2011). Although IMO supplementation was shown to decrease serum cholesterol concentrations in healthy college men, effects of indigestible oligosaccharides on blood cholesterol concentrations have been inconsistent (Hsiao-Ling *et al.,* 2001).

Isomalto-Oligosaccharides Properties

IMOs have been found to be of interest in the fields of foods, pharmaceuticals, and cosmetics due to their unique properties. The most significant property and the key to their success in particular in Asian countries, is their prebiotic character, leading to better global intestinal health, mineral absorption, cholesterol regulation, immunity, as well as prevention and resistance to various diseases (Goffin *et al.,* 2011). Isomalto-oligosaccharides are marketed in Japan and United States as dietary supplements and in functional foods (Sharma *et al.,* 2011).

Health Benefit of Isomalooligosaacaride

1. *Production of short chain fatty acid (SCFA) and stimulate the growth of bifido bacteria:* Isomaltooligosaccharide (IMO) was used preferentially by strains of Bifidobacterium bifidum, Bifidobacterium *longum*, and *Lactobacillus johnsonii*. The use of oligosaccharides as prebiotics should lead to production of intestinal lactic acid, an increase in short-chain fatty acid production, and lowering of pH in the large intestine (Saman *et al.,* 2012). Isomaltose oligosaccharide (IMO) is also known as bifidusfactor because of its powerful growth promoting effects on intestinal beneficial bacteria (Panesar *et al.,* 2011). A healthy intestinal flora helps safeguard the efficiency of our guts immune system, helps keep bad bacteria in check by the help of SCFAs from prebiotics which decreases luminal pH and thus suppresses growth of bad organism and transforms certain human waste products into substances that are useful to the organism (Sharma *et al.,* 2011). Fermentation and SCFA production are also thought to inhibit the growth of pathogenic organisms by reducing luminal Ph (Brownawell *et al.,* 2012). A low Ph reduces formation of toxic compounds such as ammonia, amines, and phenolic compounds from peptide degradation and decreases the activity of undesirable bacterial enzymes (Brownawel *et al.,* 2012). Effect of increased bifidobacteria and lactobacilli, short-chain fatty acids (SCFA) are produced as the end products of oligosaccharide fermentation. The profile of such SCFA varies between oligosaccharides and contains greater or lesser quantities of propionate and butyrate, both SCFA with positive implications in the prevention of colon cancer (Rycroft *et al.,* 2001).

Iso maltooligosaccharides have physiological functions such as the improvement of intestinal microflora based on the selective proliferation of bifidobacteria stimulation (Saman *et al.,* 2012). They are also associated with a lower risk of infections and diarrhea, and an improvement of the immune system response (Saman P*et al.,* 2012). IMOs have been developed to prevent dental caries, as substitute sugars for diabetics, or to improve the intestinal flora (Gibson and Rastall, 2006).Uses of IMO by infants &

children are equally beneficially in term of improved digestive health similarly as observed in the case of elderly population (Harmsen *et al.* 2000).

2. *Effect on Inflammatory bowel disease:* Abnormal bowel function, particularly constipation, is a common complaint of the ill or inactive elderly population (Sharma *et al.,* 2011).The enthusiasm with which probiotics have been used in inflammatory bowel disease (IBD) and their apparent benefits has led to the suggestion that prebiotics might also be useful (Macfarlane *et al.,* 2006) .Consumption of IMO effectively improved bowel movement, stool output and microbial fermentation in the colon without any adverse effect in elder peoples (Chen *et al.,* 2001). An IMO supplement could modulate bowel movements, and if this supplement influenced the nutritional status indices in institutionalized constipated elder men (Goffin *et al.,* 2011).

3. *Effect on Mineral Absorption:* A mixture of short chain fatty acids (SCFA), the fermentation products of indigestible carbohydrates, has also been shown to promote calcium and phosphorus absorption in the intestine. (Hsiao-Ling *et al.,* 2001) Uptake of calcium and magnesium is crucial for bone structure and increasing absorption can prevent conditions such as osteoporosis (Gibson and Rastall, 2006).

4. *Anti-Cariogenic Properties:* Isomalto-oligosaccharides are commercially important oligosaccharides and have many biological functions such as promotion of the growth of *bifidobacteria* in the large intestine of humans and animals and reduction of the cariogenic effect of sucrose (Tanriseven *et al.,* 2002). Koch and Miller proposed in 1882 that dental caries are caused by insoluble glucan gums forming on the surface of teeth (plaque), and the formation of acids under this plaque which attacks the tooth enamel. Studies with animal models showed that IMOs in place of sucrose reduce the amount of plaque formed and also reduces the amount of enamel attacking acids formed (Goffin *et al.,* 2011). Animal studies also demonstrated reduced cariogenic potential of this panose-rich oligosaccharide and showed that it induced significant but minimal caries in rats which have been super-infected with either *S.mutans* or *S. sobrinus* (Goffin *et al.,* 2011). It may be accounted for, in part, by the possible anticarcinogenic activity of butyrate. Butyrate, along with other short-chain fatty acids, is produced by bacterial fermentation of the various prebiotic oligosaccharides in the colon. Some studies suggest that butyrate may induce growth arrest, cell differentiation and may also upregulate apoptosis, three activities which could be significant for its possible anticarcinogenic activity (Macfrlane *et al.,* 2006.).

(5) *Effect on lipid metabolism:* The principal hypotriglyceridemic mechanism of action appears to be a decrease in liver lipogenesis through increased production of short-chain fatty acids by intestinal microorganism in the large bowel. Short-chain fatty acid production leads to increased portal concentrations of propionate relative to acetate which inhibits lipogenesis in hepatocytes (Panesar P *et al.,* 2011).

CONCLUSION

Prebiotics are food ingredients that are good for the health. Isomalto oligosaccride is an important prebiotic and it is manufactured from starch. Isomaltooligosaccharides (IMO) stimulate growth of *Bifidobacterium* and *Lactobacillus,* bifido bectria in the colon and produce short chain fatty acid this leading to better global intestinal health, mineral absorption, cholesterol regulation, immunity, as well as prevention and resistance to various diseases. IMO supplemented in the diets resulting in to control diet. Isomalto-oligosaccharides have a great potential to improve the physiochemical quality of many foods as anti-fading agent for food pigments, as food antioxidant and used as an artificial sweetener.

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