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Inulin and Oligofructose in Health and Nutrition

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Inulin is a plant storage carbohydrate, a term applied to a heterogeneous mixture of fructose polymers widely distributed in nature. Oligofructose is a subgroup of inulins composed of polymers with a degree of polymerization (DP) of less than 10. Inulin and oligofructose are not digested in the upper gastrointestinal tract. Accordingly, the calorie content is reduced. They stimulate the growth of bifidobacteria in the intestine. They do not increase serum glucose levels and do not stimulate insulin secretion.

Several commercial grades of inulin are available that have a neutral, clean taste and are used to improve the mouth feel, stability and acceptability of low-fat foods. Oligofructose has a sweet, pleasant taste and dissolves well. It can be used to enrich fiber foods, improve the taste and sweetness of low-calorie foods, and improve the texture of low-fat foods without detrimental organoleptic effects. Inulin and oligofructose have several functional and nutritional properties that can be used to develop innovative health foods for the modern consumer.

Key words: Health, Inulin, Nutrition, Oligofructose.

1. Introduction

The formation of the gut flora immediately after birth plays a key role in the development of the innate and adaptive immune systems. Under normal conditions, newborns inoculate their mother's flora as they pass through the birth canal. The diverse flora that lives in the mother's vagina and intestines feeds the baby. In the case of a caesarean section, this step obviously does not occur, but the consequences, if any, are not yet clear. In the gastrointestinal tract (GIT) of breastfed infants, bifidobacteria are soon selected for and become dominant.

This situation persists until weaning. The introduction of mixtures or solid foods immediately leads to diversification of the flora, which is expressed in changes in stool color, consistency and smell. Formula-fed infants have a diverse flora of Bifidobacteria, E. coli, and Bacteroides.

Human milk promotes the growth of bifidobacteria due to its high oligosaccharide content (10–12 g/l). These oligosaccharides are predominantly neutral low molecular weight molecules, depending on the mother's Lewis blood type. They inspired the addition of non-digestible oligosaccharides and inulin to infant formula for comparable bifidogenic effects.

The purpose of bifidogenic effects on the intestinal flora of infants is to counteract the current rise in allergic diseases and to protect against gastrointestinal infections. Breast milk prevents atopy and infections. The immune system of newborns is characterized by a Th2 profile, meaning that type 2 helper cells and cytokines predominate. It produces allergic inflammation by producing IgE-producing cells and eosinophilic stimuli.

In the normal population, gut bacteria contribute to the Th1 response to restore balance to tolerance. Bifidobacteria induce a Th1 response. Lack of adequate bacterial stimulation is thought to be responsible for the increased incidence of allergic diseases, also referred to as the allergic march. However, the sanitation hypothesis does not account for changes associated with earlier, much greater reductions in infectious diseases. Therefore, it is currently suggested to focus on differences in microbial exposure.

Children with and without allergies have different types of flora, and children without allergies have higher numbers of aerobic bacteria, lactobacilli, and bifidobacteria. Unlike Bifidobacterium teenagers, Bifidobacterium bifidus is more adhesive and appears to be particularly resistant to allergy.

Inulin and oligofructose may be safe inducers of bifidoflora, thus affecting intestinal and systemic immune balance. Here we reviewed all available information on the use of oligofructose and inulin in pediatrics, and were limited to peer-reviewed publications.

2. Manufacturing

The production process of inulin is very similar to the process of obtaining sugar from sugar beets. Roots are usually harvested, cut, and washed. Inulin is extracted from the root using a hot water diffusion process, then purified and dried. The resulting product has a molecular distribution with an average degree of polymerization (DP) 2 of 10–12 and a chain length of 2–60 units. Ready-made inulin powder contains 6-10% sugars, usually represented by glucose, fructose and sucrose.

They come from chicory root. It is not added after extraction. Inulin of the "High Potency" (HP) type has also recently appeared on the market. This product is made by removing shorter chain molecules. Inulin HP has an average DP of 25 and a molecular distribution ranging from 11 to 60. Residual sugars and oligomers were thus removed.

This product nearly doubles the performance of standard inulin without making it sweeter. Oligofructose is obtained from chicory in much the same way as inulin. The main difference is the addition of a hydrolysis step after extraction. Inulin is cleaved by the enzyme inulase into chains of 2 to 10 lengths with an average DP of 4. The resulting oligofructose product is ~30% sweeter than sucrose and contains ~5% glucose, fructose and sucrose on a dry matter basis solid foundation.

Oligofructose can also be synthesized from sucrose by transfructosylation performed by the enzyme β-fructofuranosidase, which links additional fructose monomers to the sucrose molecule. Fructans formed in this way contain 2-4 units of fructose related to terminal glucose. Glucose and fructose molecules formed as a by-product of the process and unreacted sucrose can be removed by chromatography. A typical commercial product contains 5% sugar.

The chemical structure of inulin is not just one molecule. It is a polydisperse β (2-1) fructan. In this mixture of linear fructose polymers and oligomers, each unit of fructose is linked by a β (2-1) linkage. Glucose molecules are usually found at the end of each fructose chain and are linked by α (1-2) bonds, as in sucrose. The chain lengths of these fructans range from 2 to 60 units with an average SP of ~10 (DeLeenheer and Hoebregs 1994, IUB-IUPAC Joint Commission on Biochemical Nomenclature 1982, VanHaastrecht 1995). A unique structural feature of inulin is its β (2-1) linkage.

These linkages prevent inulin from being digested like a typical carbohydrate and are responsible for its reduced caloric value and dietary fiber effects. Oligofructose is defined by the IUB-IUPAC Joint Commission on Biochemical Nomenclature and the AOAC as fructose oligosaccharide containing 2–10 monosaccharide residues connected by glycosidic linkages (Hoebregs 1997, IUB-IUPAC Joint Commission on Biochemical Nomenclature 1982). Oligofructose derived from chicory contains both fructose chains (Fm) and fructose chains with terminal glucose units (GFn). Synthesized oligofructose contains only fructose chains with glucose end units or GFn molecules. Both types of oligofructose contain β (2—1) linkages between the fructose molecules, and they both carry essentially the same nutritional benefits.

3. Functional Characteristics

The difference in chain length between inulin and oligofructose accounts for completely different functional properties. Due to its longer chain, inulin is less soluble than oligofructose and has the ability to form inulin microcrystals when sheared in water or milk. These crystals are imperceptible in the mouth, but interact to form a smooth, creamy texture and create a fat-like mouth feel. Inulin has

been successfully used to replace fat in spreads, baked goods, fillings, dairy products, frozen desserts, and dressings.

Oligofructose is composed of shorter-chain oligomers and possesses functional qualities similar to sugar or glucose syrup. It is actually more soluble than sucrose and provides ~30–50% of the sweetness of table sugar. Oligofructose contributes body to dairy products and humectancy to soft baked goods, depresses the freezing point in frozen desserts, provides crispness to low fat cookies, and acts as a binder in nutritional or granola bars, in much the same way as sugar, but with the added benefits of fewer calories, fiber enrichment and other nutritional properties. Oligofructose is often used in combination with high intensity sweeteners to replace sugar, provide a well-balanced sweetness profile and mask the aftertaste of aspartame or acesulfame k.

Both inulin and oligofructose are used worldwide to add fiber to food products. Unlike other fibers, it has no "taste" and can be used to add fiber without increasing viscosity. These properties make it a high-fiber product that looks and tastes like standard food. It's an invisible way to add fiber to your food. Oligofructose is commonly used in cereals, fruit yogurt supplements, frozen desserts, cookies, and nutritious dairy products. The nutritional properties of inulin and oligofructose are similar. Therefore, the decision on inulin versus milk powder

oligofructose is largely a function of the attributes desired in the finished product. For example, the use of high performance inulin would prove to be the method of choice when formulating a low fat table spread that has a creamy, fat-like mouth feel with no added sweetness. Conversely, when formulating a low calorie fruit preparation for yogurts using high intensity sweeteners, oligofructose could enhance the fruit flavor, balance the sweetness profile and mask any undesirable aftertaste. Another added benefit of oligofructose that is often capitalized on in yogurt is the prebiotic effect, which may serve to reinforce or enhance the action of probiotic cultures typically added to yogurt.

4. Caloric value

Inulin and oligofructose are used in many countries to replace fat or sugar and to reduce the calorie content of foods such as ice cream, dairy products, confectionery and baked goods. Inulin and oligofructose are lower in calories than common carbohydrates due to the β (2-1) bonds that link the fructose molecules together. This combination makes them indigestible human intestinal enzymes. Thus, inulin and oligofructose pass through the mouth, stomach, and small intestine without being metabolized. This has been proven by many scientific studies (Kuppers-Sonnenberg 1952, Lewis 1912, Okey 1919, Nilsson et al. 1988 Rumessen et al. 1990, Ziesenitz and Siebert 1987), and included studies of volunteers who underwent ileostomy surgery (Ellegard et al., 1997; Knudsen and Hessov, 1995). These studies show that almost all inulin or oligofructose ingested enters the large intestine and is fully fermented by the gut microflora. The energy obtained from fermentation is mainly a result of the production of short-chain fatty acids and lactate, which are metabolized and contributed to.

5 kcal/g usable energy for both oligofructose and inulin. Other fermentation byproducts include bacterial biomass and gases that are eventually excreted from the body. Due to the indigestion of inulin and oligofructose, it has been found to be suitable for consumption by diabetics. Researchers found no effect on serum glucose, stimulation of insulin secretion, or glucagon secretion.

Inulin has been used by diabetics for a long time and has been reported to be beneficial to diabetics at high doses (40-100 g/day).

5. Dietary Fiber

Another important nutritional property of inulin and oligofructose is their action as dietary fiber. Dietary fiber can be defined in two ways: analytical and physiological. The analytical definition of dietary fiber used by the AOAC is “plant cell residue that resists hydrolysis by human dietary enzymes”.

Inulin and oligofructose definitely fall within this definition and are currently measured analytically using the recently approved AOAC Fructan Method 977.08. Although there is no official list of physiological functions for which fiber must meet the definition of fiber, generally accepted physiological effects of fiber include effects on bowel function and improved blood lipid parameters. Dietary fiber is also usually low in calories.

6. Conclusions and Future Directions

The interest and number of reports on the use of inulin and oligofructose in pediatrics since the last review in 2005 is impressive. Now in the formula it is considered a dogma that a mixture of inulin and GOS is bifidogenic. Oligofructose alone or in combination with inulin may also increase bifidobacteria in young children.

Clinical studies report encouraging data on the immune-mediated effects of prebiotic supplements. Fewer childhood fevers, fewer gastrointestinal and respiratory infections, and fewer atopic dermatitis. It is likely that bifidogenic factors are required to achieve these desirable goals.

The demonstrated bifidogenic effect on gut flora is not the only mechanism involved. Compared to probiotics, prebiotics may have different or more pronounced effects on infant intestinal metabolism because they are substrates for fermentation itself. Other mechanisms of action, such as the contribution of osmotic effects to the lumen, probably make prebiotics and probiotics very different agents. The importance of osmotic factors and changes in the SCFA profile must be determined. Pediatricians welcome the laxative effects of inulin and oligofructose, as constipation and abdominal cramps are common complaints.

Effects on water balance have not been reported. Are prebiotics considered to protect against infections, allergies, or are they also therapeutic? Probiotics have been shown to be effective for the treatment of acute infectious diarrhea, but prebiotics have not. Unwanted changes in the intestinal ecosystem are responsible for numerous intestinal disorders.

It is difficult to explore how nutritional interventions alter the gut environment, possibly alter the expression of specific genes, and play a key role in the early development of GI disorders.

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