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The prebiotic inulin as a functional food – a review

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Abstract. – The newborn digestive tract is rapidly colonized right after birth. The type of feeding could significantly influence this colonization process. Infant formulas like inulin try to mimic the bifidogenic effects of human milk by addition of prebiotics. Moreover, studies in the recent past have evidenced important effects of inulin during early infant life. The present review article will highlight recent updates about the use of inulin in the pediatric clinical setting.

Key Words:
Functional foods, Inulin, Breast milk, Infants.

Introduction

Breast-feeding is considered as the gold standard for the optimum nutrition and protection for developing infants[1]. There is compelling evidence that breast-feeding has positive effects on health in the newborn and later life[2]. The World Health Organization has recommended exclusively breast-feeding for infants from birth to six months, and is continued partially up to the age of 2 years[3,4]. Although the majority of the mothers start breastfeeding their infant from the first day (50-75% of mothers), the percentage of exclusively breast-fed infants at 4 months is quite different[5].

In an attempt to maintain the breast milk benefits, the formula milk manufacturers try to offer products that could simulate the composition and biological effects of human milk as closely as possible[6,7]. A focus of research, driven by a commercial interest, is the development of some functional foods called prebiotics to confer benefits for the host health. This review article is also focused on the prebiotic called inulin and will discuss all important aspects and updates about its pediatric use in the clinical setting as well.

Inulin And Oligofructose

The Joint Food and Agriculture Organization (FAO) in association with the World Health Organization (WHO) have proposed the deciding factors affecting the classification of carbohydrates and are suggested to be based on their molecular size, polymerization degree, bond type and on monomers features[8]. Based on above literature, carbohydrates are broadly divided into two 3 categories primarily based on the degree of polymerization, but inulin is found in multiple molecular forms. So, the existence of certainly confirmed line of difference amongst oligosaccharides and polysaccharides is not a recommended by IUB–IUPAC Joint Commission on Biochemical Nomenclature[9].

Food supplement inulin falls in oligosaccharides group. Furthermore, the main group of oligosaccharides is further sub categorized into two broad categories viz. digestible oligosaccharides that included maltodextrins, which are widely used in food industry to substitute fat, to modify the texture of the products and as sweeteners. The other group is the non-α-glucan oligosaccharides, among which we highlight inulin and fructo-oligosaccharides[10]. Maltodextrins are digestible carbohydrates, whereas inulin and fructo-oligosaccharides pass through the upper gastrointestinal system without being hydrolyzed and then, reach the colon where they stimulate the development of the bifidus-predominant flora[11]. So they are called "non-digestible oligosaccharides" (NDO)[12]. NDOs also have the basic characteristic of being soluble and fermentable dietary fiber[13]. Inulin and oligofructose are natural food ingredients widely found in many plants, vegetables, fruits and cereals including leek, onion, wheat, garlic, banana and chicory[14]. It has been estimated that the average daily consumption of inulin and oligofructose in Europe is between 3-10 g/day and between 1-4 g/day in America[15]. The most important source of inulin and oligofructose for the food industry production is essentially the chicory, which is a biennal plant.

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Food Applications of Inulin and Oligofructose

The consumers demand foods with both great taste as well as health benefits[16]. Inulin and oligofructose have many nutritional, technological and health-promoting properties and are widely used in functional foods. Oligofructose is used mixed with intensity sweeteners to replace sugars providing a great taste and masking the after taste of aspartame. It is usually used in dairy products, baked goods, frozen desserts, low fat cookies and granola bars[17]. Because of the gelling characteristics, inulin is also used in dairy products, table spreads, baked goods, cream cheeses, processed cheeses, frozen desserts and dressings replacing the fat content. For example, in dairy products, inulin improves the flavor and provides the creamier mouth feel. Due to the non-digestibility by the intestinal microflora, inulin and oligofructose are used as ingredients in the diabetic's food products. Furthermore, both inulin and oligofructose are used as a fiber ingredient in food products. Moreover, both are also a good source of better viscosity and taste. In addition to this, both products have an effect on intestinal function, increasing stools frequency, stools weight and reducing the pH level[16].

Effects ofI and/or Oligofructose in Newborns

Roberfroid[18] has confirmed the existence of nomenclature for oligofructose and inulin terms as both terms are in use in different studies, and some authors have even used only oligofructose for the identification of both the compounds. Furthermore, the term fructan is being utilized for representing any compound constituting one or more fructosyl fructose linkage including inulin and oligofructose as well. The investigations on the beneficial clinical outcomes of use of inulin/oligofructose have been demonstrated well in literature. Meyer and Stasse-Wolthuis[19] reported significant bifidogenic changes on the microbiota composition upon consumption of inulin or oligofructose at recommended doses. The elevation of *Bifidobacterium* has been demonstrated well as well as studied well in response to supplementation of prebiotic in adults[20,21]. Similarly, inulin and related compounds including long-chain fructan polysaccharides (i.e., long-chain inulin and fructooligosaccharides (FOS) have shown promising effects in the studies on healthy newborns[22,23].

Possible Reported Side Effects

There are reports that evidenced negative aspects too and now we will discuss them one by one.

Effects on weight

Some researches reported the weight gain (g/day), length and head circumference gain (cm/week) of the infants in prebiotic and control formula group[24-26]. No individual study reported significant differences in weight; however, a meta-analysis[27] of most of the previously mentioned studies showed that the weight gain increased significantly in the prebiotic-supplemented group (1 g/day) compared to control formula. Also, a meta-analyses review[28] has evidenced that prebiotic supplementation is associated with slightly greater weight gains. These results showed that prebiotics have no negative effects on weight gain and allow a proper growth of newborns. Furthermore, no significant effects of prebiotics were observed in length and head circumference gain of infants in a meta-analysis[29].

Effects on Stool Consistency and Frequency

Concerning the stools frequency and consistency, Fanaro et al[30] concluded that prebiotics in infant formulas increase significantly the stools frequency compared to control formula and also some studies[31,32] found that the stools from the prebiotic group were significantly softer compared to control group. Also, a prospective work, not included in the previous meta-analyses, was performed with 160 healthy term infants. Infants were randomly assigned to receive standard formula with 0.4 g/dL GOS/FOS (90% galactooligosaccharides and 10% long-chain inulin) or control formula (standard formula) during the first 12 weeks after birth. The results showed significantly higher frequency of soft stools and in prebiotic formula group as compared to control group[23]. Regarding the digestive tolerance, Rao et al[28] showed no difference between prebiotic and control formula group in the occurrence of colic, regurgitation, vomiting and reported crying. On the other hand, Ziegler et al[31] evidenced that infants fed by a prebiotic supplemented formula (based on GOS and lactulose) had a higher risk of irritability, eczema and diarrhea. The above report justified its results by concluding that prebiotics could affect the infant's immunity; however, there were no consistent data and further researches would be necessary. So, certainty about the negative aspects of prebiotics is still an

important research question. Moreover, lower occurrences of gastrointestinal infections have been confirmed in a multicenter prospective study[33] involving 342 healthy full term infants apportioned to the GOS/FOS formula. Also, a statistically non-significant effect of prebiotic supplementation on respiratory infections was observed in the above work proving its beneficial effects on respiratory systems of infants. However, besides this beneficial aspects, one negative observation highlighted by the European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) showed induction of a state of dehydration in infants treated with prebiotics due to frequent water stools, which could be life threatening in some cases[34].

Conclusions

The applications of prebiotics viz. inulin in the clinical setting is emerging. However, there are reports, which have evidenced few negative effects. So, there is need of further research to improvise efficacy of prebiotics along with taking care of associated side effects.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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