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THE ROLE OF DIETARY FIBERS IN CHILDREN'S HEALTH

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Abstract

Dietary fiber (DF) is a polymer of high molecular weight carbohydrates which are not hydrolyzed by endogenous enzymes in the intestine of human beings, which are found in food and which have physiological effects beneficial for health. The major sources of DF are of plant origin: cereals, legumes, fruits, vegetables and tubercles. DF can be classified in soluble (pectins, hemicelluloses, inulin, gums, mucilage, psyllium, and glucomannan] and insoluble (cellulose, hemicellulose, methylcellulose, lignin, and synthetic fibers) and has the ability to retain toxic substances ingested or produced in the alimentary tract during digestive processes, to reduce intestinal transit time, to promote rapid elimination of the fecal bolus, to

reduce the time of contact of the intestinal mucosa with carcinogenic and mutagenic substances, to increase the microbial biomass, to reduce the pH of the medium, and to form protective substances by means of bacterial fermentation of food compounds. Although the literature has reported several effects of the intake of DF (reduction of coronary diseases, control of arterial hypertension, dyslipidemias, diabetes, cerebrovascular accidents, gastrointestinal disease, and cancer), little is known about the effect of DF on children's health. The objective of the present study was to describe the main characteristics of DF, its role in the diet and its effects in the presence of two very common problems in the pediatric age range, i.e., constipation and obesity.

Keywords: dietary fibers – nutrition – children's nutrition – puericulture

DIETARY FIBERS AND CHILDREN'S HEALTH

Dietary fiber (DF) can be defined as a carbohydrate polymer with ten or more high molecular weight monomer units that are not hydrolyzed by endogenous enzymes in the human intestine, that are present in foods habitually consumed and that have beneficial physiological effects on health. These fibers can also be obtained from food raw material by means of physical, chemical, enzymatic or synthetic procedures [1-3].

The main sources of DF are of plant origin: cereals, legumes, fruits, vegetables and tubercles. The major components of DF are non-starch polysaccharides (cellulose, hemicellulose, gums and mucilage, pectins), oligosaccharides (fructans), analogue carbohydrates (starch resistant and maltodextrin resistant), lignin, substances associated with non-starch polysaccharides (phenolic compounds, cell wall protein, oxalates, phytates, cutin, suberin), and fibers of animal origin (chitin, chitosan, collagen, and chondroitin) [4,5]. As a part of cereals, the bran layers are a phytochemical source that contribute to the antioxidant function of grains (6).

Table 1. Main dietary fiber types and their food sources

Fiber type	Sources
Non-starch polysaccharides	Zucchini, sugar beets, carob, algae, oatmeal, potatoes, barley, plant exudates, seed extracts, brans, fruits, whole grains, vegetables, unpeeled apple, oleaginous fruits, plant cell wall, locust seed, greenbeans

Fiber type	Sources
Oligosaccharides	Garlic, onion, banana, chicory
Analogous carbohydrates	Green bananas, potatoes, whole grains, legumes, polydextrose, seeds
Substances associated with non-starch polysaccharides	Whole cereals, fruits, vegetables
Fibers of non-plant origin	Shrimp shell, mushrooms, seafood, yeasts

DF can be classified in two categories according to their water solubility: soluble and insoluble. The soluble fibers are pectins, hemicelluloses, inulin, gums (carob, fenugreek, guaran), mucilage, psyllium and glucomannan, which tend to form a gel when entering into contact with water, increasing the viscosity of partially digested foods in the stomach. Insoluble fibers such as cellulose, part of hemicellulose, methylcellulose, lignin and synthetic fibers remain intact throughout the gastrointestinal tract and contribute to the formation of the fecal bolus, stimulate intestinal motility, increase the excretion of bile acids, and also have hypocholesterolemic and antioxidant properties [7]. While short-chain fibers are mainly fermented in the cecum and in the ascending colon, long-chain fibers are fermented throughout the colon [8].

In the large bowel fibers are partially or completely fermented by the gut microbiota to yield short-chain fatty acids (SCFAs) and gases. In humans, this fermentation process is estimated to generate 2,5 kcal/g and may provide up to 10% of daily energy intake (9).

DF intake is beneficial to health because of the ability of fibers to retain toxic substances ingested or produced in the alimentary tract during digestive processes, to reduce intestinal transit time, to promote a rapid elimination of the fecal bolus, to reduce the time of contact between the intestinal mucosa and carcinogenic and mutagenic substances, to reduce the pH of the medium, and to form protective substances by means of bacterial fermentation of food compounds (10). Any undigested carbohydrate that reaches the colon will be fermented by the intestinal bacteria in order to produce SCFA and gases such as methane, hydrogen, carbon dioxide, oxygen, as well as ammonia, contributing to flatulence as the main side effect. In turn, SCFA (especially propionate, acetate and butyrate) are absorbed and metabolized by hepatocytes, peripheral tissues and colonocytes for which they serve as a source of energy. The increased production of SCFA leads to a reduction of colonic and intracellular pH, and the more acidic medium inhibits the proliferation of pathogenic organisms as well as the formation of toxic degradation products, in addition to reducing bile acid solubility and

facilitating calcium absorption [11,12]. Fermentation also influences the fecal volume in an indirect manner by stimulating the growth and consequent increase of the microbial biomass. DF also increases water retention, which facilitates evacuation [13,14.

The current fiber intake recommendations for adults are 25-35 g/day and the guidelines for consumption in children are based on data from studies in adults. Therefore, recommendations of fiber intake during childhood are still inconclusive. For the age range up to 2 years the suggestion is to introduce in the diet cereals, vegetables and fruits of easy acceptance and digestion from weaning to the transition to the family diet. For children older than 2 years the recommendation has been fiber consumption calculated according to the child's age in years plus 5 grams. The American Academy of Pediatrics recommends intake of 0,5g/kg body weight for children older than 2 years, while Dietary Reference Intakes indicates that people all ages should consume 14 g/100 kcal, and for children 19g/day (1- 3 y) and 25 g/day (4 – 8y) (15, 16).

Although many authors have described several effects of DF intake in adults such as reduction of coronary diseases, control of arterial hypertension, dyslipidemia, diabetes, cerebrovascular accidents, gastrointestinal diseases, and cancer [17,18], little is known about the effects of DF on children's health. It is known that the prevalence of chronic diseases has been gradually increasing in the pediatric age range, including constipation and obesity which, in addition to being responsible for various physical complications, may also trigger emotional changes in children and adolescents [19,20].

Some studies suggest that a higher DF intake was associated with a lower body fat percentage in children at age of 9 years and with lower serum total cholesterol in children at ages of 13 months to 9 years (21).

Constipation is a symptom of a condition that can be classified as organic or functional depending on the causal factors. Organic constipation, which results from pathological conditions, is observed at lower frequency, whereas constipation of functional cause is the more common [22]. It is a commom condition in children and the world prevalence ranges from 1% to 80% and its course is usually prolonged, affecting quality of life more than other gastroenterological diseases [23]. The symptoms of chronic constipation are recurrent and consist of pain at evacuation due to the elimination of hardened feces, fear to evacuate, irritability, soiling, abdominal distention, recurrent abdominal pain, lack of appetite, depression, low self-esteem, anal fissures and urinary incontinence, among others [24).

Although studies calculating the economy with the use of fibers in constipation already exist [25], the real benefits of fibers are still unclear and evidence about this conduct is still conflicting. It has been stated that low fiber intake may not be a factor triggering constipation in all cases but may represent a risk for its maintenance and that the quantity of fibers ingested is associated with the development of the condition [26,27]. On the other hand, there are studies that did not detect differences in fiber intake between children with and without constipation [28]. There are also studies reporting breastfeeding as a protective factor against constipation since maternal milk contains, among various substances, undigestible oligosaccharides that act as DF. Thus, early exposure to this type of fiber may stimulate the growth of beneficial bacteria that would promote maturation of the gastrointestinal tract [29]. In addition to dietary intake, fiber supplementation is also being tested, as is the case for mannan, a water-soluble fiber that has been found to be beneficial for children with chronic constipation. [30].

As is the case for constipation, the prevalence of obesity is growing among children and adolescents all over the world, currently representing a public health problem. These individuals show various complications due to the disease, including a greater prevalence of chronic constipation compared to non-obese individuals [31]. Several studies have demonstrated various complications of childhood obesity related to a low fiber intake, such as the development of nonalcoholic fatty liver disease [32].

Among the beneficial effects of fiber intake for obese individuals, particularly important are the control of calorie intake due to more rapid satiety [33] and a better bioavailability and utilization of minerals [34].

In addition to other important aspects of childhood obesity there is also the high risk of the onset of cardiovascular diseases [35]. Complications of obesity related to the presence of a chronic inflammatory process such as the onset diabetes, vascular diseases, depression and certain types of cancer have already been observed in adults [36-38]. Within this context, DF is considered to be important for the reduction of lipid oxidation [39]. No studies demonstrating the association of DF with the improvement of the chronic inflammatory aspects provoked by obesity in children have been detected in the literature. However, despite the different current scenario due to the nutritional transition, older observations have suggested in the past an inverse relationship between DF intake and obesity. This because obesity used to be rare in developing countries where DF intake used to be high, in contrast to a low DF intake in developed countries, where childhood obesity was already common [40]. Recent studies have confirmed the association between a low DF intake, among other factors,

and excess weight in children and adolescents [41]. There are also studies suggesting a beneficial effect of a diet with high fiber intensity for children [42].

Like all other nutrients, DF play an important role in health and should be contemplated in the diet by providing appropriate presentation and quantity according to the different characteristics of the various phases of childhood [43]. High consumption of cereal fibre has some effects as: increased satiety, improve laxation, decreased transit time, reduction of adiposity, increased short-chain fatty acids production, attenuation of post prandial glycaemia/insulinaemia, reduced total and/or LDL serum cholesterol levels, beneficial effect on mineral absorption and modulation of colonic microflora, that was associated with reduced risk of all-cause mortality and death from diabetes, cardiovascular disease, infections, respiratory disease and cancer.(7).

Healthy eating habits that are learned during childhood will be incorporated into the life style of the individuals, contributing to the reduction of diseases of adulthood that have an early start during infancy.

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