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Effects of Dietary Fiber from Brown Algae on Energy Intake and Body Weight

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Abstract: In recent years, brown algae dietary fiber is safe and nontoxic, and has many biological activities, especially in controlling appetite, regulating body weight, regulating blood sugar and lipid metabolism, and regulating intestinal flora, which has attracted the attention of researchers. As a part of diet, dietary fiber is closely related to the change of intestinal microecology. The change of intestinal microecology is closely related to obesity. For example, intestinal flora can improve obesity and related metabolic diseases through its functions in energy harvesting, metabolic signals and inflammatory response. Dietary fiber, as a part of diet, can change the proportion and abundance of intestinal flora, improve inflammatory response, and regulate intestinal hormone and lipid metabolism to improve obesity. However, the recommended intake, types and mechanism of dietary fiber in preventing and treating obesity need further study. In this paper, the effects of dietary fiber from brown algae on energy intake and body weight were discussed, and its potential mechanism was analyzed, which provided scientific basis for the development and application of marine functional products.

Keywords: Brown algae dietary fiber; Energy intake; Weight.

1. Introduction

Obesity is a state of harm to health caused by excessive accumulation of body fat. Brown algae dietary fiber is a marine dietary fiber extracted from the cell wall of brown algae, and its role and mechanism in body weight control have attracted wide attention of researchers in recent years [1]. Obesity is a risk factor for cardiovascular and cerebrovascular events, hypertension, diabetes, tumors and other diseases, and even related to all-cause death of the population. Obesity is caused by the interruption of energy balance, which is related to factors such as heredity, living habits and eating environment, and the diet with high dietary fiber can prevent obesity [2]. Studies have shown that dietary fiber can effectively improve the composition and structure of intestinal flora, and regulate the metabolic level of the host body by metabolizing the fermentation products of dietary fiber. The change of intestinal microecology is closely related to obesity. For example, intestinal flora can improve obesity and related metabolic diseases through its role in energy harvesting, metabolic signals and inflammatory response [3]. Foods rich in dietary fiber usually have low energy density, which directly delays the emptying of stomach contents, increases satiety and reduces energy intake to control weight, and also has the functions of improving blood sugar, lowering cholesterol and relaxing bowels [4].

With the improvement of living standard, the role of dietary fiber intervention and the regulation of intestinal flora in the prevention and treatment of obesity has attracted much attention. Human intestinal flora is significantly involved in the production, storage and consumption of energy in diet. Human intestinal flora may be an important factor that links diet with obesity, which is influenced by diet and responds to changes in diet. As an indispensable part of diet, dietary fiber intake is closely related to intestinal flora and obesity [5]. Therefore, the intervention of dietary fiber and the adjustment of intestinal flora are important strategies to prevent the global obesity epidemic. In recent years, brown algae dietary fiber, which is safe and nontoxic, has many biological activities, especially in controlling appetite, regulating body weight, regulating blood sugar and lipid metabolism, and regulating intestinal flora, and has entered the field of vision of researchers [6]. In this paper, the effects of dietary fiber from brown algae on energy intake and body weight were discussed, and its potential mechanism was analyzed, which provided scientific basis for the development and application of marine functional products.

2. Source and main biological activities of dietary fiber from brown algae

2.1. Effects of dietary fiber on human metabolism

With the development of society and the improvement of people's living standard, people's diet structure has undergone great changes, and people have begun to pursue high-calorie, high-protein, high-fat and refined foods. The accompanying modern diseases such as obesity, hypertension, hyperlipidemia, fatty liver and diabetes are becoming more and more common. Dietary fiber is an edible carbohydrate that can't be digested by human body. It can be divided into soluble and insoluble dietary fiber according to its solubility. Dietary fiber extracted from different sources and different processing methods has great differences in composition and chemical structure, and its physiological functions are also obviously different [7]. Moreover, the undigested substances in dietary fiber can provide the carbon source needed for intestinal microbial reproduction, and have intestinal microecological function. There are many hydrophilic groups in the chemical structure of dietary fiber, which has strong water-holding capacity. It can absorb several times of its own weight of water, showing high water swelling rate and water holding capacity. This physicochemical property makes it have the function of absorbing water and preventing intestinal diseases, and the water-soluble dietary fiber has higher water-holding capacity than water-insoluble.

2.2. Main biological activities of dietary fiber from brown algae

When food rich in dietary fiber enters the digestive tract, it absorbs water and swells in the stomach, and forms high-viscosity sol or gel, which will produce satiety and reduce food intake and heat absorption. In recent years, brown algae dietary fiber, as a green and healthy food, has been widely used in bread, meal substitutes and other food industries, and because of its aqueous solution and gel properties, it has been widely used in 3D bio-printing materials, sustained-release materials, nanoparticles, medical dressings and other fields. Brown algae dietary fiber is an active substance extracted from dark algae, which exists in the cell wall of brown algae in the form of water-insoluble salt. It is an acidic gel polysaccharide. Studies have shown that brown algae dietary fiber can affect the digestion and absorption function of intestinal tract, prevent the onset and persistence of some cardiovascular and gastrointestinal diseases, play an important role in maintaining normal health of human body, and have potential use as dietary supplement [8]. It is not only a good food for obese patients, but also increases the peristalsis of gastrointestinal tract, increases the volume and speed of human defecation, reduces the pressure in rectum, and at the same time reduces the pressure in urinary system, thus alleviating the symptoms of urinary system diseases such as cystitis, bladder calculus and kidney calculi, and quickly discharging poisons from the body.

3. Regulation of dietary fiber from brown algae on organism metabolism

3.1. Regulation of blood sugar

Brown algae dietary fiber has obvious influence on the permeability of lipid digestion. In an experiment, protein stable emulsion was used to simulate digestion in the mouth, stomach and small intestine. It was found that adding 0.1% brown algae dietary fiber to pig intestinal mucus could reduce the diffusion coefficient of fluorescent labeled lipids in emulsion chyme, which indicated that brown algae dietary fiber could change the permeability of intestinal mucus layer and reduce the absorption rate of fat in small intestine [9]. Brown algae dietary fiber has high viscosity and gelling characteristics, which can increase the viscosity of gastrointestinal chyme, absorb water and some nutrients at the same time, thus hindering the absorption of lipids such as glucose and cholesterol. Using functional foods such as probiotics and prebiotics to influence the structure and quantity of intestinal flora, and improving glucose and lipid metabolism and insulin resistance is considered as an important way to develop safe and effective functional foods to improve glucose and lipid disorders and metabolic diseases. The regulation process of glucose and lipid metabolism of brown algae dietary fiber is shown in Figure 1.

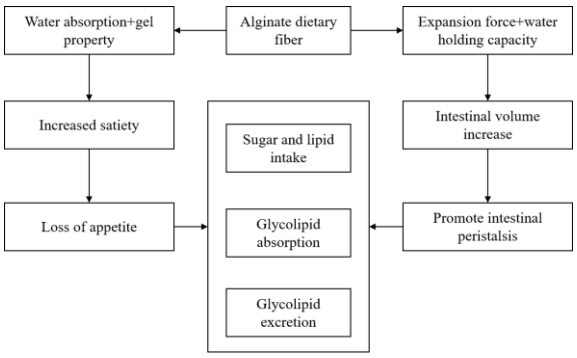

Figure 1. Regulation process of glucose and lipid metabolism of brown algae dietary fiber

The increase of chyme viscosity can slow down the diffusion rate of chyme, delay the transmission time and increase the thickness of the water layer without stirring, thus reducing the absorption rate of glucose. Brown algae dietary fiber absorbs water and swells, stimulates intestinal peristalsis, reduces intestinal digestion and absorption capacity, and promotes defecation. Brown algae dietary fiber contains many hydrophilic groups, has good water-holding capacity and swelling power, can increase the volume and speed of human defecation, and make the feces large and soft, so that it can easily pass through the intestinal tract. Intestinal flora changes dynamically and effectively with the change of diet, and so does the richness of intestinal flora. The research of changing the plant-based diet to meat-based diet and increasing dietary fiber intake found that the diversity and richness of intestinal flora changed rapidly after the change of dietary structure. Calcium-containing brown algae dietary fiber can reduce the level of cholesterol in blood, and its mechanism may be that brown algae dietary fiber reduces intestinal reabsorption, stimulates cholesterol in liver to synthesize bile acid, and leads to increased excretion of bile acid in feces, thus reducing plasma cholesterol.

3.2. Effect on energy intake and weight

With the deepening of the research on the relationship between obesity and intestinal flora, scientists have found that the increase of body weight is closely related to the number and abundance of firmicutes and Bacteroidetes in the intestine, which account for about 98% of the intestinal flora. Firmicutes help the body absorb energy from food, and Bacteroidetes mainly play a major role in the metabolism of polysaccharides and steroids [10]. Using functional foods such as probiotics and prebiotics to influence the structure and quantity of intestinal flora, and improving glucose and lipid metabolism and insulin resistance is considered as an important way to develop a safe and effective way to prevent and treat metabolic diseases caused by obesity. Intestinal flora, a metabolic product that affects intestinal flora, can decompose dietary fiber that the human body can't digest, produce short-chain fatty acids, and participate in regulating the energy metabolism of the body; At the same time, it participates in the regulation of host gene function, and affects the host's intake and absorption of glycolipids and other substances.

The physical and chemical characteristics and functional characteristics of dietary fiber from different sources were studied. It was found that kelp dietary fiber had the strongest swelling power and water holding capacity compared with other dietary fibers. The results of small intestine exercise test also showed that kelp dietary fiber had the best intestinal

propulsion rate among several dietary fibers from different sources, while the soluble dietary fiber from kelp dietary fiber mainly came from brown algae dietary fiber. Adding dietary fiber from brown algae to daily diet has negative energy balance effect, which can reduce appetite and energy intake, so as to achieve the purpose of weight control. Brown algae dietary fiber can produce volume effect on intestinal tract, stimulate intestinal peristalsis, accelerate food residue discharge, reduce intestinal digestion and absorption capacity, and promote glucose and lipid excretion. Figure 2 shows a fat-reducing meal material with brown algae dietary fiber.

Figure 2. Fat-reducing food ingredients with brown algae dietary fiber

Brown algae dietary fiber contains many hydrophilic groups and has good water-holding capacity. Higher water-holding capacity can increase the volume and speed of defecation, and reduce the pressure in rectum and urinary system. The fucoidan dietary fiber reacts with gastric acid to form colloid, increase the viscosity of gastric contents, cause gastric antrum to swell, stimulate the mechanical tension receptors in the distal gastric wall, provide satiety signals to the brain center, output instructions to reduce food intake, reduce appetite, and reduce the digestion and absorption rate of nutrients. Using MRI technique, transparent gel blocks were observed in the stomach of rats fed with brown algae dietary fiber and calcium, which could obviously increase the stomach capacity of rats, affect the gastric distension and gastric emptying rate, and lead to the decrease of food intake. Researchers found that brown algae dietary fiber forms a hard lump in the stomach, and think that the gel formed by brown algae dietary fiber may be the reason for the enhancement of satiety by increasing stomach swelling and activating gastric wall tension receptors.

4. Conclusions

Brown algae dietary fiber can inhibit the absorption of glycolipid, promote the excretion of glycolipid, and affect the digestion and absorption ability of body. At the same time, it can adjust the type and quantity of intestinal flora, and affect the metabolites of intestinal flora, so as to improve the metabolic disorder of glycolipid and prevent metabolic diseases induced by it. As dietary fiber that is not directly digested and absorbed by human body, brown algae dietary fiber can form gel in stomach, prolong gastric emptying time, and then reduce appetite and energy intake, which is helpful for obesity patients to lose weight. In terms of lipid metabolism and regulating intestinal flora, brown algae dietary fiber can promote bile acid secretion, increase the content of short-chain fatty acids in intestinal tract through microbial fermentation, and regulate the abundance and composition ratio of intestinal flora, thus playing a series of biological activities. As a kind of dietary fiber, brown algae dietary fiber is rich in brown algae. It is of great significance to develop functional food based on brown algae dietary fiber, which can regulate body weight and body fat, and it will provide a new way of food therapy with multiple effects for obese people. Increasing the research on the health effects of brown algae dietary fiber and broadening its application fields can not only meet the needs of the vast food market, but also optimize and improve the dietary structure of Chinese people, reduce the occurrence of related diseases and ensure people's health at the same time of economic development.

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