Effects of Dietary Fiber on Diet and Intestinal Microflora

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ABSTRACT
There are many microorganisms in the human body, among which intestinal microbes are the most diverse and abundant. Intestinal flora refers to the general name of the microbes living in the intestinal tract, mainly composed of firmicutes, Bacteroidetes, proteobacteria, actinobacteria and other bacteria. The composition of intestinal flora is not invariable and the structure of intestinal flora is influenced and restricted by many factors. Factors such as genetics, age, sex, diet, lifestyle, and antibiotic use can all contribute to changes in gut microbiota. This paper reviews the effects of dietary fiber on intestinal microflora in daily life, and introduces the effects of dietary fiber on intestinal microflora in detail.

Keywords: *Dietary fiber, intestinal flora, diet*

1. INTRODUCTION

In recent years, with the rapid development of economy and the improvement of living standards, people's lifestyle and diet have also undergone great changes. Intestinal tract is not only an important place for digestion and absorption of human body, but also the largest immune organ, playing an extremely important role in maintaining normal immune defense function [1]. The human gut is inhabited by a wide variety of microorganisms called the gut microbiome. A wide variety of intestinal bacteria constitute a huge and complex micro-ecosystem, which evolves together with the host and directly participates in human digestion, nutrient absorption, energy supply, fat metabolism, immune regulation, disease resistance and many other aspects, playing an important role in human health [2]. More and more evidence shows that intestinal flora can regulate absorption of dietary fat and fat-soluble vitamins, decomposition of carbohydrates and synthesis of amino acids, etc. [3]. Metabolic diseases such as obesity and non-alcoholic fatty liver are closely related to structural changes and diversity disorders of intestinal flora [4]. Studies have shown that high-fat and high-cholesterol diet will lead to structural changes in intestinal flora, which is reflected in the decrease of bacteroidetes and bifidobacteria, and the increase of Firmicutes and proteobacteria. Intestinal flora can detoxify heavy metals in a variety of ways (absorption, metabolism, isolation and excretion), among which diet is a major factor. Different diets have great differences in intestinal microbial structure due to their different nutritional structures [5].

With the improvement of living standard, people's diet has changed a lot. The problem of diet health has gradually become the focus of society. The human body's first exposure to complex microbiota begins at birth through the birth canal [6]. Intestinal microbiota is not immutable, and it will change with different people, objects and environments. There are many influencing factors in intestinal tract, among which diet is considered to be the most important determinant of the structure of intestinal microflora. More and more studies have shown that dietary composition directly affects the composition of intestinal flora [7,8].

Dietary fiber is the general name of polysaccharide and lignin that cannot be digested by the human body. It is also known as the seventh nutrient and can be divided into water-insoluble dietary fiber and water-soluble dietary fiber according to their different solubility. Dietary fiber can not be digested and absorbed by the small intestine, but can be stored in the large intestine through partial or full fermentation to produce physiological functions such as hypoglycemic and cholestatic alcohol, promoting defecation, preventing obesity and eliminating harmful substances in the body [9]. In recent years, foreign researchers have found that dietary fiber can change the composition of intestinal microflora [10,11], and domestic studies have also confirmed that dietary fiber can regulate the type and composition of intestinal microflora. Dietary components, as the energy metabolism source of intestinal bacteria, play an important role in changing the composition of intestinal microbes and affecting the integrity of intestinal barrier function [12].

A large number of studies have shown that dietary fiber and intestinal bacteria have a certain mutual regulatory effect. Dietary fiber first plays a very important role in human body. Most dietary fiber will

not be digested, directly into the large intestine, and dietary fiber with water, ion exchange, adsorption, etc. Will affect large intestine for the absorption of dietary fiber, in the intestinal flora can carry on the related to the dietary fiber decomposition, produce digestive enzymes to digestive enzymes as part of pantothenic acid, while pantothenic acid sufficient to regulate the digestion and absorption of the intestinal tract [13]. On the other hand, to maintain the related vitality of intestinal flora, it is necessary to have nutrients. Protein, fat, cellulose and vitamins are all nutrients of intestinal flora. Therefore, dietary fiber intake actually provides certain nutrients for intestinal flora, which can provide an appropriate value-added environment for intestinal flora. And bacteria can use cellulose for related synthesis, synthesis of vitamins is the human body's essential nutrients, inhibit the increase of streptococcus, escherichia coli, so as to avoid a series of problems.

2. RESEARCH

2.1 Effects of dietary components on intestinal microflora and intestinal barrier

In addition to monosaccharides (such as glucose and fructose) and disaccharides (such as sucrose and maltose) that are easily absorbed by the human body, diet also contains a large number of polysaccharides that are not digested by the human body, namely dietary fiber [14]. The human body itself cannot secrete the polysaccharide hydrolases necessary for the decomposition of these polysaccharides, but the intestinal flora can secrete a variety of polysaccharide hydrolases to degrade dietary fiber and use them as its own energy source [15]. Dietary fibers in food mainly include resistant starch, non-starch polysaccharides and oligosaccharides, which can induce the growth of intestinal bacteria secreting polysaccharide hydrolase [16]. Walker, etc. [17] of 14 diet overweight men to study the intestinal flora, the results showed that high resistant starch diet can increase the relative abundance of thick wall bacteria in the gut, non-starch polysaccharides and low sugar diet can increase the relative abundance of bacteroides, show that dietary fiber can increase the intestinal bacteroides and thick wall relative abundance of the door, to avoid obesity. Dietary fiber can also effectively promote the growth of some probiotics, such as fructose-oligosaccharides, which can increase the proportion of intestinal bifidobacteria from 12.4% to 21.0%[18]. Sonnenbur et al. [19] studied the changes of intestinal microbes in mice with human microbiota under low-fiber diet, and the results showed that low-fiber diet significantly reduced the microbial diversity in the intestinal tract of mice, but such microbial diversity could not be recovered when the mice were given a normal fiber diet. Zhang Zhiyu et al. [20] found that low-fiber diet aggravated the inflammatory response induced by OVA in allergic mice, and dietary fiber intake reduced helper T (HELPER T, helper T) in intestinal lymph nodes by inhibiting serum OVA-specific immunoglobulin E-mediated (IgE) level.

The production of Th2 cytokines in Th2 cells increased the release of Th1 cytokines, which significantly inhibited allergic reactions. In addition, dietary fiber intake also increased the relative abundance of Bacteroidetes and actinobacteria, decreased the relative abundance of Firmicutes and proteobacteria, and significantly increased the relative abundance of probiotics such as Lactobacillus and bifidobacteria. Dietary fiber produces a large amount of endogenous short-chain fatty acids (SCFAs) from catabasis of intestinal bacteria, and dietary fiber and bacterial SCFAs can promote oral tolerance and prevent food allergy by enhancing retinoic acid dehydrogenase activity, Treg cell differentiation and IgA generation in CD103+DCs [21]. Dietary fiber has a variety of health properties, including a reduced glycemic response and reduced cholesterol levels, which may contribute to weight control [22]. Tucker et al. [23] conducted a study to investigate whether changes in fiber intake affect body weight and found that eating more foods with high dietary fiber content can reduce the risk of weight gain.

2.2 The mechanism of dietary fiber regulating intestinal microflora

Dietary fiber after glycolysis intestinal flora, the main metabolite is SCFAs, including acetate, propionate, butyrate, SCFAs can lodge The intestinal wall cells to provide energy source, can also be transferred to the peripheral circulation, via the portal vein as a signal molecule, adjust the host a variety of signal mechanism [24], high dietary fiber food for health benefits, to a large extent, it is related to the mechanism of SCFAs in intestinal flora metabolism. Lin et al. [25-26] found in their study that compared with the normal control group, the levels of substances such as acetate, butyrate and propionate in fecal metabolites of colorectal cancer patients decreased, while increased dietary fiber intake improved the activity of intestinal flora to produce butyrate, providing a large amount of butyrate and reducing the risk of colorectal cancer [27]. Therefore, dietary fibre-rich food supplementation and regulation of SCFAs production and composition is an effective way to improve the health status of the host, especially by increasing butyrate content, to improve the preobesity events of rats, including hepatic steatosis and elevated serum total cholesterol level [28]. Pectin is an important water-soluble dietary fiber that is present in the cell walls of fruits and vegetables. [29] It was found that bifidobacterium longum BB-46 combined with pectin was more effective in increasing butyrate producing bacteria in rats than bifidobacterium longum BB-46 alone. Butyrate produced by pectin fermentation

can inhibit intestinal cholesterol absorption and progression of atherosclerosis in lipid-carrying protein E-deficient mice [30]. Another major metabolite of intestinal flora is trimethylaminen-oxide (TMAO), and elevated circulating TMAO level is considered to be a risk factor for a variety of diseases, such as cancer [31], diabetes [32], cardiovascular diseases [33], etc. Although TMAO is not directly produced by dietary fiber through intestinal microflora fermentation, regulating intestinal microflora and choline utilization pathway through dietary fiber can reduce circulating TMAO concentration. Li et al. [34] found that soluble dietary fiber reduced trimethylamine metabolism and inhibited TMAO production by regulating intestinal flora. β -glucan is a kind of soluble fiber, and diet supplemented with β -glucan can reduce serum TMAO concentration in patients with chronic kidney disease, and is safe and effective [35].

TMAO is transformed from choline compounds, but the regulatory effect of dietary fiber may be more significant than the transformation effect of choline itself. Leal-witt et al. [36] observed in their study that changes in TMAO level were not related to differences in choline intake, but were negatively related to fiber intake. Therefore, dietary fiber regulates the level of various metabolites of intestinal flora, which is conducive to maintaining the balance of body dynamics and preventing and treating diseases. Acetate, also known as acetate, is the most abundant SCFAs and plays an important regulatory role in body weight control and pancreatic insulin sensitivity by affecting lipid metabolism and glucose homeostasis [37]. The relevant mechanism of acetate in regulating host immune function has been increasingly explored. Inflammasome is a key component of immune homeostasis, and its maladjustment can lead to various inflammatory responses. Xu et al. [38] found that acetate can interact with short chain fatty acid receptor (G protein-coupled receptor 43, GPR43), reduces Ca^{2+} mobilization, promotes nod-like re Ceptor protein 3 (NLRP3) ubiquitination, and eventually induces NLRP3 degradation through autophagy. Thus reducing NLRP3 inflammasome associated inflammation. In vivo studies, acetate protected mice from NLRP3 inflammasome dependent peritonitis and lipopolysaccharide-induced endotoxemia; It also reduced the levels of pro-inflammatory cytokines and chemokines, down-regulated the phosphorylation level of Mito Gen-activated protein kinase (MAPK) in lung tissue, and protected mice from lipopolysaccharide induced acute lung injury through its anti-inflammatory and antioxidant activities [39].

In the tumor microenvironment, immune T cells compete with tumor cells for glucose, limiting the metabolism of T cells and leading to low reactivity during cancer, which is conducive to tumor development [40]. Qiu et al. [41] found that low reactive T cells can be genetically reshaped and activated by acetate surface, improving their ability to produce Interferon-γ and enhancing their anti-tumor ability. In addition, Pandey et al. [42] found that after acetate intervention on tumor cells, cell survival regulatory factors and cytochrome C expression could be increased to inhibit tumor cell survival.

2.3 Mechanism of dietary fiber affecting lipid metabolism through intestinal microecological pathway

Studies have shown that dietary fiber of different foods and forms can improve the intestinal flora, and the physical and chemical properties and content of dietary fiber can have a significant impact on the composition of intestinal flora and its metabolites [43]. Animal experiment proves, cereals, bean dregs, red jujube, bananas, etc in the food dietary fiber can promote the proliferation of bifidobacterium and lactobacillus, enterobacter and enterococcus, gas harmful bacteria such as clostridium capsule proliferation, and suppress the effect of harmful bacteria and promote the growth of beneficial bacteria are enhanced with the increase of concentration of dietary fiber. The solubility of dietary fiber is closely related to its function. Li Ti et al. [44] found that dietary fiber from soybean dregs prepared by wet microparticle method can promote beneficial bacteria growth more effectively than dry grinding method, indicating that water-soluble dietary fiber has a better effect on promoting the growth of probiotics. This is because water-soluble dietary fiber, such as glue and resin, can be decomposed and utilized by microbes in the intestinal tract to produce acetic acid, propionic acid, butyric acid and other volatile fatty acids and CH. And other gases, reduce the intestinal pH value, so as to inhibit the growth of Salmonella, Escherichia gram-negative bacteria, promote the growth of bifidobacteria, lactobacillus and other beneficial bacteria; Insoluble dietary fiber mainly accelerates fecal excretion through water absorption and expansion, shorteningits residence time in the intestinal tract and discharging a large number of bacteria and their fermentation products, so as to harmonize the balance of bacteria and the health of microenvironment. In terms of affecting sugar and lipid metabolism, water-soluble dietary fibers have stronger physiological functions. They can not only dissolve in water, but also absorb water and expand, delaying the body's digestion and absorption of sugar, thus inhibiting the reaction of postpranpranal glucose and insulin increase. At the same time, water-soluble dietary fibers can chelate cholestol. Reduce blood LDL cholesterol level by 5% to 10% [45].

3. DISCUSSION

Diet has a significant impact on the composition,

diversity and richness of intestinal flora, and dietary fiber is an important energy source for cecum and colon flora. Intestinal flora produces SCFA and is beneficial to the host. SCFA plays an important role in maintaining health, energy metabolism and preventing certain diseases. SCFA produced by dietary fiber may prevent diet-related obesity and improve energy homeostasis. The main SCFA products of microbial fermentation of fiber in intestinal tract are acetate, propionate and butyrate, among which propionate has an inhibitory effect on cholesterol synthesis.

At present, more and more studies have shown that diet can affect host health through the interaction with intestinal flora, and different food processing methods may also affect the physical and chemical properties of food to a certain extent, thus affecting the regulatory effect of its flora.

4. CONCLUSION

With the improvement of living standards and the proposal of the concept of health preservation, people pay more attention to health. Dietary fiber has attracted more attention due to its unique function, and the effect of dietary fiber on intestinal flora is one of the research hotspots at home and abroad. A large number of research results show that intestinal flora is involved in human metabolic activities. People's Daily dietary habits have a certain impact on the structure and abundance of intestinal flora, and dietary fiber in fruits and vegetables can improve the abundance and structure of intestinal flora, increase the number of dominant bacteria and reduce the number of harmful bacteria to a certain extent. At the same time, the stability of intestinal barrier can be maintained and improved by increasing the content of short-chain fatty acids, so as to enhance immunity and avoid various diseases caused by intestinal flora disorder. Therefore, in-depth understanding of the different effects of dietary fiber on intestinal flora is of great practical significance for improving the added value of dietary fiber processed products, preventing various intestinal diseases and improving human health.

AUTHORS' CONTRIBUTIONS

The paper was written by the author independently.

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