Effects of Adding Probiotics on Food and the Human Body

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Abstract. The normal growth and reproduction activities of probiotics have beneficial effects on the human body: regulating the human intestinal flora, promoting digestion and absorption, forming a barrier to protect the intestinal mucosa, reducing blood sugar and cholesterol, enhancing human immunity, scavenging free radicals to delay aging, etc. In addition, the active metabolites secreted by it also play an important role in the human body: decomposing cholesterol to produce acids to inhibit pathogenic bacteria, breaking down fats to produce short-chain fatty acids to promote the self-regulation of gastrointestinal mucosal cells, and metabolizing macromolecular substances (proteins, polysaccharides) to produce nutrients (amino acids, monosaccharides). And it is also widely used in food processing, human health and aquaculture. Probiotics also play an important role in food processing, where can change the pH value of food, extend the shelf life of food, improve the flavor of food, as a substitute for additives and increase the nutritional value of food. Although the traditional concept is that only live probiotics can exert their probiotic effects, more and more studies have shown that some of the probiotic effects of probiotics are closely related to their active metabolites, and some of the active metabolites produced by probiotics can stimulate tissue development and affect the body's nutritional level and physiological functions. At present, the more studied probiotic active metabolites mainly include extracellular polysaccharides, bacteriocins, organic acids, short-chain fatty acids, vitamins, which has been shown to play an antibacterial, where can prevent and treat diseases, regulate and improve the state of the gastrointestinal tract, promote digestion and absorption and other effects. In this paper, two effects of probiotics on the human body are analyzed, including the effects of growth and reproduction and active secretions on human health, and the research progress of probiotics on dairy products and plant products. In addition, the relevant mechanisms of action are highly summarized. The effect of the clinical effective dose of probiotics on functional foods and improving physical health is elaborated, as well as the influencing factors of probiotic intake on intestinal health, and the recommendations of current international standard regulations on probiotic intake are introduced. Through the analysis of the effect of probiotic intake on human intestinal health, the types, functions and applications of probiotic active metabolites are reviewed, and the current existing problems are proposed, and it is hoped to provide practical reference for the industrialization and R&D application of food processing, health care, livestock breeding and other fields, as well as the formulation of probiotic-related standards and regulations.

Keywords: Probiotics, Food, Human Health, Influencing factors, Mechanism.

1. Introduction

In recent years, probiotics have become well known for their high safety, non-resistance, and impact on host health. Probiotics are derived from the Greek language. In 1857, Pasteur discovered a putrefactive microorganism, lactic acid bacteria. In 1889 Tissier discovered bifidobacteria through research. Because of the research of previous generations, in 1930, the Japanese medical doctor Shinoda commercialized fermented yogurt by cultivating caseous lactic acid bacteria. In 1990, scientist Moro discovered that it was Bacillus acidophilus through isolation experiments. Probiotics' own life activities and the active substances they secrete will have a positive effect on the health of the human body [1].

Although the active metabolites of probiotics have good prebiotic function and application potential, they still need to be further explored in terms of increasing yield, reducing production purification costs, and exploring mechanisms of action [2]. Yogurt, fermented milk, cheese and ice cream are the most common probiotic products on the market, but probiotic-enhanced foods are no longer limited to dairy products, and non-dairy products with added microorganisms: fermented fruit

and vegetable drinks, also have great commercial value. Different types of probiotics have different functional characteristics, common strains, acidophilus has a bacteriostatic function, but also can enhance the absorption of lactose, optimize the composition of microorganisms in the intestine. However, various types of bifidobacteria can promote digestion and absorption and prevent various inflammations in the intestine. Some probiotics also have the function of scavenging free radicals and anti-aging. With the abuse of drugs and the increasing prominence of antibiotic disadvantages, as well as people's pursuit of health, human beings have a new understanding of probiotics [3]. Compound probiotic products are gradually becoming a hot topic of research, which also means that probiotics and related products will benefit more people. Adding an appropriate number of probiotics to food can play a good role in bacteriostatic bacteria, and can play a role in preventing diseases and improving the health of the human body [4].

As a physiological flora, probiotics have many benefits for the human intestine, and have preventive effects on many diseases such as hypertension, diabetes, hyperlipidemia and cancer. At the same time, probiotics also have good nutritional health care functions, so they are widely used in the food field, such as functional foods and food additives, and are deeply loved by consumers [4]. In summary, the intake of the right number of probiotics has multiple benefits for the human body: stimulating cells to prevent malignant proliferation of gastrointestinal cells against tumors, protecting the gastrointestinal mucosa to inhibit bacteria, scavenging free radicals and anti-aging. Prevention and treatment of various diseases [5]. However, the specific mechanism of action of probiotics is still lacking in research, and the role of probiotics on the human body, as well as related applications in food, still need further exploration.

This paper summarizes the research on probiotics in recent years and analyzes the effects of probiotics on food, including the flavor substances brought by probiotics to food and the regulation of pH value. This paper also summarizes the effects of probiotics on human health and food characteristics. These include the active metabolites associated with the growth and reproduction of probiotics, as well as the functional role of these active substances. Provide more reference for the problems and development direction of probiotic products in food processing, medical, animal husbandry and other fields, as well as probiotic products on the market.

2. Effects of probiotics on human health

Of all the flora in the gut, probiotics are the dominant flora. Probiotics can bind to the mucosa of the gastrointestinal tract through protein specificity, forming a biological barrier and adhesion. Probiotics due to the difference in strains, the function is also different, probiotics can regulate the gastrointestinal flora, maintain the balance of the internal environment, laxative, regulate immune and allergic reactions, for the body's microbial flora, microenvironment, immune system and so on play a pivotal role [6]. Among the approved probiotic health foods, the most claimed function is to enhance immunity, followed by the regulation of intestinal flora.

In addition, probiotics are first colonized in the intestinal mucosa through adhesion, occupy favorable growth space through habitat, ecbiosis, competition and secretion of metabolic substances, play an adhesion role, and achieve the effect of inhibiting foreign harmful microorganisms. Most of the probiotics have the characteristics of resistance to stomach acid and bile salts, so they are more able to experiment with the environment in the gastrointestinal tract than the general microorganisms, so as to form a growth advantage, thereby forming a stable flora and playing a role in beneficial human health [6]. The size of this type of adhesion is closely related to the ability of probiotic cells to secrete proteins in vitro to bind specifically to surface cells. The adhesion ability of probiotics is an important indicator, which is a prerequisite for probiotics to be able to dominate in the human gastrointestinal tract, and to form a stable flora through continuous reproduction, thus playing a role in regulating the intestinal flora [6].

2.1. Promote digestion and absorption

Studies have shown that probiotics in most fermented milk can produce a variety of extracellular proteins, many of which adhere to the cell surface, forming surface proteins [7]. Surface proteins are involved in cell communication and interaction with the surrounding environment. Cell surface proteins, for example, produced by lactic acid bacteria, provide nutrients to cells through adhesion, as well as uptake products, and degrade carbon and nitrogen substrates [7]. In addition, the ability of probiotics to adhere to the gastrointestinal mucosa usually depends on its specific binding to epithelial cell receptors on the surface of the gastrointestinal mucosa.

It is shown that most probiotics are able to secrete viscous proteins that interact with the surrounding environment to help them colonize the mucosa of the gastrointestinal tract without shedding. And secondly, such secretions of proteins indicated in cells can also play a function of communication with the outside world. Lactic acid bacteria produce cell surface proteins that provide nutrients to cells through adhesion and uptake products and degrade carbon and nitrogen matrices.

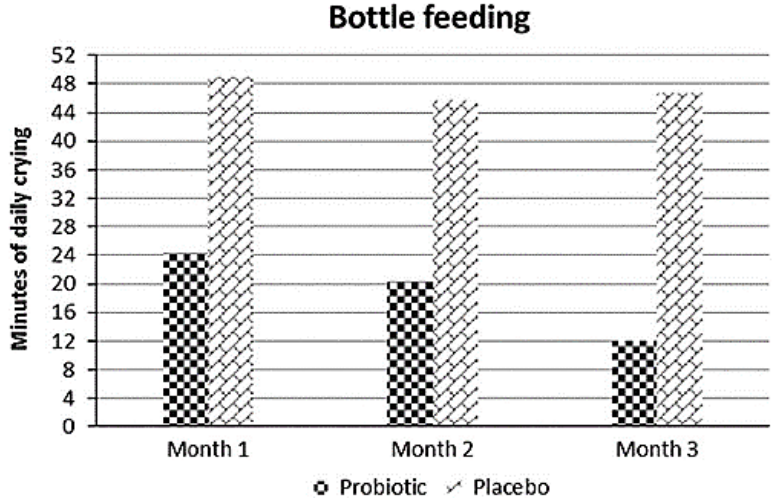


Figure 1. Consumption of probiotic foods slows infant crying [8]

Lactose intolerance, food hypersensitivity, enterologic nervous system diseases, gastroesophageal reflux and intestinal hormone secretion disorders lead to gastrointestinal discomfort in infants. In a randomized, double-blind controlled trial of changes in the gut microbiota, healthy individuals increased the frequency of bowel movements and improved intestinal comfort after ingesting Bifidobacterium lactis BB-12, as shown in Figure 1. It should be noted that when probiotics improve constipation, they will generally be combined with appropriate dietary fiber and prebiotics [8].

2.2. Prevention of bacterial infection

As more and more strains develop resistance, through in-depth study of the interaction between bacteria and pathogenic bacteria, new ideas for the treatment of diseases are provided for bacterial and viral infections, taking advantage of the function of probiotics that already exist to resist antibacterial strains. Probiotics can exert an adhesion effect and occupy the role of colonization site, thereby multiplying in large quantities to prevent pathogenic bacteria from binding to receptors in the gastrointestinal mucosa, and can inhibit pathogenic bacteria such as *E. coli*, *Staphylococcus aureus* and *Salmonella* [9]. The adhesion of probiotics is also effective in preventing local infections caused by the translocation and spread of pathogenic bacteria [9]. After colonization in dairy products, lactobacilli are propagated by growth to inhibit the sensation of closticoid spores and the growth of enterococcus.

In the gastrointestinal tract with limited growth space and nutrients, the ability of probiotics to compete with these two spaces and nutrients can greatly affect the composition of the intestinal flora. In the case of limited nutritional content, probiotics through adhesion, valuation and mass multiplication in the gastrointestinal tract, probiotics rely on their growth advantages and consume

harmful flora of nutrients [9]. For example, the number of bifidobacteria and lactic acid bacteria in the intestine is dominant, so it inhibits the reproduction of other flora [9], as shown in Figure 2. Studies have shown that Salmonella typhimurium absorbs a large amount of iron from the inflamed intestine during infection, and after a single dose of *E. coli*, which can effectively absorb and utilize iron.

At the genus level, individual analyses were made for some species that exhibited differences, and the significantly different Campylobacter spp., Lactobacillus spp., Philococcus spp., Faecococcus spp., Septella segmentation, and unnamed Enterobacter spp. were analyzed separately. As can be seen from Figure 2, the intervention of CCFM 1054 significantly reduced the abundance of Campylobacter spp., while the abundance of Lactobacillus spp. was significantly improved ($P<0.05$), which means that CFM 1054 has the potential to alleviate Campylobacter jejuni infection in vivo by changing the abundance of certain specific flora in the intestine.

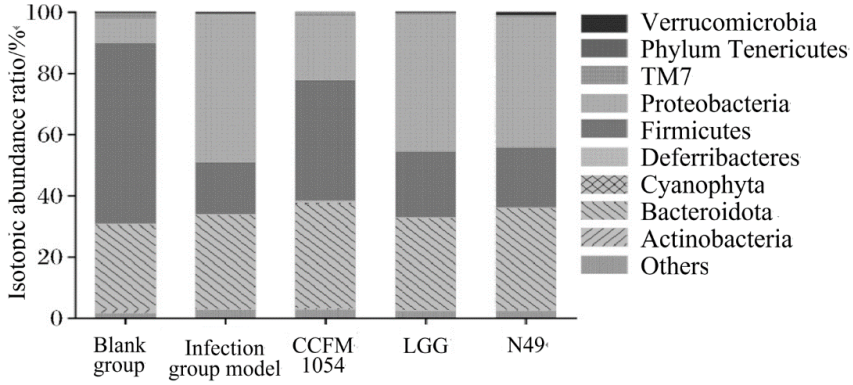


Figure 2. Changes in mouse intestinal flora at the gate level after lactic acid bacteria intervention [9]

2.3. Probiotics lower blood sugar and cholesterol

When the serum content of cholesterol is high, it can lead to blockage of blood vessels and a decrease in the efficiency of blood transport, which in turn can induce cardiovascular disease. People who drink yogurt probiotics for a long time generally have lower serum cholesterol levels than people who don't drink yogurt probiotics very often.

When lactic acid bacteria grow and multiply in the intestine, they can break down cholesterol, and their metabolites can reduce the body's absorption of cholesterol. Lactic acid bacteria colonize the mucosa of the enteral membrane and then continuously secrete metabolites, thereby reducing the contact of cholesterol with the mucous membrane and reducing the body's absorption of cholesterol. In addition, lactic acid bacteria are able to break down cholesterol into bile salts, which are then excreted through the body's circulatory system. In summary, probiotics can reduce the content of cholesterol in the body, but also reduce the body's synthetic cholesterol from the source of digestion and absorption [10].

As shown in Table 1, the results show that the total cholesterol (TC) content in the human body decreased by 4.81% after 6 consecutive weeks of consuming probiotic supplements, of which the content of low-density cholesterol (LDL-C) decreased by 8.92%, and the content of non-high-density lipoprotein (non-HDL) decreased by 6.01%. In the absence of oxygen, lactic acid bacteria cells are able to break down cholesterol in a medium containing bile salts and high cholesterol. It can be seen that lactic acid bacteria can lower cholesterol in the body.

Table 1. Serum heat cell count, HDL, HDL-C and LDL-C content in three groups of mice [10]

Constituencies	TC	TG	HDL-C	LDL-C
Normal group	2.18±0.98	0.83±0.39	1.83±0.82	0.50±0.29
Control group	4.13±0.73	1.56±0.34	2.16±0.50	0.63±0.36
Fermentation group	2.18±0.76	0.93±0.21	2.18±0.50	0.40±0.33

2.4. Enhance the body's immunity and fight tumors

Lactic acid bacteria in probiotics can multiply in the intestine, stimulate macrophages in the peritoneum, produce interferon, and significantly activate the phagocytosis of macrophages, macrophages through the phagocytosis, ingestion and elimination of infected bacteria, viruses and damaged cells, senescent red blood cells to promote cell division, accelerate cell metabolism, enhance cellular immunity, and enhance the body's non-specific and specific immune response, improve the body's immunity. Cancer is a malignant tumor disease that causes long-term accumulation of carcinogens in the body and will induce normal cell mutations [11].

Lactic acid bacteria can inhibit the deterioration of tumors. Lactic acid bacteria can decompose nitrosamine carcinogens into non-toxic substances in the body and eliminate carcinogens. Lactic acid bacteria can reduce the content of active bacterial enzymes, thereby reducing the conversion of carcinogen precursors into carcinogens. In addition, lactic acid bacteria are able to reduce the abnormal proliferation rate of normal cells in the body, as well as reduce the probability of carcinogens inducing normal cell mutations, thus reducing the possibility of tumor production. The results showed that after treatment with Helicobacter pylori with a concentration of 10μM for 3h, and the relative expression levels of mRNA of the virulence genes vacA and flaA were significantly reduced, indicating that Lactobacillus reuteri has an inhibitory effect and can inhibit the expression of toxic genes in Helicobacter pylori.

Yogurt probiotics can produce a variety of biological enzymes with special physiological functions, such as organic acid decomposition enzymes, nitrosamine decomposition enzymes, endotoxin control enzymes, lipolytic enzymes, vitamin synthases and choleidases. Probiotics are able to produce proteolytic enzymes that promote the breakdown of proteins into small molecules of peptides and amino acids, thereby promoting the body's digestion and absorption of proteins. Probiotics are able to produce polysaccharide decomposition enzymes, catalyze the oxidative breakdown of polysaccharides, and decompose polysaccharides into small molecules of glucose and galactose, providing energy for normal life activities of the human body and galactose is partially digested and absorbed, providing raw materials for the body to synthesize cerebrosides and nerve substances, promoting the development of the body's brain. Lipase in turn can hydrolyze triglycerides into small molecules: glycerol and fatty acids, thereby promoting the body's digestion and absorption of fat. To be sum up, these decomposition enzymes have an accelerated catalytic decomposition effect on substances that are not easy to decompose in the intestine, to maintain the balance of the intestinal microecology, reduce the accumulation of substances that are not easy to decompose in the intestine, and these decomposition enzymes can significantly improve the body's protein in food. The digestion rate and metabolism of polysaccharides and fats are conducive to the digestion and absorption of nutrients by the body [12].

2.5. Effect of Lactobacillus paracasei K56 on defecation function in mice

As shown in Figure 3, in the mouse group, the first stratification time was significantly longer than that of the normal control group leader [13]. The number and total weight of black feces were less than those in the control group, which indicating that the mouse intestinal peristalsis inhibition model was established. Compared with the model group, the K56 strain of Lactobacillus paracasei had no significant effect on the time of first melena in mice, and the time of first melena in mice in the low and medium dose groups had a shortening trend, which was shortened by 10.15% and 11.22% respectively compared with the model group (see Figure 3A). The number and weight of melena in the medium-dose and high-dose groups increased significantly, of which the number of melena particles increased by 44.42% and 56.22%, respectively (see Figure 3B), and the weight of melena decreased by 44.76% and 63.81%, respectively (see Figure 3C).

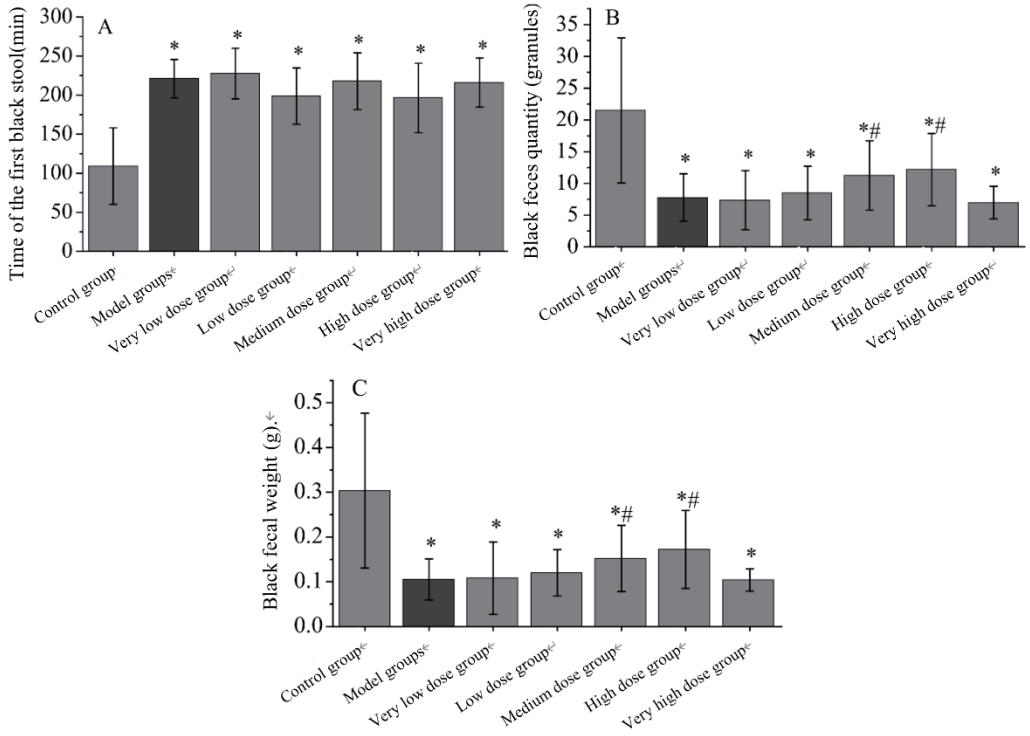


Figure 3. Effect of Lactobacillus casei K56 on defecation function in mice [13]

2.6. Delaying the aging of the body

Probiotics have antioxidant effects, so they have great significance for delaying human aging. Due to the ability to age, superoxide anion free radicals will produce large amounts in the body's normal metabolic processes. However, probiotics are able to secrete metabolic superoxide dismutase, which breaks down free radicals and reduces associated biochemical reactions, thereby delaying aging and improving biological activity. Secondly, the common probiotics, lactic acid bacteria, are valued in the intestine and produce acidic substances in the metabolic process: acetic acid, formic acid and lactate, thereby reducing the intestine pH value and redox potential. Acetic acid in metabolic substances has a strong bacteriostatic function and can enhance intestinal immunity. Because acetic acid can produce a specific chemical environment, it is not conducive to the growth and reproduction of harmful microorganisms, thereby reducing the biological activity of pathogenic bacteria [13]. When the number of harmful microorganisms in the gastrointestinal tract declines, the content of growth and metabolism substances harmful to the body will further decrease, and the accumulation of toxins in the body will decrease, reaching the effect of reducing the burden of liver detoxification and promoting physical health.

In addition, lactic acid bacteria can also produce a bacteriocin, which can also inhibit the growth and reproduction of harmful microorganisms and enhance the body's immunity. Secondly, lactic acid bacteria can also decompose food residues in the gastrointestinal tract into nutrients that are beneficial to the body and can stimulate the normal development of the body [14]. In summary, probiotics can affect the nutritional status of the body, including affecting the physiological function of bacteria in the gastrointestinal tract, have a regulatory effect on immune mechanisms including tumor prevention, enhance the body's resistance to harmful viral bacteria, and have a protective effect on normal somatic cells, can reduce the stimulation of toxic substances secreted by harmful microorganisms, thereby delaying the aging of the body.

3. Effects of probiotics on food

According to the growth and metabolism characteristics of probiotics and the physicochemical properties of foods in dairy fermentation, the probiotics contain a total of 137 strains: 74 strains of

Lactobacillus, 49 strains of Bifidobacterium and 14 strains of Streptococcus thermophilus. The three commonly used categories of dairy products include Bifidobacterium, Lactobacillus acidobacteria and Gram-positive bacteria. In fermented plant beverages, the commonly used probiotics are Lactobacillus bulgaricus, Lactobacillus thermophilus, Lactobacillus plantarum and Lactobacillus cheese [14].

3.1. Research on the effect of probiotics on sensory traits in food

The taste and texture of food plays a decisive role in consumer purchase. According to market research and analysis, most consumers pay more attention to the sensory properties of food. During the fermentation of probiotics, a variety of vitamins are produced, and the content of thiamine, riboflavin, pyridoxine, glutamic acid is increased, which can produce a pleasant fragrance. Aspartic acid and glutamic acid are produced after fermentation of carrot juice by lactic acid bacteria, fermented carrot juice tastes better than it do not. The fermentation of lactic acid bacteria enhances the umami taste of carrot juice, the content of methanol, acetaldehyde, 2-nonanol and heptanol in carrot juice fermented by lactic acid bacteria has increased, and isobutyl alcohol, diacetyl and ethyl acetate are also produced during the metabolism of lactic acid bacteria, giving carrot juice a unique flavor. Carrot juice is fermented with Lactobacillus rhamnosus to produce lysine, threonine, serine, glycine and serine. As a result, fermenting carrot juice using Lactobacillus plantarum and Lactobacillus acidophilus produces a harmonious taste and unique aroma. The organoleptic qualities of banana puree with acidophilus added to it were found to be acceptable. The study found that the fermented mango lactose acid ratio is appropriate, sweet and sour, probably because the reducing sugar is consumed during the fermentation process and organic acids are produced. In the experiment to study the effects of 6 kinds of probiotics on jujube juice, the aroma of fermented jujube juice was analyzed by electronic nose, and the aroma of jujube juice fermented by different probiotics was found to be clearly distinguished [15].

3.2. Functional food additive

Lactobacillus bulgaricus, Streptococcus thermophilus, Streptococcus ductrine, Acetobacter acetate, Leuconobacter enteroeptibularis and Streptococcus cheese are all probiotics. Among them, the main characteristic flavors of Lactobacillus bulgaricus and Streptococcus thermophilus are acetaldehyde, butyrosketone Streptococcus lactococcus, Acetobacter acetate, Enterobacterium, as well as streptococcus, produce pleasant flavor substances during the fermentation of dairy products: acetaldehyde lactic acid acetate and butanedione, among others. The fermentation effect of such probiotics can play a role in enhancing the flavor components of food to reduce the use of food flavors and spices, and make food greener and healthier [16].

In terms of probiotic fermented fruits, the study has involved 17 kinds of fruits, including apples, prickly pears, guavas, citrus, grapes and so on. There are 9 species of edible probiotics involved, mainly Lactobacillus plantarum (Lactobacillus plantarum, Lactobacillus salivary) fermented Lactobacillus). There are also a small number of intestinal leuconobacteria and pentosaccharides. In these fermented products, common functional studies focus on antioxidant, tumor suppression, hypoglycemic and other aspects, of course, these functional studies are still very preliminary, mainly in vitro function research. Fermented fruits contain a variety of active ingredients, one is non-flavonols, including resveratrol, epichales and gallic acid, and the other is flavonoids, including quercetin and catechols. In addition, there are some vitamins B12 and Y-aminobutyric acid. In addition, the active ingredients in the fruit may change after fermentation, such as the total phenol and flavonoid content decreases or rises, the sweetness of the fruit decreases, the antioxidant properties rise, and the acidity of the fruit rises [17].

In terms of probiotic fermented vegetables, there are 9 kinds of vegetables involved in the study, including loofah, cabbage, tomato, dried beans and so on. Some are used to make kimchi, some are used to make vegetable juice, and vegetable juice fermentation may have some effect on flavor. There are 8 species of edible probiotics involved, mainly Lactobacillus, but also some Pentococcus

pentosaccharides and Leuconobacter enteric membranes. At the same time, there are more related functional studies, antioxidants, tumor suppression and hypoglycemia, as well as lowering blood lipids, improving enteritis and liver protection. This kind of research is relatively shallow, mostly in vitro research or animal research. Probiotic fermented vegetables also have a lot of active substances, including non-flavonols, flavonoids, vitamins, and polysaccharides (asparagus polysaccharides). There will also be some changes during the fermentation process, and the increase in acidity will lead to an increase in antioxidant properties. During fermentation, the decline in nitrite will lead to an increase in flavor substances. For example, co-fermented cowpea enhances aromatic activity and key volatile compounds, thereby improving the overall sensory quality of fermentation [18].

In terms of probiotic fermentation of grains, there are 10 kinds of grains involved in the study, including sweet potatoes, black rice, soybeans, chickpeas and so on. There are more than 17 edible probiotics involved in this field, and the more obvious is the involvement of bifidobacteria (bifidobacterium, bifidobacterium long, bifidobacterium short). At present, related functional studies focus on antioxidants, hypoglycemia, improvement of osteoporosis, reduction of allergens, inhibition of spoilage bacteria and reduction of anti-nutrients [19]. Fermenting grain with probiotics can inhibit the growth of some spoiled bacteria from the source, thereby avoiding the production of toxins of putrefaction bacteria during fermentation, which is conducive to improving product safety. After fermentation, grains contain a large number of active molecules, including non-flavonols, flavonols, polymers (strong antioxidant activity), vitamins, active polypeptides and so on. Grains in the process of fermentation will also appear active molecule changes such as acidity increase is a feature, antioxidant resistance will also increase [19].

4. Conclusion

Food composition has a certain influence on the growth and reproduction of probiotics, and the effect process and mechanism lack experimental research. Probiotics can improve the quality of food, can increase the nutritional composition of food and improve the physical and chemical indicators of food, but also can provide special flavor to food. However, the growth and reproduction of probiotics in fruit and vegetable juices is not stable enough, and the related applications still need more experiments. so probiotic food is currently a very important research topic. Dairy products and fruit and vegetable juice products are suitable carriers for probiotics, which can multiply in large quantities in such foods and can improve the nutritional and economic value of foods. Therefore, foods containing probiotics have good prospects for development.

The functional activity of many active substances produced by probiotic metabolism is mostly verified by in vitro experiments, and a large number of animal experiments and clinical trials are still needed to verify. Nevertheless, some of the active metabolites that have been industrialized have given us enough confidence and hope, and also hinted at the direction we still need to work on in the field of probiotic active metabolite development research and industrialization. There may be a "synergistic effect" of the metabolically active substances of probiotics that need to be used in conjunction with different substances. Based on the multi-component characteristics of the epizoite, Offspring also have "versatility" in physiological functions. However, the functional role of probiotics on animals is not yet clear, and further experiments are still needed, including animal experiments, clinical trials and in vitro experiments. Therefore, the study of post-bioidents will become another important development direction in the field of probiotic active metabolite research.

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