

Function and Application Progress of Probiotics in Food

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Abstract Probiotics have a long history of use in human production and life. With the gradual deepening of the research on the functions of probiotics, their various nutritional and health benefits for the human body have also become increasingly clear. Existing research shows that probiotics can regulate intestinal flora, and improve immunity and even the symptoms of some diseases. Therefore, in the food industry, the application of probiotics from traditional fermented foods to functional foods has become more and more extensive. In this paper, the research progress of nutritional function and application of probiotics in food at home and abroad was reviewed, in order to provide some reference for the safe application of probiotics in food.

Key words Probiotics; Physiological function; Food; Development and application

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In recent years, with the continuous development of society, consumers have improved their awareness of health and paid more attention to food nutrition-related issues. Probiotics refer to "living microorganisms" that provide one or more specific and clinically-proven functional benefits to host organisms by ingesting sufficient quantity^[1]. Because they can resist the invasion of pathogenic bacteria, maintain the balance of intestinal flora^[2] and enhance the innate immunity of the body by regulating hosts' specific and non-specific immunity^[3], and have a significant inhibitory effect on classical resistant bacteria and other emerging resistant microorganisms^[4], and they can synthesize B vitamins, various amino acids and minerals necessary for the human body to improve hosts' health^[5], inhibit the proliferation of cancer cells and reduce the incidence of chronic diseases such as tumors and some allergies^[6], foods containing probiotics have become popular in the market and attracted widespread attention, making the research of functional probiotics the focus. In this paper, the research progress on the function and application of probiotics in food was briefly described, in order to provide reference for the application of probiotics in food.

Definition of Probiotics

Probiotics are an important group of microorganisms that co-exist with the human body in the intestine. There are a wide variety of probiotics which are widely distributed. At present, probiotics can be roughly divided into following five types: ① *Lactobacillus*, such as *Lactobacillus acidophilus*, *Lactobacillus fermentum* and *Lactobacillus bulgaricus*, ② *Streptococcus*, such as *Streptococcus*

thermophilus, *Streptococcus lactis* and *Streptococcus pneumoniae*, ③ *Bacillus*, such as *Bacillus megaterium*, *Bacillus natto* and *Bacillus coagulans*, ④ *Bifidobacterium*, such as *Bifidobacterium bifidum*, *Bifidobacterium breve* and *Bifidobacterium longum*, and ⑤ other types, such as *Saccharomycetes* and *Escherichia coli*. At present, the most commonly used probiotics are mainly yeast, *Lactobacillus* and *Bifidobacterium*^[7].

Functions of Probiotics

Among the probiotic health foods that have been approved at present, the most important nutritional and health benefits of probiotics claiming to the human body are regulating gut microbiota and enhancing immunity^[8]. In addition to these two main functions, probiotics also have nutritional functions such as promoting nutrient absorption and improving metabolism^[9].

Improving intestinal function

Probiotics are a group of microorganisms that can survive in the human intestine and have a positive impact on hosts. Studies have shown that probiotic functional foods play a significant role in improving gastrointestinal function. ① Probiotics can promote the digestion and absorption of food, and enhance the utilization of nutrients and the functions of intestinal peristalsis and defecation. ② Probiotics can regulate the structure of intestinal flora by competing with harmful bacteria in the intestine for nutrients and producing antimicrobial substances, inhibit the growth of harmful bacteria, maintain a good intestinal microecological balance, and improve bile acid metabolism and lactose tolerance, playing a positive role in the prevention and treatment of intestinal diseases. ③ Probiotics can affect intestinal environment, and improve acid-base balance and mucosal barrier function, thus promoting the proliferation of beneficial bacteria. ④ Probiotics can also reduce gastric acid secretion and relieve stomach discomfort.

Prevention and treatment of intestinal diseases

Probiotic functional food has shown good effect in preventing

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and treating intestinal diseases. Clinical trials have proved that the symptoms of digestive system-related diseases such as diarrhea, constipation and heartburn can be effectively improved by ingesting food or supplements containing enough probiotics^[10]. In addition, probiotics can also reduce the risk of intestinal infection and the disorder of intestinal flora caused by antibiotics, and have a certain auxiliary treatment effect on intestinal inflammatory diseases such as ulcerative colitis and Crohn's disease.

Enhancing the immune function of the body

Probiotics can significantly regulate human intestinal flora, which is closely related to the regulation of immune system. Latest research shows that there is a consistent correlation between intestinal flora and immune cell dynamics, and intestinal flora can directly affect the immune system of the body^[11]. The regulation of probiotics on intestinal flora can interfere with the composition and function of intestinal epithelial cells and immune cells, enhance the immune function of the body, and also improve the resistance of the human body to pathogens by protecting the human body from gastrointestinal pathogens^[12].

Application of Probiotics in Food

Probiotics have the functions of improving intestinal health, enhancing the immune system, synthesizing and improving the absorption and utilization rate of nutrients, which makes the application of probiotics in food become a hot research and development direction.

Dairy products containing probiotics

The most probiotic-containing foods on the market now are dairy products, and the most commonly-used probiotics in dairy products include *Lactobacillus bulgaricus*, *Lactobacillus*, *Bifidobacterium*, etc. Ma *et al.*^[13] evaluated the potential of producing low-phenylalanine fermented milk by *Lactobacillus plantarum* YZX21 and *Bifidobacterium animalis* F1-7, and the results showed that *L. plantarum* YZX21 and *B. animalis* F1-7 had good gastrointestinal tolerance, self-aggregation and adhesion. Loulouda *et al.*^[14] found through experimental research that raisins, apple slices and wheat grains rich in *Lactobacillus casei* can be mixed into yogurt in fresh and freeze-dried forms to produce a new type of probiotic dairy products. Raisins, apple slices and wheat grains improve the viability of embedded *L. casei* cells, but also show less dehydration due to their water-holding capacity, and the foods thus have improved sensory and nutritional characteristics.

Fruit and vegetable juice containing probiotics

Because fruits and vegetables contain a lot of vitamins, minerals, dietary fiber and other substances, and these substances are very suitable substrates for the growth of probiotics, the application of probiotics in processing fruit and vegetable juice products is increasing, and the antioxidant activity of probiotic beverages is enhanced during the production and fermentation process, which improves the nutritional value of beverages. In some probiotic fermentation experiments, it is found that probiotics can change the pH value of fruit and vegetable juice, produce aroma components

and various vitamins and minerals beneficial to human health, and improve the sensory quality and nutritional value of products. Meanwhile, probiotics can transform a small amount of phenols in fruit and vegetable juice into free state, thus increasing the free state of phenols and improving the antioxidant capacity of fruit and vegetable juice^[15].

Meat products containing probiotics

With the development of science and technology, the strategy of using probiotics to design new functional meat products has emerged, and is mainly used in fermented sausages. It is found that traditional meat starters contain a mixture of lactic acid bacteria and *Staphylococcus*, which is used to maintain the safety and sensory characteristics of sausages^[16]. Camila *et al.*^[17] added screened *L. casei* SJRP66 and SJRP169 to low-fat fermented sausages, respectively. The results showed that the addition of probiotics had no effect on oil oxidation and product color value.

Summary and Prospects

As a new healthy food, probiotic functional food is of great significance in human health maintenance. Although probiotics have development potential in human health, clinical trials and mechanism research need to be further strengthened. Through more clinical trials, the efficacy and safety of probiotic functional food can be accurately evaluated, and more evidence can be provided for its application in medical practice. Meanwhile, through in-depth mechanism research, we can reveal how probiotics interact with human body and its regulation mechanism in the process of intestinal flora balance and metabolite production, which lays a foundation for the development and utilization of probiotics in food.

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