Transactions on Materials, Biotechnology and Life Sciences
ISSN: 2960-1932, eISSN: 2960-2319 | Volume 3
BLSME 2024

The Health Regulatory Effect of Lactic Acid Bacteria on Human Body

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Abstract. Probiotics are a kind of active microorganisms that are beneficial to the host by colonizing in the human body and changing the composition of the flora in a certain part of the host. The organic acids, special enzymes and actinomycin's produced by lactic acid bacteria (LAB) have special physiological functions. LAB can regulate the normal flora of gastrointestinal tract and maintain the microecological balance, so as to improve gastrointestinal function, increase food digestibility and biotiter, reduce serum cholesterol, control endotoxin, inhibit the growth of spoilage bacteria in intestinal tract, and improve body immunity. This paper studied the existence mode and influencing factors of probiotics and took LAB as an example to mainly describe the research progress of LAB in probiotics, discussed the mechanism of probiotics to maintain the ecological balance of intestinal flora, summarized the impact of probiotics on human body, and aimed at various problems and deficiencies faced by the probiotic industry at present. Some suggestions on the future research direction are put forward.

Keywords: Probiotics; Lactic Acid Bacteria; Health Regulatory; microecological balance.

1. Introduction

Probiotics are beneficial intestinal bacteria that regulate the balance of intestinal flora and enhance intestinal digestive function. Through the control of the host's mucosal and systemic immune function, it can produce single microorganisms or a well-defined mix of microorganisms that are beneficial to health. Common types of probiotics include Lactobacillus, bifidobacterium, yeast, etc., which can compete with harmful bacteria in the human body in oxygen, inhibit their excessive proliferation, and play a good role in maintaining the balance of intestinal microenvironment and purifying intestinal environment.

The most common probiotics are lactic acid bacteria (LAB), which are bacteria without spores and that produce lactic acid from fermented sugars. In nature, this bacterium is distributed widely and has a wide variety of species, with at least 18 genera and a total of more than 200 species. Most of the LAB do not move, a few of the pericapillary movement, the cell form is bacillus or coccus. Because bifidobacterium produces less than 50% lactic acid, bifidobacterium is not classified as LAB, and it is separately classified as bifidobacterium. However, due to their health benefits, bifidobacterium and Enterococcus are also included in LAB [1-3]. The majority of them, except for a few, are essential and have significant physiological functions in the human body, and are abundantly present in the human intestine. First of all, LAB has important theoretical and academic value, and is an ideal material for the study of classification, biochemistry, genetics, molecular biology and genetic engineering. It has great application value in industry, agriculture, animal husbandry, nutrition and medicine and other important fields closely related to human life. This article summarized basic situation about probiotics and the factors that affect their intake, and used LAB as an entry point to explore the impact of probiotics on human health and their mechanisms.

2. Probiotics intake

2.1. Foods that contain probiotics

Probiotics are found in a variety of fermented foods, such as yogurt, fermented foods, buttermilk and other foods. Yogurt is made from milk fermented by Lactobacillus, bifidobacterium and

Streptococcus thermophilus, which is one of the good sources of probiotics. However, not all yogurt contains probiotics, normal temperature yogurt in the process of processing probiotics is inactivated, need to supplement probiotics can choose to contain active probiotics of low temperature yogurt. Fermented foods are made from vegetables, beans and products, and contain probiotics and some beneficial metabolites. Buttermilk is made by fermentation of LAB to produce probiotics. Probiotics can be supplemented by eating them directly or by adding flavored buttermilk to a spoon.

2.2. Drugs containing probiotics

There are many probiotic drugs in clinical practice. When diarrhea, constipation, functional dyspepsia and other diseases related to intestinal microbiota imbalance occur, taking drugs containing probiotics can supplement the normal intestinal microbiota, inhibit the excessive reproduction of pathogenic bacteria in the intestine, adjust the balance of the microbiota, and maintain normal intestinal peristalsis, such as drugs made from bifidobacteria. Some drugs can also treat indigestion, loss of appetite, malnutrition, abnormal fermentation in the intestines, enteritis, and intestinal mucosal damage caused by the use of antibiotics.

In addition, many herbs can promote the effectiveness of probiotics and provide prebiotics, creating complementary effects [4].

3. Factors affecting the intake of probiotics

The effect of probiotics depends on many factors, both intrinsic and extrinsic, such as strain, quantity and dose, survival rate, compatibility of probiotics, individual differences, time of use, and frequency.

Different types of probiotics may have different effects and effects on the human body due to their different properties and physiological functions. For example, LAB can produce lactic acid, which lowers the pH of the gastrointestinal tract and inhibits the growth of harmful bacteria; Bifidobacteria maintain intestinal health by regulating the immune system and improving intestinal permeability. The dosage and dose of probiotics are important factors affecting the effect of probiotics.

In general, the more probiotics, the better the effect of maintaining the balance of bacteria in the gut. However, too much probiotics can cause side effects. The survival rate of probiotics is another important factor affecting their effectiveness. Probiotics may suffer varying degrees of loss before they work, resulting in a decrease in the number and activity of the probiotics that eventually work. Some probiotics can have a synergistic effect and enhance their efficacy in specific combinations. For example, Bacteroides fragile acts on DC cells through substances such as PSA and butyric acid, further acts on CD4+ T cells or regulatory T (Treg) cells to inhibit inflammation, and acts on neurological diseases such as epilepsy through the cerebrotectal axis. Lactobacillus rhamnosus is a classic "mental bacterium", and regulates anxiety and depression-related behaviors through the vagus nerve. Regulating gamma-aminobutyric acid neurotransmitters, Lactobacillus rhamnosus strengthens the intestinal epithelial signaling pathway during the gut-brain axis interaction of Bacteroides fragile, which plays a dual role in the synthesis and balance of neurotransmitters [5-7].

Different individuals may have different reactions and effects to probiotics. This has to do with an individual's gut microbiota status, immune system, genetics and other factors. For example, some people may have an allergic reaction to a certain probiotic, or the effect of probiotics is not obvious due to an imbalance in the gut flora. The effect of probiotics is also related to the timing and frequency of intake. In general, probiotics need to be consumed continuously for a certain period of time in order to achieve the desired effect. At the same time, frequent replacement or interruption of intake may lead to an imbalance of gut bacteria, thus affecting the effect of probiotics.

4. The mechanism of LAB affects the human body

The gut microbial ecosystem is the largest and most complex microecosystem in the human body, in which there are a large number of different types of various bacteria, the number of which is about

10 times that of human cells [8]. The normal human gut contains 400 to 500 types of bacteria, most of which are found in the distal small intestine, colon, and cecum. LAB, bifidobacterium and yeast belong to the intestinal origin bacteria, which are constant in the body and symbiotic with the intestine, and are obligate anaerobic bacteria. In balance, their protein digestion and absorption, vitamin synthesis, and immune function all contribute to the health of the host.

4.1. Produce antimicrobial substances

After entering the body, lactic acid bacteria can multiply rapidly, producing rich lactic acid and carbon dioxide, resulting in a decrease in pH. The reduction of pH has two functions, one is to provide an acidic environment for inhibiting the growth of harmful bacteria and pathogenic bacteria, and improve the balance of intestinal flora. The second is to promote intestinal peristalsis, give full play to microbial activity, make food better digested and absorbed, and maintain the effective operation of the intestinal microbial ecosystem. From the bifidobacterium point of view, it can produce a broad spectrum of antibacterial substances, inhibit the activity of pathogens, such as salmonella, Shigella, Vibrio cholerae and so on. In addition, the tissue acid produced by lactic acid bacteria has a more obvious effect on gram-negative bacteria. The replication of pathogens can be prevented by lactic acid bacteria. Bacteriostatic effect can be observed when Lactobacillus bulgaricus, Lactobacterillus acidophilus, and Lactobacillus lactis produce hydrogen peroxide. Lactic acid bacteria can secrete bacteriocin to inhibit pathogenic bacteria, and has an inhibitory effect on a variety of gram-positive bacteria, including staphylococcus, streptococcus and micrococcus [8].

The production of antibacterial substances by lactic acid bacteria mainly includes two ways: induction and regulation. In the induction process, when lactic acid bacteria are stimulated by the external environment, it will trigger the expression of genes that produce antibacterial substances, so as to synthesize and secrete antibacterial substances. In the process of regulation, lactic acid bacteria control the synthesis and secretion of antibacterial substances by regulating their own gene expression. In addition, lactic acid bacteria can also genetically pass antibacterial genes to other microorganisms, thereby expanding the range of antibacterial substances produced.

4.2. Promote the absorption of nutrients

LAB can produce different kinds of enzymes that promote the absorption and conversion of nutrients. Produce a variety of special enzyme systems such as organic acids, synthesis of polysaccharides, decomposition of LAB growth factors, decomposition of fat, cholesterol reduction, synthesis of vitamins, etc., used to supplement the host's inadequate digestive enzymes. In addition, LAB had strong adsorption capacity for zinc. For example, after pH5.0, 32℃, 24 h, the adsorption rate of zinc reached 27.1 mg/g, which helped to reduce the loss of zinc in the body [9].

4.3. Enhance the immune system

LAB can regulate immune function and inhibit excessive immune response. The regulation of immune function is manifested in influencing non-specific immune response and stimulating specific immune response (Fig.1) [10]. The activity of mononuclear phagocytes and polymorphonuclear leukocytes can be improved through the application of LAB, which also stimulates the production of reactive oxygen species and mononuclear factors, and influences the non-specific immune response. It can also stimulate specific immune response. By stimulating intestinal mucosal lymph nodes, the body antigens and metabolites of LAB can stimulate immune active cells, produce specific antibodies and sensitized lymphocytes, regulate the immune response of the body, and activate macrophages to strengthen and promote their phagocytosis. Suppressing excessive immune response balances the body's immune system by preventing immune cells from producing excess inflammatory mediators.

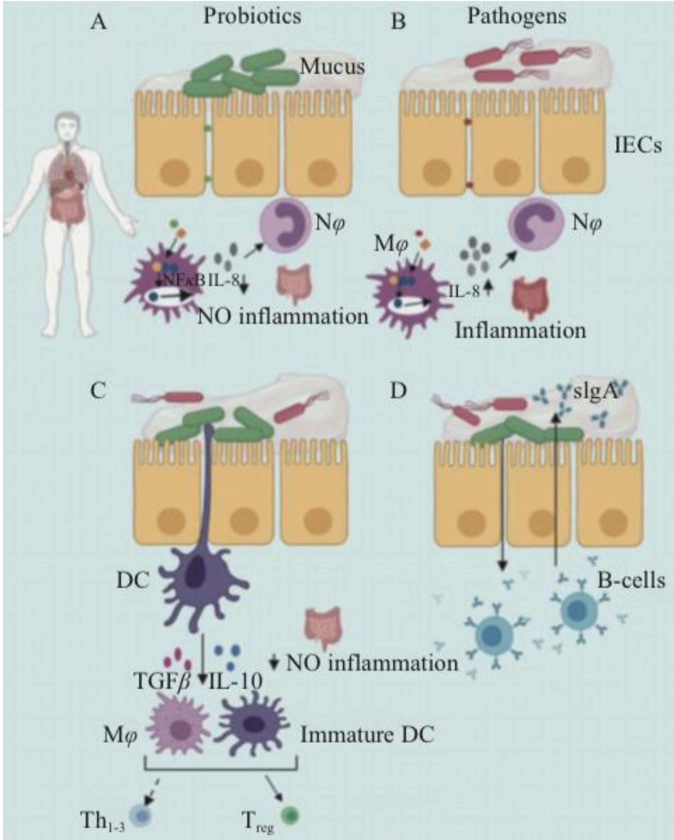

Figure 1. Immunomodulatory effects of probiotics [10].

4.4. Enhance epithelial barrier function

LAB can use a variety of mechanisms to affect the integrity of the epithelial barrier (Fig. 2) [11]. For example, the secretion of mucins and glycoproteins to increase the accumulation of goblet cells to form a mucus layer; Promoting the secretion of defensin and other antibacterial proteins through intestinal epithelial cells can eliminate the symbiont in the mucous layer; It can enhance the stability of the intercellular junction complex and reduce the intercellular permeability of intestinal epithelium to pathogens and other antigens. Most probiotics can inhibit intestinal pathogens by producing bacteriocin, organic acids and other antibacterial substances; It competes with symbiotic bacteria and intestinal pathogens for adhesion sites in the mucous layer or intestinal epithelium, thereby preventing the colonization of harmful bacteria and enhancing barrier function; Changes in natural gut flora composition or gene expression to enhance the integrity of the gut barrier through symbiotic flora [12].

The occupying effect inhibits the adhesion and growth of pathogens, enhances the competitive antagonism, secretes antibacterial substances, improves the activity of digestive enzymes, and synthesizes organic acids [13]. The release of mucin can improve the permeability of the intercellular barrier and prevent toxin accumulation. Probiotics also initiate repair of damaged barrier function mediated by tight junction complex reconstitution through expression and redistribution of occlusive band protein (ZO-2) of protein kinase C (PKC) [11].

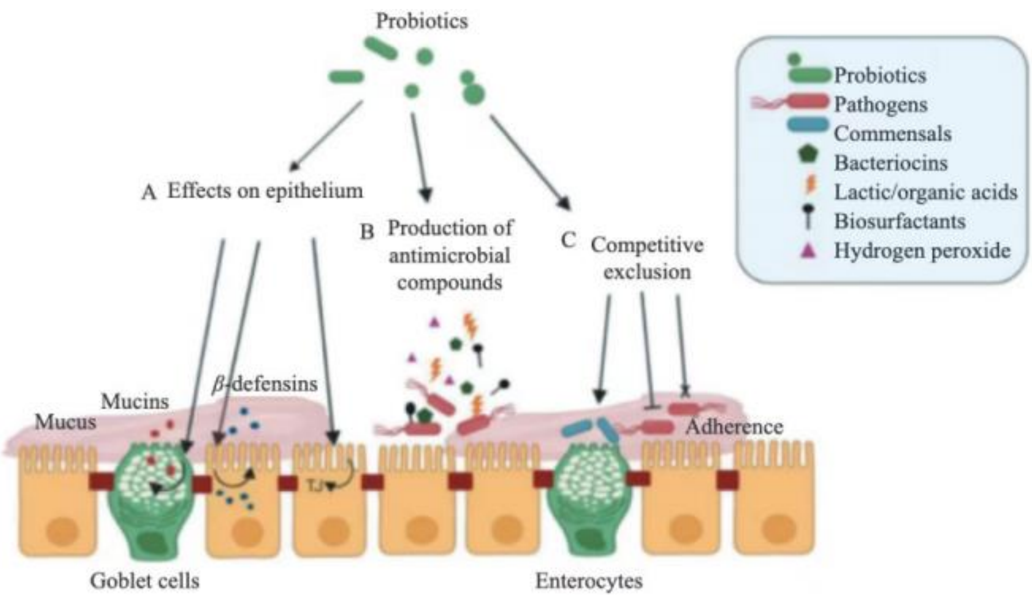

Figure 2. Regulatory mechanism of probiotics [11].

4.5. Colonization antagonism

There are many attachment sites in the human digestive tract epithelium, and pathogenic bacteria composed of glycoproteins or glycolipid sugar chains stick to the surface of host cells to form infection.

LAB compete with pathogenic bacteria for these attachment sites, which is one of the manifestations of colonization antagonism. The native bacteria that live in the gut inhibit the colonization or proliferation of other foreign microorganisms in the gut is called "competitive rejection" or "colonization resistance". This antagonism is caused by competition between the native flora and pathogenic bacteria for attachment sites, so the more adsorption sites are occupied by beneficial microorganisms, the more difficult it is for pathogenic microorganisms to colonize the intestinal mucosa. Obligate anaerobic bacteria, represented by LAB, are the main force constituting colonization resistance and are called colonization resistance factors [14]. Through adhesin, LAB can interact closely with intestinal mucosa to form a biological barrier, form resistance and produce metabolites to resist the adhesion and colonization of harmful microorganisms, and protect the host from invasion. For example, Lactobacillus plantarum299v can promote the secretion of mucin by intestinal epithelial cells, which not only provides a suitable growth environment for LAB, but also inhibits the colonization of pathogenic bacteria [15]. Bifidobacteria adhere to the surface of intestinal epithelial cells through lipid wall phosphoric acid, occupy the surface of intestinal mucosa together with other anaerobic bacteria, forming a membrane barrier, and produce extracellular glycosidase to degrade complex polysaccharides on epithelial cells as potential pathogens and endotoxin binding receptors, and competitively inhibit the adhesion and colonization of intestinal endogenous and exogenous potential pathogens to intestinal epithelial cells. This encourages them to leave the infected gut and thus play an antagonistic role in colonization [16]. Intestinal mucosin can also limit the adsorption of pathogenic bacteria on intestinal mucosa.

The second manifestation is that native gut bacteria compete with foreign bacteria for nutrients. But the role of competing nutrients in the gut is not supported by direct experimental evidence. It has been suggested that this competition does not work much, but that this inhibitory effect can manifest itself when a substance such as biotin becomes a limiting factor for harmful bacteria [1].

5. Conclusion

As a kind of natural microorganism, probiotics play an important role in the human gut. Probiotics can promote the synthesis and absorption of vitamins and maintain the normal nutritional metabolism of the human body. Probiotics can regulate the body's immune response and reduce the overactivation of immune cells in the body, thus easing allergy symptoms; Probiotics can also inhibit the release of sensitizing substances and reduce respiratory symptoms; Probiotics can reduce cholesterol levels in many ways, including reducing cholesterol synthesis, promoting cholesterol excretion and inhibiting cholesterol absorption. Probiotics can also improve the symptoms of cardiovascular diseases such as atherosclerosis. In short, probiotics play an important role in improving intestinal health, improving immunity, promoting nutrient absorption, alleviating allergy symptoms, reducing cholesterol, alleviating lactose intolerance, anti-tumor effect, alcohol metabolism effect, alleviating anxiety and depression and other mental symptoms, as well as delaying aging. However, it is important to be aware of individual differences and possible side effects when using probiotics, for example, taking probiotics may have adverse consequences for people with severe digestive tract diseases, immune deficiencies, or allergies to probiotic ingredients.

Probiotics have broad development prospects in clinic, and probiotics will be more applied in medical research, drug development and other fields. The combination of probiotics and other drugs has become an auxiliary therapy for the treatment of a variety of diseases, and probiotic products will develop in a diversified and differentiated direction in the future. Strains will be more developed and applied, and multi-strain synergies will be more widely used. In general, the development prospect of probiotics industry is promising, but it also faces some challenges. Due to the complexity of human intestinal flora and immune system, it is still a difficult task to study the influence mechanism of probiotics. In order to better play the role of probiotics in regulating intestinal flora and preventing or treating diseases, Further research on the interaction mechanism between probiotics and host microenvironment is needed.

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