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Role of the probiotics in pathologies Metabolics of gut Microbiota

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Abstract

The gut microbiota is the central regulator of human metabolism, it is considered a superorganism, it fulfills functions related to homeostasis and the maintenance of systemic health, contributing to immunity and epithelial integrity, any alteration is related to non-compliance or interruption of some of its functions, for this reason in search of balance, prevention and treatment measures have been implemented, oneof them is the use of probiotics, which has been proven to bring beneficial actions towards the health of the host. , such as lactobacillus and bifidobacteria, here we willreview the association between gut microbiota, probiotics and the use of probiotics like a treatment of prevention for pathologies of gut microbiota.

Keywords: Gut Microbiota; Probiotics; Prevention of Pathologies Metabolics; Gastrointestinal microorganisms; Dysbiosis

1. Introduction

The microbiota is often called a superorganism, due to the extensive number of microorganisms that make it up, mostly bacteria, interacting with each other in a dynamic way. (6) It contains between 100 and 150 times more genes than thehuman genome and is closely related to development, homeostasis and disease.(10)

It has an essential role in the development and maintenance of systemic health through antagonism of pathobionts and production of metabolites that contribute to immunity and epithelial integrity; commonly, perturbations of the commensal microbiota are associated with systemic changes in immune homeostasis and contribute to disease susceptibility and outcome. (1)

In search of restoring balance and improving the health of the host, a wide variety of treatments have been used that completely target the microbiota, such as the use of probiotics. (6) It has been proven that they are capable of conferring health benefits, especially in terms of prevention such as infections of the gastrointestinal tract, sincethey facilitate the absorption of nutrients and alter the dynamic interaction of the microorganisms of the microbiota. (8)

In recent years, numerous studies have pointed to microbial dysbiosis as a key driving factor in many gastrointestinal conditions, including cancers. However, comprehensive mechanistic understandings of how gut microbes collectively influence carcinogenesis remain limited; In addition to their role in carcinogenesis, the gut microbiota has now been shown to play a key role in influencing clinical outcomes of cancer immunotherapy, making them valuable targets in cancer treatment. (11)

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2. Probiotics

Probiotics are defined as live microorganisms that, when administered in adequate amounts, provide a health benefit to the host. (3) They modulate the composition of the microbiota by inhibiting the growth of potentially pathogenic bacteria through the production of bacteriocins and the creation of a more acidic environment, unfavorable for pro-inflammatory bacteria but which favors the growth of beneficial species such as lactobacillus and bifidobacteria, and they also increase diversity. bacterial and decrease fungal diversity and can increase the production of fatty acids with anti-inflammatory and anticarcinogenic properties. (5)

In pathological conditions characterized by inflammatory processes, it is postulated that probiotics exert beneficial effects by reducing disease activity and favoring the induction of remission. It is argued that this decrease in inflammation occurs by inhibiting the growth of pathogenic bacteria by improving barrier functions that prevent invasion of tight junctions, by reducing the pH of the intestine, and by stimulating both specific and nonspecific immune responses. (7)

2.1. Gastrointestinal microorganisms

The human gastrointestinal tract provides a suitable environment for a diverse microbial population, with more than 400 to 500 different species of bacteria identified to date. The main introduction of this variety to the host probably occurs in close connection with labor and birth of the neonate, with Lactobacillus and Prevotella spp predominating in the vaginal canal during birth. This microbial population may be susceptible to changes in diet, host age, disease states, and lifestyle. (2)

The intestinal microbiota influences multiple metabolic processes in the host, suchas energy regulation, glucose and lipid metabolism. When there is a microbial imbalance, known as dysbiosis, metabolic alterations can occur. Several studies have established a causal relationship between microbial function and these metabolic perturbations. Treatments targeting the gut microbiota have been shown to improve metabolic function in humans, and fecal transplantation of microbiota from patients with obesity, steatosis, or type 2 diabetes can partially replicate the donor's metabolic profile in animal recipients. (4)

The bacteria present in the large intestine maintain a continuous interaction with the epithelial cells of the colon and other microorganisms, influencing physiological processes. Given the close link between the gut microbiome and normal colon physiology, dysbiosis in the gut. (9)

The excessive presence or uncontrolled growth of certain microorganisms in the intestine can change the beneficial relationship they normally have with the body into a harmful relationship. This has been linked to several gastrointestinal diseases, such as inflammatory bowel disease, irritable bowel syndrome, metabolic syndrome, and non-alcoholic fatty liver disease. (12)

In a healthy state, a layer of mucosa acts as a barrier between epithelial cells and bacteria in the intestine. In general, beneficial bacteria residing in the intestine do nothave direct contact with epithelial cells. However, in patients with inflammatory boweldisease (IBD), a higher density of bacteria that are associated with the mucosa is observed. These bacteria come from biofilms containing a significant amount of Bacteroides fragilis (B. fragilis) and a considerable amount of extracellular matrix. This suggests that the microbiota is more aggressive and that biofilms are more invasive in IBD patients compared to healthy individuals. (13)

The composition of the intestinal microbiota plays a fundamental role in metabolic diseases. Therefore, controlling and regulating the gut microbiota could represent a promising solution to address these conditions. (14) The presence of a healthy gut microbiota may have a protective effect against the development of inflammatory bowel diseases (IBD). This implies that regulating the composition of the intestinal microbiota could be considered as a possible treatment option in the future. (13) In addition, the intestinal microbiota constantly releases bioactive molecules inside the intestine, and some of these molecules can pass into the blood circulation and have an additional impact on metabolic processes by acting as specific ligands. In this process, intestinal integrity plays a crucial role by preventing harmful bacterial metabolites from being transferred to the circulation. (14)

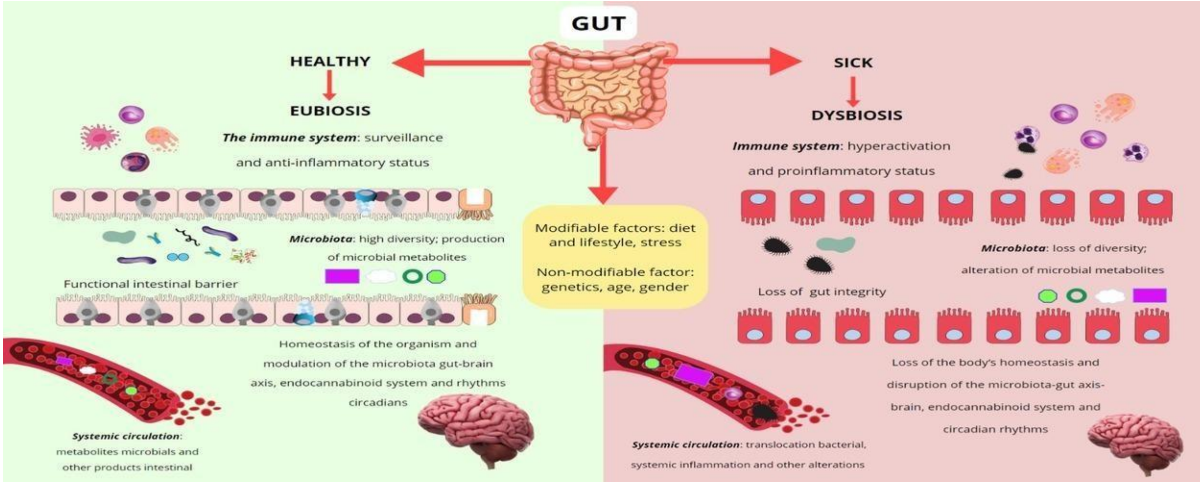

Figure 1 Microbiota in health and disease (dysbiosis).

Throughout life, sudden alterations in a person's gut microbiota are common. Factorssuch as infections, antibiotic use, hygienic practices, dietary changes, and even vacation travel can cause temporary instability in the gut microbiota, however, in most cases, the gut microbiota eventually resets and recovers completely. (12)

The intestinal microbiota is mainly composed of five bacterial groups: Bacteroidetes, Firmicutes, Actinobacteria, Proteobacteria and Verrucomicrobia. (13)

The persistence of a dysbiotic imbalance, characterized by a decrease in "peacekeeping" organisms and an increase in disease-associated microbiota, may contribute to the development of malignant diseases. Among the most common intestinal microorganisms associated with the gastrointestinal tract are H. pylori, E. coli, various Mycoplasma species, S. bovis, Clostridium septicum, Epstein-Barr virus (EBV), and human papillomavirus. (12)

There are many mechanisms for probiotics to inhibit pathogenic microorganisms, such as stimulation of epithelial barrier function, production of antimicrobial substances, and limiting the access of pathogenic microorganisms to nutrients, resources and competitive exclusion due to competition for binding sites. (13)

2.2. The use of probiotics

The use of probiotics can cause changes in the composition of the intestinal microbiota, which reflects the ability of probiotics to survive during their passage through the digestive tract. (15)

Probiotics are mainly microorganisms present in the human intestine and can have beneficial effects by helping to maintain the balance of the intestinal microbiota. In everyday life, common probiotics, such as Lactobacillus or Bifidobacterium, are oftenconsumed in the form of supplements containing active bacteria. (16) The foundation for the application of probiotics dates to observations made in the early 19th century. It was first proposed as a treatment due to the observation that children suffering from diarrhea had a decrease in the population of bifidobacteria in their intestine. This observation suggested that oral intake of bifidobacteria could replenish this subpopulation of the gut microbiota and potentially improve the health of affected individuals. (17)

Clinical trials have been conducted with a variety of probiotic strains to treat inflammatory and gastrointestinal diseases. But drug development associated with preclinical and clinical studies is lacking.

With the advancement of research on probiotics, the mechanism by which these microorganisms contribute to maintaining health has become more evident. In recentyears, it has been observed that probiotics are capable of preventing the adhesion ofpathogens to the intestinal surface, strengthening the epithelial barrier and modulating the immune system. In addition, it has also been observed that probioticsexert a regulatory effect on intestinal microecology and have a beneficial impact on the human body. (16)

2.3. Probiotics in inflammatory bowel disease

Inflammatory bowel disease (IBD), which encompasses conditions such asulcerative colitis (UC) and Crohn's disease (CD), is a global disease with a higher incidence in Western countries, although an increase in incidence is observed in newly industrialized countries. (13)

Although the history (chronic inflammatory state) and some symptoms of Crohn's disease (CD) and ulcerative colitis (UC) are similar, these diseases have significant differences from each other. An accurate diagnosis is crucial for proper treatment. Crohn's disease can affect any part of the digestive tract, from the mouth to the anus. (Table 1)

There have been many reports providing evidence that some strains of probiotics may be useful during treatment and prevention against IBD, in both murine and rat models of the disease.

Approximately, they indicate some differences, probably caused by the selected research methods and the selected bacterial strain. In the animal model for colitis induction, the most common are DSS dextran sulfate sodium or TNBS 2,4,6-trinitrobenzenesulfonic acid. The use of DSS is dictated by its strong, rapid anddose-dependent UC-like effect. (18)

Table 1 Diseases that alter the gut microbiota (19, 20, 21, 22)

Intestinal Disorders	Observations	Mechanisms	Effect of Probiotics
Crohn's Disease	Increase in Candida and fecal fungal diversity	Candida induces a Th17-mediated response that exacerbates inflammation	Can reduce Candida load andmodulate the immune response,improving symptoms
Ulcerative Colitis	Increase in Debaryomyces and Candida, decrease in alternaria and Aspergillus	Candida induces Th17 and IL-23 responses, affecting the intestinal microbiome	Help restore the gut microbiota,reducing inflammation and improving remission
Irritable Bowel Syndrome	Increase in Candida and Malassezia, decrease in Sporobolomyces	Fungicides reduces visceral hypersensitivity	Can decrease Candida proliferation, improving hypersensitivity and gut inflammation
Intestinal Graft-Versus-Host Disease (GVHD)	Increase in Candida	Candida induces Th17 and IL-23 responses, exacerbating	Probiotics can balance the gut microbiota, reducing the

3. Conclusion

The intestinal microbiota has gained interest in recent years regarding the regulation of intestinal homeostasis. The metabolic importance of the intestinal microbiota for the pharmacokinetics of nutrients and drugs underscores the potential of using probiotics for preventive or therapeutic applications in various gastrointestinal disorders. Their ability to restore microbial balance is essential, as they decrease theproliferation of fungal and bacterial pathogens and enhance the host's immune response. These therapeutic effects result in a significant improvement in clinical symptoms and a reduction in the progression of diseases such as Crohn's disease, ulcerative colitis, and irritable bowel syndrome.

On the other hand, it allows the development of more specific and effective treatments, taking advantage of the beneficial interactions between microorganisms and the human body; it contributes to the prevention of diseases by promoting a healthy microbiota through diet and other lifestyle factors. In addition, it improves the understanding of complex and multifactorial diseases, such as autoimmune, gastrointestinal and neurological diseases, by revealing the essential role that the microbiota plays in modulating the immune system and other bodily functions. In summary, this knowledge opens new avenues for personalized medicine and public health, improving both quality of life and health outcomes globally.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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