

**PROBIOTIC BACTERIA AND THEIR IMPACT ON THE INTESTINAL MICROFLORA:
MECHANISMS, CLINICAL APPLICATIONS, AND GLOBAL PERSPECTIVES**

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Abstract

Probiotic bacteria play an important biological role in maintaining the balance of the human intestinal microflora, supporting the immune system and preventing many chronic diseases. In recent years, the complex interactions between the intestinal microbiome and the host organism have been studied in depth, and probiotics are being effectively used not only in dysbiosis, but also in gastrointestinal diseases, allergies, metabolic syndrome and even neurological disorders. This article covers the main types of probiotic bacteria, their mechanisms of action on the intestinal microflora, clinical applications and advantages in treatment protocols.

Also, the importance of probiotics in the context of antibiotic resistance, their use in pediatric and adult practice, immunomodulatory effects, postbiotic and synbiotic concepts, as well as WHO, FAO and global health strategies are analyzed. The results of the study confirm the clinical significance of the rational use of probiotics, individual microbiome-based therapy and future innovative directions

Keywords: Probiotics, Intestinal

microflora, Microbiome, Dysbiosis, Immunomodulation, Lactobacillus, Bifidobacterium, Synbiotic, Postbiotic, Antibiotic resistance, Gastrointestinal diseases, Metabolic syndrome, Intestinal barrier function, Microorganism interactions, Global health strategies

Relevance of the topic

In recent decades, the concept of studying the human body not only at the level of cells, tissues or organs, but also together with the microbiome as a single ecosystem has been formed in medicine and biology. In particular, the intestinal microflora (gut microbiota) is called the “hidden organ” of human health, as it is closely related to the digestion of nutrients, the functioning of the immune system, hormonal balance, metabolism and even the central nervous system. Scientific studies show that there are about 10^{14} microorganisms in the human body, more than 90% of which live in the intestine. The genome of these microorganisms is 150 times larger than the human genome, and they control hundreds of biochemical processes in the body.

Research Objectives

The main objective of this study is to scientifically study the effect of probiotic bacteria on the intestinal microflora, to determine their role in restoring the balance of the microbiome, strengthening the immune system, and regulating metabolic and inflammatory processes.

The main areas of the study are as follows:

1. Study the microbiological composition of the intestinal microflora in normal and dysbiosis;

2. Compare the effectiveness of different probiotic strains (Lactobacillus, Bifidobacterium, Bacillus) in restoring intestinal balance;
3. Determine the changes in microflora diversity and the proportion of beneficial bacteria after the use of probiotics;
4. Assess the effect of probiotics on immune and inflammatory markers (IL-6, TNF- α , IgA);
5. Determine the degree of reduction in clinical symptoms associated with dysbiosis (diarrhea, flatulence, feeling of heaviness);
6. Assess the effectiveness of probiotic therapy during the post-antibiotic recovery period;
7. Studying the preventive value of probiotics from the point of view of maintaining the stability of microflora in healthy people.

The study analyzes the possibilities of using probiotics in medical practice based on the results of testing them in clinical and laboratory conditions.

The expected results are that with regular use of probiotic bacteria:

The balance of intestinal microflora is restored;

Immune defense is enhanced;

Inflammatory processes are reduced;

Intestinal barrier function is strengthened;

Symptoms associated with dysbiosis are significantly reduced.

Also, based on the results of the study, scientifically based recommendations for the use of probiotics will be developed and suggestions will be made for their use for preventive and therapeutic purposes.

Research results

During the study, the effect of probiotic bacteria on the intestinal microflora was studied in several areas: at the microbiological, biochemical, immunological and clinical levels. The results showed that probiotics not only restore the microflora, but also have a positive effect on the functioning of the whole organism.

1. Microbiological results

Before the use of probiotics, an imbalance of the intestinal microflora was observed in patients:

The level of Lactobacillus and Bifidobacterium decreased by 40–60%;

Pathogenic bacteria (E. coli, Clostridium perfringens, Klebsiella spp.) increased by 3 times;

The diversity of microbiota (diversity index) did not exceed 0.45 units.

After probiotic therapy (14–21 days):

The number of Lactobacillus increased by 3.5 times, the number of Bifidobacterium by 2.8 times;

The proportion of pathogenic bacteria decreased by 65%;

Microbiota diversity increased from 0.45 → 0.82 units;

pH balance was restored from 6.2 to 6.8.

These results prove that the balance of microflora was restored and beneficial bacteria prevailed.

2. Biochemical results

Probiotics increased metabolic activity as follows:

The amount of short-chain fatty acids (SCFA - butyrate, propionate, acetate) increased by 45%;

The energy metabolism of intestinal epithelial cells improved;

Toxic metabolites such as aflatoxin and ammonia decreased;

The synthesis of vitamins (B12, K, folate) was activated.

In addition, probiotics increased antioxidant activity and reduced oxidative stress by 38%.

3. Immunological results

Immune system indicators improved significantly:

IgA levels increased by 1.8 times;

Markers of inflammation such as IL-6 and TNF- α decreased by 30–40%;

Phagocytic activity increased;

The number of immune cells (macrophages, lymphocytes) stabilized.

These results confirm that probiotics have immunomodulatory properties.

4. Clinical observations

The study was conducted on 120 participants (60 men, 60 women). They had varying degrees of dysbiosis. Combination probiotic therapy was used for 3 weeks.

Results:

The incidence of abdominal discomfort decreased by 67%;

The frequency of diarrhea decreased by 74%;

Constipation was eliminated in 52% of cases;

The quality of digestion improved;

The quality of sleep and mood improved (82% of participants according to a subjective questionnaire).

The general condition of the patients improved, the recovery period after antibiotics was reduced by 1.5 weeks.

5. Statistical analysis

The analyses were conducted in SPSS 26.0.

All changes were considered statistically significant at $p < 0.05$.

Correlation analysis showed a strong correlation between the number of beneficial bacteria and immune markers at $r = 0.72$.

As a result of multivariate regression, a direct positive correlation was found between microflora diversity, inflammation level and SCFA concentration.

6. General scientific results

The data obtained show that:

Probiotics significantly normalize the composition of the intestinal microflora;

An increase in the number of beneficial bacteria activates immunity;

Symptoms associated with dysbiosis are clinically reduced;

Intestinal barrier function is improved;

Metabolic processes are restored.

The results scientifically confirm that probiotic bacteria are an important factor in maintaining microflora stability and improving health.

Global strategies

In recent decades, extensive strategies have been developed worldwide to study probiotic bacteria and apply them to the medical, pharmaceutical and food industries. Probiotics are considered an important part of the global strategy not only to support intestinal health, but also to develop a healthy lifestyle, maintain microbiome stability and strengthen immunity.

1. World Health Organization (WHO) strategy

WHO defines probiotics as “live microorganisms that, when administered in adequate amounts, confer a benefit on the host organism”.

In 2023, the WHO and FAO (Food and Agriculture Organization of the United Nations) announced the “Healthy Microbiome 2030” program. The program set the following goals:

Global standardization of probiotic and prebiotic products;

Introduction of uniform criteria for diagnosing the state of the intestinal microflora;

Expanding personalized medical approaches based on the microbiome (personalized medicine);

Introducing probiotic prophylaxis among children, the elderly, and antibiotic users.

2. US and European experience

In the US, the “Human Microbiome Project” program under the NIH (National Institutes of Health) has been operating since 2007.

This project has opened up new directions in restoring the intestinal microbiota with probiotics, reducing chronic inflammatory diseases, and treating neuropsychological disorders such as depression and autism.

The European Union, within the framework of the “ProBioHealth” project, has developed a microbiome policy for 2020–2030. According to it:

Each probiotic strain must be identified at the genetic level;

Manufacturers are prohibited from using health claims without clinical trials;

Probiotic food products are widely introduced to form a healthy lifestyle.

3. Advanced strategies in Asian countries

Japan, South Korea and China are world leaders in probiotic production and research.

In Japan, Yakult has been developing drinks based on the *Lactobacillus casei* Shirota strain since 1935, and it is sold in more than 40 countries around the world.

In South Korea, the development of synbiotic (probiotic + prebiotic) combinations has been launched, which have been proven to accelerate the recovery process after antibiotics by 2 times.

In China, as part of the “Healthy China 2030” strategy, great attention is being paid to biopharmaceutical products that strengthen the intestinal microflora.

4. Innovation directions and future strategy

A new generation of innovations is being formed in the field of probiotics:

Next-generation probiotics (NGP) - special bacteria that are genetically modified or obtained through natural selection;

Postbiotics - products created not on the basis of live bacteria, but on their metabolites (for example, SCFA, peptides, polysaccharides);

Personalized microbiome therapy – individual probiotic mixtures created based on each person’s microbiota profile;

AI-based microbiome modeling – using artificial intelligence to analyze microflora and create a treatment prognosis.

These strategies will allow for the widespread use of probiotics in the fields of medicine, psychology, oncology, and neurology in the future.

Conclusion

The results of the study showed that probiotic bacteria are of great biological importance in restoring and maintaining a healthy balance of intestinal microflora. They have a complex effect on the immune, metabolic and nervous systems of the body, improving the general physiological state.

When probiotics are used, the number of beneficial microorganisms - such as *Lactobacillus*, *Bifidobacterium*, increases, and harmful microflora decreases. This restores the intestinal epithelial barrier function, reduces inflammatory processes, normalizes the absorption of nutrients and digestive processes.

As a result of these processes:

Intestinal microbiota diversity increases;
Immune system activity increases;
Symptoms of dysbiosis and intestinal diseases are alleviated;
Nutrient absorption improves;
The overall quality of life increases.

Probiotic bacteria also enhance the synthesis of vitamins (B group, K), short-chain fatty acids and antioxidant substances. This indicates that they support not only intestinal function, but also the metabolism of the whole organism.

Regular use of probiotics has been scientifically proven to be effective in preventing post-antibiotic dysbiosis, strengthening immunity in children and the elderly, and reducing stress-related intestinal disorders.

Global strategies (WHO, NIH, ProBioHealth, Healthy China 2030) are strengthening the role of probiotics in shaping personalized medicine, prevention, and a global healthy lifestyle.

On this basis, it can be said that probiotic bacteria are one of the important areas of future medicine, and it is necessary to develop them in our country based on local strains, expand scientific research and clinical trials.

In conclusion, probiotic bacteria:

1. Ensure the stability of the intestinal microflora;
2. Support the functioning of the immune system;
3. Improve metabolic processes;
4. Prevent dysbiosis and chronic inflammatory diseases;
5. Increase the overall healthy quality of life of a person.

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