
PROBIOTICS IN HEALTH NUTRITION

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DOI <https://doi.org/10.30525/978-9934-26-653-9-16>**INTRODUCTION**

In recent years, the concepts of "probiotics", "probiotic products" have become widespread, this term in the literal translation of the two words "pro" and "bio" means "for life" in contrast to "antibiotics" – "against life". Probiotics are living microorganisms that have a positive effect on human health, which is realized in the gastrointestinal tract. Probiotic products are fermented products prepared using probiotic cultures, or products enriched with them. Fuller interprets the concept of "probiotics" as living microorganisms. Over the years, there have been several interpretations of the term "probiotic". Lilly and Stillwell first used this term to refer to metabolites produced by some microorganisms to stimulate the growth of others. The term "probiotics" in translation means "for life" in relation to a living organism, in contrast to the term "antibiotics" ("against life"). Disruption of the microbiocenoses of the human and animal body due to the widespread use of antibiotics has led to the emergence of resistance to them of pathogenic microflora. Parker proposed the term "probiotics" to refer to natural adjuvants – living microorganisms, the introduction of which into the body contributes to the maintenance and restoration of the biological balance of its normoflora and has a positive effect on it. Fuller interprets the concept of "probiotics" as living microorganisms, which, when introduced into animal feed or into human food products (yogurts), have a positive effect on the body by improving the intestinal microflora. Gibson and Robefroid call probiotics live microorganisms (for example, strains of live bacteria in yogurt), which must be present in sufficiently large quantities, remain stable and viable both during their storage and after introduction into the body, must adapt to the host organism and have a beneficial effect on its health. These same authors first proposed to introduce, along with the term "probiotics", the term "prebiotics". Unlike probiotics, prebiotics are substances or dietary ingredients that selectively stimulate the growth and biological activity of microorganisms in the intestine, which in turn positively affect the composition of the microbiocenosis. Most foreign authors include lactulose, fibrous oligosaccharides, pectin, bran,

methylcellulose, some microalgae (chlorella, spirulina), vitamins and their derivatives (pantothenic acid) as prebiotics. All existing probiotics are divided into two large groups – liquid and dry. Microorganisms in the composition of dry probiotics are in a state of a kind of "hibernation". The shelf life of dry preparations is longer than that of liquid ones, they do not require strict adherence to storage conditions. Therefore, many companies, especially foreign ones, prefer to use dry probiotics, which are stored longer and are convenient to transport. The disadvantage of dry probiotics is that when dried, the bacteria in their composition lose some of their beneficial properties, and after entering the body, they need at least 8-10 hours for the bacteria to transition from "hibernation" to an active form and begin to act. The bacteria in the composition of liquid probiotics are bacteria "with an active vital position", that is, they fully retain all their valuable properties and begin to act immediately after entering the body. Liquid probiotics contain bacteria in an active state, therefore they require strict adherence to storage conditions, and this shelf life is much shorter – no more than three months. Liquid probiotics contain not only bacteria, but also their waste products. Getting into the human body, they help restore and form the internal environment of the intestine, favorable for the growth and reproduction of beneficial microorganisms and harmful to foreign microflora. There are also reports of the ability of probiotic fermented milk products to reduce the risk of malignant neoplasms, in particular colon and breast cancer. Probiotic products include microorganisms and substances of microbial origin, which allow a natural way to enhance the beneficial effect on the physiological and biochemical processes of the human body by optimizing its microbiological status. Intensive development in recent years of the production of probiotic products is due to a decrease in the adaptive capacity of people of different age groups of the population, caused by the action of negative external and internal factors. The ability of a person to mobilize and manage his own body's forces is one of the main levers in the evolutionary development of life on Earth.

1. Classification of probiotics and application

In 1965, D. M. Lilly and R. H. Stillwell drew attention to the phenomenon of enhancing the growth of the protozoan *Tetrahymena pyriformis* by another protozoan *Colpidium campylum*, which modified the environment by producing certain substances in it. In this work, the term "probiotic" (from the Greek – "for life") was first proposed ¹. It is believed that the concept of probiotics was proposed by Nobel laureate Ilya Mechnikov, who in the late 19th and early

¹ Lilly, D. M., & Stillwell, R. H. Probiotics: growth-promoting factors produced by microorganisms. Science. 1965. 147(3659). P. 747-748. <https://doi.org/10.1126/science.147.3659.747>

20th centuries proposed the first analogues of modern probiotics based on lactic acid bacteria with high antagonistic activity against putrefactive intestinal microbiota ². It is with the ability to suppress the development of pathogenic microorganisms that the preventive and therapeutic effects of probiotics are primarily associated. In the modern sense, probiotics are live microorganisms that confer a health benefit on the host, as evidenced by R. Fuller ³. The official term and definition of “probiotic” as such were established by a joint expert consultation of the Food and Agriculture Organization of the United Nations (FAO) and the WHO in 2001. Thus, these are live microorganisms that, when administered in adequate amounts, confer a benefit on the person who consumes them. This widely accepted definition has been used worldwide for over two decades by regulatory authorities, scientists and industry to provide a common understanding of the term ⁴. Current research continues to focus on the specific benefits and applications of probiotic strains for human and animal health.

Following the ideas of I. Mechnikov, the Bulgarian physician Stamen Grigorov in 1905 isolated *Lactobacillus bulgaricus*, now known as *Lactobacillus delbrueckii* subsp. *bulgaricus* ⁵ from homemade yogurt. His discovery served as the basis for the scientific research of A. Tissier, who first described the Gram-positive non-spore-forming rods he found in the intestines of newborn children, calling them bifidobacteria, as well as the proposals of A. Gartier, who suggested using acidophilic milk fermented with acidophilic rods isolated from the intestines ⁶. Modern realities force many physicians to investigate probiotics and other alternatives to pharmaceuticals. This is due to the increasing rate of multidrug resistance among pathogenic bacteria, especially in hospitals, the increasing demand for natural alternatives to drugs, and the emergence of scientific and clinical evidence for the effectiveness of probiotic strains ^{7 8}. However, much remains to be done to standardize the meaning of the term “probiotic” and to prove which strains actually meet the criteria for true

² Співак, М. Я., Сафронова, Л. А. Пробиотики як альтернативні аптимікробні засоби. Інфекційні хвороби. 2025. Т. 1. Р. 4-8.

³ Fuller, R. Probiotics in man and animals. *The Journal of applied bacteriology*/ 1989. 66(5). С. 365-378. <https://doi.org/10.1111/j.1365-2672.1989.tb05105.x>

⁴ Probiotics: official definition, scientific requirements and vigilance points during product development. <https://www.rni-consulting.com/en/probiotics-official-definition/>

⁵ *Lactobacillus delbrueckii* subsp. *bulgaricus*. https://uk.wikipedia.org/wiki/Lactobacillus_delbrueckii_subsp._bulgaricus

⁶ Філімонова, Н. І., Сілаєва, Л. Ф., Дика, О. М., та ін. Мікробіологія: підручник для студентів вищих навчальних закладів (2-ге вид.; за заг. ред. Н. І. Філімонової). 2019. Харків: НФаУ, Золоті сторінки. 246с.

⁷ Климнок, С. І., Волч, І. Р., Загречук, О. М., Кравець, Н. Я., Медвідь, І. І., & Михайлишин, Г. М. Мікробіом організму людини: навчальний посібник. Тернопіль: Осадна Ю. В. 2023. 263 с.

⁸ Pal, M., & Jadhav, V. J. Significance of probiotics in human health. *Beverage and food world*. 2013. P. 65-67.

probiotic microorganisms. Unfortunately, many so-called probiotic products have not been properly identified, documented, manufactured according to the required manufacturing practices, or have not been clinically proven to be effective, yet various companies claim that consumers and caregivers believe that they are using reliable products. Thus, defining standards and guidelines is a necessary first step in ensuring that probiotic products are indeed legitimate and effective.

Awareness of the possible catastrophic consequences of the further spread of serious violations of microbial ecology among the population has become one of the reasons for the intensive introduction of microbiological therapy methods into the clinic. In recent years, there has been a more active rethinking of a number of classical concepts and a transition from methods of total destruction of microflora to the search for ways to restore the natural, harmonious relationship of the human body with its own microbiomes and the exogenous world of microorganisms. That is why at the turn of the 20th and 21st centuries, medicine entered the era of probiotics. Various microorganisms are now used as probiotics (Table 1). Certain requirements are imposed on microorganisms used as the basis of probiotics: They must:

- be isolated from the organism of those species of animals and humans for which they will be intended;
- be safe for the host organism;
- not have any pathogenic or toxic effects;
- have a positive effect on the macroorganism, confirmed by laboratory studies and clinical observations;

Table 1

Microorganisms as probiotics

| Microorganism | Genus | Species |
|---------------|------------------|--|
| bacteria | Lactobacillus | Lactobacillus L. acidophilus, L. brevis, L. bulgaricus, L. casei, L. cellobiosus, L. delbrueckii, L. fermentum, L. johnsonii, L. lactus, L. paracasei, L. plantarum, L. reuteri, L. rhamnosum, L. sporogenes |
| | Biofidobacterium | B. animalis, B. bifidum, B. infantis, B. longum, B. thermophilus |
| | Streptococcus | S. alivarius, S. cremonis, S. intermedius, S. lactis, S. thermophilus |
| | Bacillus | B. coagulans |
| | Enterobacter | E. faecium |
| | Enterococcus | E. faecium, E. faecalis |
| | Leuconostoc | L. mesenteroides |
| | Pediococcus | P. acidilactici |

Continuation of table 1

| | | |
|-----------|---------------|--|
| mushrooms | Aspergillus | A. niger, A. oryzae |
| | Gonoderma | G. lucidum, G. sinensis, G. tsugae |
| yeast | Saccharomyces | S. boulardii, S. cerevisiae, S. carlsbergensis |
| | Monascus | M. purpureus, M. anka |
| | Candida | C. utilis |

– when introduced in large quantities, they must have a minimal ability to translocate from the lumen of the digestive canal into the internal environment of the macroorganism;

– have a high colonization potential (be resistant to low pH values, bile acids, pancreatic secretion, antimicrobial substances);

– have a high growth and reproduction rate in conditions corresponding to the microclimate in the intestine;

– stimulate the body's immune system;

– have anticarcinogenic activity;

– adhere to intestinal epithelial cells;

– have clear physiological, biochemical and genetic marking both to exclude falsification and to periodically monitor the identity of the initial probiotic strains and production cultures;

– preserve viability during storage.

In addition, to restore or maintain the microbial ecological system, other modern means are used, presented in Table 2⁹.

Table 2

Probiotic drugs

| Group of drugs | Features |
|---|--|
| Probiotic | Pharmaceutical preparations, special products and biologically active additives, the active component of which is living microorganisms; when administered naturally, they are capable of causing beneficial effects on the physiological functions, metabolic and behavioral reactions of the organism by optimizing its microecological status |
| A preparation based on inactivated microorganisms | Inactivated biomass of probiotic microflora |
| Prebiotics | Food ingredients that selectively stimulate the growth and activity of certain microbial populations, primarily representatives of the host's intestinal microbiota, thereby causing positive effects in the body |

⁹ Amiri, A., Firoozeh, F., Zibaei, M., & Khaledi, A. Effects of probiotics on human health and disease: A review. *Acta Medica Bulgarica*. 2021. 48(1). P. 95-100. doi:10.2478/amb-2021-0015.

Continuation of table 2

| | |
|-----------------------------|---|
| Synbiotic | Probiotic and prebiotic complex |
| Metabiotic | Structural components of the cells of probiotic (symbiont) microorganisms and/or their metabolites and/or signaling molecules capable of optimizing physiological functions, regulatory, metabolic and/or behavioral responses through modification of host cells |
| Metabolite-type preparation | Physiologically active metabolites of probiotic microflora |
| Functional food product | Live microorganisms, their metabolites and/or other compounds that positively affect the intestinal microflora |
| Nutraceutical | Nutrient substrates that promote intestinal health |

It has been proven that probiotics remain the most priority group of microbiological therapy agents. They include pharmaceuticals, special products and biologically active additives based on living cells of healing microflora, which, when administered naturally, cause positive effects on the physiological, biochemical and immune reactions of the human body through optimization and stabilization of the function of its normal microflora. In Ukraine, the first bacterial therapy based on living cells of the intestinal microflora, called eubiotics, became widespread in the mid-1970s. These are single-strain or two-component bacterial preparations based on lyophilized biomass of bifidobacteria, *E. coli*, and lactobacilli (Bifidumbacterin, Bifikol, Colibacterin, and Lactobacterin, etc.), which are still quite often used in patients with dysbiosis. More and more data are emerging that allow us to state that probiotics can be used for various purposes¹⁰⁻¹¹, in particular: restoration of the balance of the colonic microflora after antibacterial therapy¹²⁻¹³; reduction of blood cholesterol levels¹⁴; improvement of microcirculation¹⁵; inactivation of allergy mediators (histamine,

¹⁰ Tijjani, K. I., James, M., & Altin, C. Probiotics and their attributes in human health therapy. *International Journal of ResearchGranthaalayah*. 2020. 8. P. 158-164. <https://doi.org/10.29121/granthaalayah.v8.i5.2020.66>

¹¹ Bodke, H., Jogdand, S., & Jogdand, S. D. Role of probiotics in human health. *Cureus*. 2022. 14(11).P. 101-119. <https://doi.org/10.7759/cureus.31313>

¹² Ng, K. M., Aranda-Diaz, A., Tropini, C., Frankel, M. R., Van Treuren, W., O'Loughlin, C. T., ... & Huang, K. C. Recovery of the gut microbiota after antibiotics depends on host diet, community context, and environmental reservoirs. *Cell host & microbe*. 2019. 26(5). P. 650-665. <https://doi.org/10.1016/j.chom.2019.10.011>

¹³ Rajyalakshmi, K., Oudah, M. A., Babu, M. K., Priya, A. S., Shabana, S., & Satya, A. K. Benefaction of probiotics in human gastro intestinal tract. *International Journal of Physiology, Nutrition and Physical Education*. 2019. 4(2). P. 459-465.

¹⁴ Momin, E. S., Khan, A. A., Kashyap, T., Pervaiz, M. A., Akram, A., Mannan, V., ... & Pervaiz Sr, M. A. The effects of probiotics on cholesterol levels in patients with metabolic syndrome: a systematic review. *Cureus*. 2023. 15(4). P. 141-151. <https://doi.org/10.7759/cureus.37567>

¹⁵ Aboulgheit, A., Karbasiafshar, C., Zhang, Z., Sabra, M., Shi, G., Tucker, A., ... & Sellke, F. W. *Lactobacillus plantarum* probiotic induces Nrf2-mediated antioxidant signaling and eNOS expression resulting in improvement of myocardial diastolic function. *American Journal of Physiology-Heart and Circulatory Physiology*. 2021. 321(5). P. H839-H849. <https://doi.org/10.1152/ajpheart.00278.2021>

serotonin)^{16 17}; anticarcinogenic effect^{18 19}; reduction of immunomodulatory effect²⁰; antibacterial effect^{21 22 23}; ammonia levels in the blood^{24 25}; synthesis of enzymes (phosphatase, lysozyme) and proteins²⁶; influence on the genetic apparatus²⁷; – synthesis of vitamins (group B, folic acid)^{28 29}.

It is believed that the prospects of probiotic therapy, provided that this method is used rationally, are very great. The creation of probiotics and their widespread use are today a strategic direction in the fight against many infectious and somatic diseases.

The interest in using microbiological therapy methods with an insufficiently perfect system of their application implies, first of all, that they should be safe

¹⁶ Gao, C., Major, A., Rendon, D., Lugo, M., Jackson, V., Shi, Z., ... & Versalovic, J. Histamine H2 receptor-mediated suppression of intestinal inflammation by probiotic *Lactobacillus reuteri*. *ASM Journals MBio*/ 2015. 6(6). P. 1110-1128. <https://doi.org/10.1128/mBio.01358-15>

¹⁷ Azad, M. A. K., Sarker, M., & Wan, D. Immunomodulatory Effects of Probiotics on Cytokine Profiles. *Biomed Res. Int.* 2018. 1. P. 1-10. <https://doi.org/10.1155/2018/8063647>

¹⁸ Commane, D., Hughes, R., Shortt, C., & Rowland, I. The potential mechanisms involved in the anti-carcinogenic action of probiotics. *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis.* 2005. 591(1-2). P. 276-289. <https://doi.org/10.1016/j.mrfmmm.2005.02.02>

¹⁹ Sliżewska, K., Markowiak-Kopec, P., & Sliżewska, W. The role of probiotics in cancer prevention. *Cancers.* 2020. 13(1). 20 p. <https://doi.org/10.3390/cancers13010020>

²⁰ Singh, K., & Rao, A. Probiotics: A potential immunomodulator in COVID-19 infection management. *Nutrition Research.* 2021. 87. P. 1-12. <https://doi.org/10.1016/j.nutres.2020.12.014>

²¹ Samot, J., & Badet, C. Antibacterial activity of probiotic candidates for oral health. *Anaerobe.* 2013. 19. P. 34-38. <https://doi.org/10.1016/j.anaerobe.2012.11.007>

²² Chandrasekhar, S. N., Mallikarjun, S. B., & Salim, H. P. Comparative evaluation of antibacterial activity of probiotics SK12 and SM18: An in vitro study. *International Journal of Clinical Pediatric Dentistry.* 2020. 13(6). P. 611-616. <https://doi.org/10.5005/jp-journals-10005-1838>

²³ Михайлишин Г. І., Волч І. Р., Климяк С. І., Покришко О. В. Аналіз видового складу мікроорганізмів при дисбіозі вагіни та шляхи його корекції. Здобутки клінічної і експериментальної медицини. 2024. 1(3). P. 68-73. <https://doi.org/10.11603/1811-2471.2024.v.i3.14708>

²⁴ Jang, H. D., Kim, H. J., Cho, J. H., Chen, Y. G., Yoo, J. S., & Kim, I. H. Effects of dietary probiotic complex on growth performance, blood immunological parameters and fecal malodor gas emission in growing pigs. *Journal of Animal Science and Technology.* 2007. Vol. 49. No. 4. P. 501-508.

²⁵ Zou, Q., Fan, X., Xu, Y., Wang, T., & Li, D. Effects of dietary supplementation probiotic complex on growth performance, blood parameters, fecal harmful gas, and fecal microbiota in AA+ male broilers. *Frontiers in Microbiology.* 2022. 13. P. 121-142. 1088179. <https://doi.org/10.3389/sfmicb.2022.1088179>

²⁶ Salehi, M., Bagheri, D., Sotoudeh, E., Ghasemi, A., & Mozanzadeh, M. T. The combined effects of propionic acid and a mixture of *Bacillus* spp. probiotic in a plant protein-rich diet on growth, digestive enzyme activities, antioxidant capacity, and immune-related genes mRNA Transcript abundance in *Lates calcarifer* Fry. *Probiotics and antimicrobial proteins.* 2023. 15(3). P. 655-667. <https://doi.org/10.1007/s12602-021-09902-4>

²⁷ Wang, J., & Ji, H. Influence of probiotics on dietary protein digestion and utilization in the gastrointestinal tract. *Current Protein and Peptide Science.* 2019. 20(2). P. 125-131. <https://doi.org/10.2174/1389203719666180517100339>

²⁸ LeBlanc, J. G., Levit, R., Savoy de Giori, G., & de Moreno de LeBlanc, A. Application of vitamin-producing lactic acid bacteria to treat intestinal inflammatory diseases. *Applied microbiology and biotechnology.* 2020. 104(8). P. 3331-3337. <https://doi.org/10.1007/s00253-020-10487-1>

²⁹ Megala, G., & Kavitha, M. Folate from probiotic bacteria and its therapeutic applications. *Archives of Microbiology/* 2025. 207(6). P. 124-142. <https://doi.org/10.1007/s00203-025-04327-x>

for the health of all categories of the population, and with prolonged use should not cause side effects, have high colonization activity, proven clinical efficacy, multicomponent composition, corresponding to the "local" geographical physiological microflora. The use of probiotic drugs may pose a certain risk to some individuals, especially immunocompromised ones, since probiotics are living organisms. It is very likely that they can cause infection in the host. Therefore, the safety of probiotics is of particular importance. Their individual strains may demonstrate different safety profiles. Despite the fact that the safety of the use of drugs and products of the probiotic series is considered a proven fact, some complications have been registered in patients who take certain probiotics for a long time. In particular, there are known cases of acidemia in infants, autoimmune diseases, allergic manifestations and other conditions caused by the appointment of large doses of certain probiotics. This indicates the need for a deeper analysis of the safety of the use of drugs. That is why, when selecting probiotic strains, the WHO recommended that they be safe in terms of the following properties ³⁰:

- the presence of hemolytic activity;
- the ability to synthesize toxins;
- their metabolic activity;
- the nature of antibiotic resistance;
- infectivity for animals with weakened immunity;
- consequences for consumers;
- the ability to cause side effects in humans.

Today, the following side effects are distinguished that may be associated with the oral use of probiotics, in particular, the development of infectious processes caused by strains that are part of the probiotic;

- the development of metabolic disorders; excessive immunostimulation of the intestinal lymphatic system; formation of new clones of bacterial strains through the transfer of genes responsible for the expression of pathogenicity factors. All of the above side effects are microbiological and depend on the taxonomic nature and biological properties of the strains of microorganisms used in the preparation. Therefore, the issues of substantiation of the species and strain composition of probiotics are of exceptional importance.

Probiotics are produced in four main forms:

- monocomponent probiotics contain only one type of microorganisms.

For example, "Bifidumbacterin" – bifidobacteria, "Lactobacterin" – lactobacteria, "colibacterina" – colibacteria, etc.

³⁰ LeBlanc, J. G., Laiño, J. E., del Valle, M. J., de Giori, G. S., Sesma, F., & Taranto, M. P. B-group vitamins production by probiotic lactic acid bacteria. *Biotechnology of lactic acid bacteria: Novel applications*. 2015. 1. P. 279-296. <https://doi.org/10.1002/9781118868386>

- multicomponent probiotics include several types of microorganisms.

For example, "bifilong", "Bifikol", "Okarin", "Acylakt", "Linex", etc.

- combined probiotics (synbiotics) – "two in one" – contain probiotics and prebiotics.

For example, "Bifidumbacterin forte", "Bifilys", "Biform", "Bactistatin", "Primadofilus", "Polybacterin" and etc.

- recombinant (genetically engineered) probiotics – in the production of such drugs, useful genes are implanted into bacteria that bring new properties to the colony.

For example, the drug "Subalin" contains microbes capable of synthesizing interferon.

Medicinal prebiotics include "Duphalac" ("Lactulose"), "Calcium pantothenate", "Lysozyme", etc.

As manufacturers claim, probiotics have a wide range of applications for improving and treating the body.

1. Single-celled "antibiotics". Bacteria-probiotics, getting into the intestines, immediately start a war with harmful (pathogenic) microbes for free living space. They densely populate the intestinal wall, leaving no free space for pathogenic microorganisms. Having settled in the intestines, beneficial bacteria change the pH of the environment to the acidic side. And the pathogens of intestinal infections cannot stand the "acidic life" and die in such conditions. Finally, some bacteria have learned to synthesize real antibiotics. However, these antibiotics act "according to reason": only on harmful microorganisms. Due to these properties, pre- and probiotics are used during intestinal infections, including viral ones.

2. Solve problems with digestion. Pre- and probiotics stop the processes of fermentation and putrefaction in the intestines, participate in the digestion of food, absorb gases with their surface, thereby reducing bloating and improving digestion. Probiotic bacteria secrete a number of substances that strengthen and heal the intestinal wall during various inflammatory processes. Therefore, they are used for stool disorders (diarrhea and constipation), bloating, rumbling and abdominal pain.

3. The second liver. Beneficial probiotic bacteria are able to neutralize many substances, starting from toxic metabolic products and ending with antibiotics, heavy metals and carcinogens (substances that provoke the development of cancer). Pre- and probiotics are able to absorb toxins, "slags" and even viruses with their surface. Being excreted with intestinal contents, they cleanse the body of "garbage", showing the properties of sorbents and detoxifiers.

4. Strengthen immunity. Probiotics in the composition of the intestinal microflora have a powerful immunomodulatory effect. They strengthen our

defense against a variety of diseases: colds, herpes and even cancer! Probiotics can neutralize the manifestations of allergies and autoimmune diseases (when allergies develop to one's own cells and organs). It has been established that in Caucasian centenarians over 95 years of age, the composition of the intestinal microflora is very similar to that of children: the main link is lacto- and bifidobacteria. In them, the number of these bacteria does not decrease with age and has a clear connection with life expectancy. Perhaps deciphering the nature of this pattern will help humanity find the secret of eternal youth^{31 32}.

2. Antagonistic properties of probiotics

Probiotic bacteria are found throughout the human gastrointestinal tract. Their physiological significance is multifaceted, but first of all they take an active part in ensuring the protective function of the intestinal microflora. Among the lactic acid bacteria most often used in probiotics for human consumption, G.W.Tannock lists such species as: *L.acidophilus*, *L.delbrueckii* ss. *bulgaricus*, *S.salivarius* ss. *thermophilus*, *B. adolescentis*, *B.bifidum*, *B.breve*, *B.longum*, *B.infantis*. Bacilli and fungi are also used for probiotics, most of which are traditionally associated with the digestive tract. Lactic acid bacteria, by their presence, create an antagonistic environment directed against pathogenic microbes – gram-negative and gas-forming anaerobes. In the intestinal tract, they block the receptors for the inoculation of pathogenic microorganisms and create conditions for the development and growth of beneficial bacteria such as *E. coli*.

Lactic acid bacteria are immobile microorganisms that do not form spores, are catalase-negative, gram-positive, do not form pigment, do not reduce nitrates to nitrites, and are one of the most widespread groups of microorganisms in the biosphere. It has been established that the natural habitat of lactic acid bacteria is the soil and the rhizosphere of plants. Studies have shown that the digestive tract of the studied animals contains quantitatively and qualitatively different types of lactic acid bacteria, which vary depending on age, nutrition and the habitat of animals and humans.

Bifidobacteria are strict anaerobes. Being part of the human intestinal microflora, they play an important role in the vital activity of the macroorganism by maintaining a certain pH (3.8 – 4.0) in the large intestine, secreting lactic, acetic and butyric acids, which prevent the growth of many pathogenic and conditionally pathogenic bacteria. These bacteria ferment glucose to acetic

³¹ Lau C.S., Chamberlain R.S. Probiotics are effective at preventing *Clostridium difficile*-associated diarrhea: a systematic review and meta-analysis. *Int J Gen Med*. 2016. Feb 22. 9. P. 27-37.

³² Sanders M.E., Merenstein D.J., Ouwehand A.C., Reid G., Salminen S., Cabana M.D., et al. Probiotic use in at-risk populations. *J Am Pharm Assoc JAPhA*. 2016. Dec. 56(6). P. 680-686.

and L(+)-lactic acids in a molar ratio of 3:2, with a small amount of formic and succinic acids. Bifidobacteria and lactobacteria participate in the synthesis and absorption of vitamins B, K, folic and nicotinic acids, contribute to the synthesis of essential amino acids, better absorption of vitamin D and Ca salts. Metabolites of bifidobacteria and lactobacteria also have antiallergic effects. In addition to the set of acids, these bacteria also produce vitamins, and vitamins of group B (B₁, B₂) are produced in larger quantities than in the process of life of *Escherichia coli*. Bifidobacteria are included in the composition of more than 70 different food products and a number of therapeutic drugs that are used for intestinal digestion disorders in children, for enterocolitis, cirrhosis of the liver, after the use of antibiotics and to improve intestinal peristalsis.

The products of the vital activity of lactic acid bacteria were probably one of the first antiseptics of microbial origin. In folk medicine, fermented milk compounds have long been used to treat burns and wounds, and for impaired gastrointestinal function. Initially, the antagonistic effect of lactic acid bacteria in relation to other microorganisms was explained by the inhibitory effect of organic acids (primarily lactic acid) that they produced. Later it was discovered that the antagonistic properties of bacteria are based not only on the formation of organic acids, but also on the formation of specific antibiotic substances (they are called bacteriocins or microcins, colicins). For example, *S.lactis* secretes nisin, *Str.cremoris* – diplococcin, *L.acidophilus* – acidophilin and lactocidin, *L.brevis* – brevin, *L.plantanum* – lactolin. All these biologically active substances are unstable and do not have high antibiotic activity. In the study of the antibiotic properties of lactic acid rod-shaped bacteria, special attention was paid to the acidophilic bacillus, which is able to take root in the intestinal tract, has a beneficial effect on the body, suppresses pathogenic intestinal microflora, and promotes recovery from gastrointestinal diseases. Acidophilic paste is used in obstetric practice, dermatology, and surgery (treatment of burns, ulcers). It is believed that the antagonistic properties of *acidophilus* are due to both the lactic acid it produces and the antibiotic substances^{33 34 35}.

After it was established that lactic acid bacteria are a necessary component of the protective intestinal microflora, they became the most widely used microorganisms for the creation of probiotic preparations. R. Fuller believes

³³ Grossi E., Buresta R., Abbiati R., Cerutti R., Pro-DIA study group. Clinical trial on the efficacy of a new symbiotic formulation, Flortec, in patients with acute diarrhea: a multicenter, randomized study in primary care. *J Clin Gastroenterol.* 2010. Sep 44. Suppl 1. P. 35-41.

³⁴ Allen S.J., Martinez E.G., Gregorio G.V., Dans L.F. Probiotics for treating acute infectious diarrhoea. *Cochrane Database Syst Rev.* 2010. 11. CD003048. P. 71-77.

³⁵ Hempel S., Newberry S.J., Maher A.R., Wang Z., Miles J.N.-V., Shanman R., et al. Probiotics for the prevention and treatment of antibiotic-associated diarrhea: a systematic review and meta-analysis. *JAMA.* 2012. May 9. 307(18). P. 1959-1969.

that the probiotic effect of the introduction of lactobacilli is achieved only under the condition of preserving other components of the protective flora and a deficiency of lactobacilli. In the absence of these conditions, the effectiveness of lactobacilli as probiotics is questionable. Also, not all strains of a given genus or species are equivalent as probiotics, as well as their different effects on the organoleptic properties of the fermented product.

To date, the way in which probiotics exert their biological effect is not known for certain, however, certain factors of influence on the intestinal microbial ecosystem are known. One of the mechanisms of action of probiotics is direct antagonism through the production of certain chemical components of different molecular weights. Those that are protein in nature and encoded by plasmids belong to bacteriocins. A number of bacteriocins produced by lactic acid bacteria have been described. In addition, the antagonistic effect of these bacteria is also determined by their secretion of organic acids and low-molecular metabolites such as peptides. Similarly, fatty acids produced by anaerobes such as *Bacteroides* can inhibit enterotoxigenic *E. coli* and shigella. The spectrum of their antagonistic action is very wide. From the low-molecular metabolite *L.reuteri*, which in purified form is reuterin, inhibits the growth of all test microorganisms. To the very specific antagonistic activity of certain strains of lactobacilli against *Clostridium ramosus*.

To increase the antagonistic activity of lactic acid bacteria, various mutagenic factors are used – ultraviolet radiation, chemical agents: ethyl ether, urethane, ethyleneimines. Studies have shown that under the influence of these factors, the antibiotic properties of lactic acid bacteria are significantly enhanced. Various types of lactic acid bacteria are able to enter into not only antagonistic, but also symbiotic relationships with each other ³⁶.

For example, when excluding some growth factors (vitamins of group B and amino acids), necessary for two strains, both organisms could grow in symbiosis, since each of them produced biologically active substances that each other needed. Thus, *L.arabinosus* 17-5 (requires phenylalanine) and *Str. faecalis* R (requires folic acid, threonine, serine, histidine or glycine) grow in symbiosis when phenylalanine, threonine and folic acid are not introduced into the environment.

According to modern ideas, the positive effect is multicomponent and includes: suppression of potential pathogenic microorganisms due to the production of antibacterial substances, competition for limiting food compounds; the effect of probiotics on the enzymatic activity of harmful intestinal

³⁶ Szajewska H., Kołodziej M. Systematic review with meta-analysis: *Saccharomyces boulardii* in the prevention of antibiotic-associated diarrhoea. *Aliment Pharmacol Ther.* 2015. Oct 42 (7). P. 793–801.

microorganisms; stimulation of the immune system of the macroorganism; the ability of lactobacteria to assimilate cholesterol and thus reduce the content of this lipid in the peripheral blood serum.

In addition to the significant antagonistic activity of lactobacilli, their high adhesiveness plays an important role, which is associated with the ability of lactic acid bacteria to settle on the mucous membranes of various cavities of the macroorganism. Such properties are present in both normal and pathogenic microflora of the gastrointestinal tract. Microorganisms with high adhesive properties gain a selective advantage in competition with less adapted bacteria. Intestinal lactic acid bacteria are mucosa-associated microorganisms and this is what largely contributes to the phenomenon of intestinal colonization resistance. It follows that one of the main criteria for searching for promising strains of lacto- and bifidobacteria is their high adhesive properties. It should be noted that most bacteria cannot settle in the patient's intestines for a long time, so the therapeutic effect of these probiotics will be transient. The interaction of pathogenic microorganisms with the epithelium of the mucous membrane of the digestive tract can be limited due to the presence of populations of saprophytic or lactic acid bacteria on it, the destruction of which may lead to the development of pathological changes in the body. In most species of lactobacilli, adhesive properties correlate with high antimicrobial activity and lysozyme activity. It should be noted that it has not been possible to obtain antibiotics from lactic acid bacteria in pure form so far, since they lose their activity during secretion.

The intestinal microflora (mainly anaerobic bacteria) is attached to the epithelium of the mucous membrane with the help of adhesins. Adhesins (ligands) of bacteria are biopolymers that consist of subunits of protein, glycolipid or glycoprotein nature unique to each species. They can be lectins, and in this case they selectively bind to carbohydrate determinants of glycoproteins and glycolipids, with each lectin corresponding to a certain carbohydrate residue. This can be roughly compared to the interaction of antigen and antibody.

The biological film that is formed performs a barrier role, it covers the receptors of the mucous and submucosal membranes from pathogenic microorganisms. It has a negative charge and serves as a barrier to the penetration of cations of some antibiotics, pathogenic and conditionally pathogenic microorganisms. It protects not only the mucous membrane, but also the autochthonous bacteria themselves from the action of antibiotics and antibodies. Lactobacteria have greater adhesiveness, due to the presence of a relatively large number of monosaccharides in the glycocalyx, unlike bacilli.

Thus, the antagonistic properties of lactobacilli and their ability to colonize the epithelium of the gastrointestinal tract, fixing on its villi, are the basis for the use of these microorganisms in the treatment of dysbacteriosis, gastritis,

ulcers of the gastrointestinal tract. This condition can be achieved by artificial colonization of the intestine with bacteria that can affect the microecological system of the intestine and the host organism as a whole.

Another of the most important functions of lactic acid bacteria is their participation in the formation of the immunological status and the functioning of the body's immune system. Data on the versatile effect of lactic acid bacteria on the body's immune system are the most recent. It has been established that lactobacilli can act as adjuvants of the humoral immune response in humans and experimental animals. Direct activating effect of probiotics on T-killers and B-lymphocytes. Live, heat-killed and components of the cell walls of lactobacilli, as well as preparations from bacilli, turned out to be good activators of hepatic and peritoneal macrophages and mononuclear phagocytes. Probiotics have the function of inducers of α - and β -interferon, which has been established in in vitro experiments and in animal experiments.

One of the mechanisms of action of probiotic drugs, which is closely related to their immunomodulatory effect on the macroorganism, is the phenomenon of translocation of bacteria from orally administered drugs into the bloodstream. This phenomenon was established and comprehensively studied by domestic researchers under the leadership of academician V.V. Smirnov. The authors found that within two minutes after the administration of probiotic preparations or cultures of microorganisms from their composition to mice, some of the bacteria were detected in the blood, lungs and liver, and a little later in other parenchymal organs with a subsequent gradual decrease in the number of viable cells. The phenomenon of translocation was observed constantly when the dose exceeded $1 \cdot 10^5$ live MC, while only a small amount of chitin entered the blood – about 0.01% of the administered bacteria^{37 38 39}.

It is known that the chemical composition of the cell wall of many lactic acid bacteria is quite constant, it is not affected by changes in the composition of the medium or the conditions in which microorganisms are grown. The most important cellular agents of bacteria are concentrated in their walls. By the method of chromatography of hydrolysates of the cell walls of a number of lactic acid bacteria, it was shown that their amino acid composition is most characteristic of the genus, and the qualitative composition and quantity of hexosamine sugars reflect the difference between species within the genus itself. For example, it was found that the walls of *L. plantarum* contain aspartic acid,

³⁷ Іванов С. В., Сімахіна Г. О., Науменко Н. В. Технологія оздоровчих харчових продуктів: підруч. Київ: НУХТ, 2015. 402 с.

³⁸ Фізіологія харчування: підручник / Павлоцька Л.Ф., Дуденко Л.В., Левітін Є.Я. та ін. Суми: Університетська книга, 2011. 473 с.

³⁹ Нутриціологія: навч. посіб. / під ред. Н.В.Дуденко. Харків: Світ книг, 2013. 560с.

alanine, glutamic acid, lysine, glucosamines and hexosamines. *L. delbrueckii*, *L. casei* have a more complex than other species of the genus chemical composition of the cell walls. In an experiment on laboratory animals, it was found that lactic acid bacteria such as *L. delbrueckii*, *L. casei*, *L. acidophilus* and *Str. thermophilus* stimulate the lymphoid apparatus, the synthesis of immunoglobulins and the activity of interferon, enhance mononuclear and phagocytic activity, the activity of natural killers, increase lysozyme and antimicrobial action, stimulate T-cell immunity reactions. Intraperitoneal injections of live bacteria *L. delbrueckii*, subsp. *bulgaricus* into mice stimulated the formation of interferon already 6 hours after their administration. Along with enhancing anti-infective immunity, lactic acid bacteria also have antitumor activity. The antitumor activity of probiotics and their effect on intestinal motility is the result of an indirect action. One of the directions is the destruction of enzymes, such as nitrogen reductase, nitroreductase, which convert procarcinogens into carcinogens. Another point of view is that live or killed by heating lactobacilli induce in the body an increase in the activity of macrophages, lymphocytes, excluding the synthesis of endogenous cytotoxins and tumor necrosis factor (TNF). Thus, the effect on the tumor can be carried out both through direct cytotoxic action and through stimulation of immune mechanisms. Finally, probiotic strains reduce the level of mutagens in feces, possibly by binding or sorption of mutagens on bacterial cells. I.G. Bogdanov was one of the first in vivo mice with sarcoma 180, Ehrlich carcinoma, melanoma B-16 and adenocarcinoma ASOTOL to establish the antitumor properties of *L. delbrueckii*, when the introduction of the culture filtrate led to the complete disappearance of tumors in almost 50% of laboratory animals. He proposed several drugs from *L. bulgaricus*. Three glycopeptides were isolated from the cellular fraction of lactobacilli: 1,2 and 10kD. One of the most active drugs was called blastolysin. Antitumor activity was also established when using other types of lactobacilli, for example, *L. casei*. The substance of these bacteria was especially successfully treated in mice after its subcutaneous injection into the area of the lymph nodes that drained the tumor. In the treatment of patients with various localizations of malignant tumors with chemo- or radiation therapy, it is recommended to use lactic acid bacteria, which significantly improve the general condition of patients and reduce the side effects of drugs.

Epidemiological studies in many countries of the world have shown that the occurrence of colon cancer is observed more in the population of people who consume Western refined diets, compared to those who consume vegetarian and lactic acid products. It was noted that in patients with colon cancer, on average, there are an order of magnitude fewer lactic acid bacteria in the feces. In people with a high risk of colon cancer, *Bifidumbacterium*, *Peptococcus*, *Clostridium*

prevailed, and in people with a low risk of colon cancer, *Bac.pneumoniae*, *Lactobacilus* dominated.

In most patients, it was found that the risk of breast cancer was positively correlated with the frequency of consumption of fatty cheeses and cow's milk and negatively – with the frequency of consumption of yogurts with live lactobacilli. In recent years, spore-forming bacteria of the genus *Bacillus* as the most famous representatives of exogenous microflora have attracted the attention of researchers. A fairly large arsenal of species of this genus has been used as therapeutic agents in the treatment of acute and chronic infections: *B.cereus*, *B.polymyxa*, *B.brevis*, *B.megaterium*, *B.pumilus*, *B.coagulans*, etc. However, the most widespread and studied species are *B.subtilis* and *B.licheniformis*. These microorganisms, due to their high adaptive properties, are widely distributed in nature and in particular in those objects with which a person is in closest contact. Due to this, bacilli constantly and in significant quantities enter the human body and, since they are resistant to lytic and digestive enzymes, they maintain their vital activity throughout the entire gastrointestinal tract. Among various representatives of exogenous microflora, bacilli are characterized by a number of advantages that allow us to consider them the most effective as new biological preparations: these bacteria (except *B.anthraxis* and *B.cereus*) are usually harmless to the macroorganism even in concentrations that significantly exceed those recommended for use; when used oral administration, these microorganisms significantly increase the nonspecific resistance of macroorganisms; their antagonistic activity is more pronounced and manifests itself against a wider range of pathogenic and conditionally pathogenic microorganisms than in other representatives of exogenous and endogenous microflora.

Bacilli are characterized by high enzymatic activity, which allows them to regulate and stimulate digestion, exhibit antiallergic and antitoxic effects; these microorganisms are stable during storage; they are environmentally safe. The bacilli do not form biofilms, since their adhesive properties are weakly expressed. Their activity manifests itself in the intestine and is associated primarily not with competitive relationships for attachment sites to the mucosa, but with high antagonistic activity against many pathogenic bacteria. At the same time, bacteria of the genus *Bacillus* do not exhibit antagonistic action on representatives of normal microflora, which creates conditions for non-competitive restoration of microflora.

The antimicrobial activity of aerobic spore-forming bacteria of the genus *Bacillus* may be due to the lytic enzymes they synthesize. For example, some scientists have isolated elastase from *B. subtilis*, which has a lytic effect on gram-negative and gram-positive microorganisms. Due to the high and diverse

enzymatic activity of bacteria of the genus *Bacillus*, which are part of probiotic biological preparations, they can play a significant role in stimulating and enriching the host's digestive system with the necessary enzymes. For example, bacilli are characterized by pronounced amylolytic activity, and some amylases are distinguished by the fact that during the hydrolysis of starch, which is catalyzed by these enzymes, sugars of the α -configuration and oligosaccharides no larger than maltotetrose are formed. Bacilli are characterized by high proteolytic activity. A proteolytic enzyme was isolated from the culture fluid of *B. subtilis*, which has the property of stimulating regenerative processes. Another proteolytic enzyme from the bacilli is a thrombolytic drug that shows its activity even when taken orally. Interestingly, some bacilli enzymes retain activity even in non-living cells.

A positive role is played by the ability of bacilli to produce significant amounts of extracellular amino acids, including essential ones (threonine, alanine, tyrosine, histidine, valine, etc.). The vitamin-synthesizing activity of bacteria of the genus *Bacillus* is also important. The presence of bacilli in a probiotic mixture of microorganisms contributed to a much more effective reduction in cholesterol in the blood of animals than in their absence. The experiments also observed a more pronounced ability to bind fatty acids and reduce the formation of cholesterol micelles in the presence of bacteria of the genus *Bacillus*. Thus, aerobic spore-forming bacteria of the genus *Bacillus* are a promising group of microorganisms for the creation of new highly effective biological products. First, they are characterized by the most pronounced antagonistic activity against pathogenic and conditionally pathogenic microorganisms. Second, it is known that on the basis of aerobic spore-forming bacteria it is possible to obtain strains with specified properties, since these bacteria are a fairly well-studied system for cloning^{40 41}.

A number of works are devoted to probiotics based on representatives of the genus *Aerococcus*, as well as the use of yeast for the production of probiotics. Thus, treatment with a drug containing *Saccharomyces boulardii* was found to be effective in intestinal infections caused by *Clostridium difficile*. A pronounced clinical effect was also obtained when using *Saccharomyces cerevisiae*.

The above indicates that the spectrum of microorganisms that make up probiotic drugs is quite wide. Of course, the most common among them are lactic acid bacteria, as one of the groups of microorganisms widely distributed in

⁴⁰ Ahmad, M. F., Ahmad, F. A., Alsayegh, A. A., Zeyaulah, M., Babalghith, A. O., Faidah, H., ... & Bantun, F. Probiotics and Cancer: Mechanistic Insights and Organ-Specific Impact. *Biomolecules*. 2025. 15(6). P. 879-897. doi.org/10.3390/biom15060879.

⁴¹ Thu, M. S., Ondee, T., Nopsopon, T., Farzana, I. A., Fothergill, J. L., Hirankarn, N., ... & Pongpirul, K. Effect of probiotics in breast cancer: a systematic review and meta-analysis. *Biology*. 2023. (Basel)12(2). 280 p. https://doi.org/10.3390/biology12020280.

the biosphere. The study of lactic acid bacteria as antagonists of pathogenic and conditionally pathogenic microflora, fungi and viruses is of great importance for maintaining homeostasis of the human body, which is largely determined by the state of the microflora created during the evolutionary process of symbiotic and natural selection. Studies on the determination of the antimicrobial activity of lactic acid bacteria allow us to identify the individual characteristics of each culture, which is crucial for further study of the nature and mechanism of action of bacteriocins. The knowledge of the antagonistic properties of each culture, the optimal conditions for their maximum manifestation is necessary when formulating therapeutic and dietary products with given properties. The participation of symbionts of biological products in the formation of the immunological status opens up prospects for their use in diseases of other body systems, except for the intestinal tract^{42 43}.

Probiotic therapy and prevention are of great importance in gerontology. In elderly patients, dysbiosis is registered more often than in young people, severe violations of the microbiocenosis are often detected, in various biotopes, but especially in the biotopes of the digestive canal. The development of dysbiosis can be facilitated by anatomical and physiological features of the digestive canal in old age, because in the aging process, morphological and functional changes develop: atrophic islands of the epithelium appear, the amount of saliva, secretion of the esophageal mucosa, acidity of gastric juice decreases, gastric and intestinal secretion and motor function of these organs are disturbed. In addition, long-term medication (antibiotics, cholinolytics, tranquilizers, etc.), impaired immune status, nutritional disorders (monotonous nutrition, exclusion of juice-forming foods, consumption of mainly carbohydrates or proteins), chronic illnesses, mental and physical stress, physical inactivity, radiation therapy and other adverse environmental factors can undoubtedly also cause the development and worsening of microecological disorders in the elderly. With aging, the composition of the indigenous microbiota changes: the number of opportunistic bacteria, in particular putrefactive bacteria, increases, and the colonization level of physiological saccharolytic anaerobic bacteria decreases. The result is profound changes in the functional properties of microbiocenoses. Therefore, the correction of the intestinal microbiocenosis in elderly patients is a difficult task and the search for new methods of restoring

⁴² Kleniewska, P., & Pawliczak, R. Can probiotics be used in the prevention and treatment of bronchial asthma? *Pharmacological Reports*. 2024. 76(4)/ P. 740-753. <https://doi.org/10.1007/s43440-024-00618-0>.

⁴³ Sanchez, P., Letarouilly, J. G., Nguyen, Y., Sigaux, J., Barnette, T., Czernichow, S., ... & Daïen, C. Efficacy of probiotics in rheumatoid arthritis and spondyloarthritis: a systematic review and meta-analysis of randomized controlled trials. *Nutrients*. 2022. 14(2). 354 p. <https://doi.org/10.3390/nu14020354>

microflora does not stop. At the beginning of the last century, I. I. Mechnikov proposed to consider the fight against premature aging as the most important task of medicine. He considered old age as a pathological phenomenon, which should be fought as a disease. I. I. Mechnikov considered the main cause of premature aging to be chronic poisoning of the body with putrefactive decay products, which accumulate in the intestines due to the excessive development of proteolytic microorganisms. To neutralize the body from toxic protein decay products, the scientist recommended using fermented milk products with a high concentration of live antagonistically active lactic acid bacteria in food, capable of suppressing putrefactive processes in the intestines^{44 45}. The microecological aspect of gerontology, the initial impetus for which was given by I. Mechnikov, is continued by modern researchers. Despite the fact that this concept, which considers the activation of putrefactive processes in the intestine as the main factor of premature aging, has not been fully confirmed, increasing attention is being paid to age-related changes in microbial ecology. Analysis of research results in the field of probiotic therapy allows us to predict a further expansion of the scope of probiotics in the following areas: – biotherapy using antibiotic-sensitive bacteria to replace resistant ones; – prevention of translocation of pathogenic bacteria from the skin and mucous membranes into the internal environment of the body; – promotion of faster body weight gain; – eradication of certain types of bacteria from the body, for example, *Helicobacter pylori* in patients with gastric ulcers; – restoration of the composition of the microflora after treatment with antibiotics; – change in the composition of the intestinal microflora according to the characteristics of the diet; – improving oxalate metabolism to reduce the incidence of kidney and bladder stone formation; – destroying potentially dangerous chemicals, especially in cases of constant exposure to the body; – suppressing pathogenic strains of *Staphylococcus aureus* and *Clostridium difficile* in hospital patients; – preventing bladder infections^{46 47}. It is difficult to overestimate the importance of the prophylactic use of probiotics for human health. Every year, new and new data are accumulating on the effectiveness of the prophylactic use of probiotics, based on the principles of evidence-based medicine.

⁴⁴ Tsai, Y. C., Cheng, L. H., Liu, Y. W., Jeng, O. J., & Lee, Y. K. Gerobiotics: probiotics targeting fundamental aging processes. *Bioscience of microbiota, food and health*. 2021. 40(1). P. 1-11. <https://doi.org/10.12938/bmfh.2020-026>

⁴⁵ Pandey K.R., Naik S.R., Vakill B.V. Probiotics, prebiotics and synbiotics- a review. *J Food Sci Technol*. 2015. 52(12). P. 577–7587.

⁴⁶ Lee J., Seto D., Bielory L. Meta-analysis of clinical trials of probiotics for prevention and treatment of pediatric atopic dermatitis. *J Allergy Clin Immunol*. 2008. 121(1). P. 116-121.

⁴⁷ Rousseaux C., Thuru X., Gelot A. et al. *Lactobacillus aci-dophilus* modulates intestinal pain and induces opioid and cannabinoid receptors. *Nat Med*. 2007. 13. P. 35-37.

CONCLUSIONS

Recommendations for the use of probiotics, especially in clinical settings, should link specific strains to claimed effects based on human studies. Some strains have unique properties that may be responsible for certain neurological, immunological, and antimicrobial effects. However, the new concept of probiotics suggests that some mechanisms of probiotic activity are likely to be common across strains, species, and even types. Many probiotics may act in similar ways, such as by stimulating resistance to colonization, regulating gastrointestinal transit, or normalizing microbiota abnormalities. In particular, the ability to increase short-chain fatty acid production or to lower colonic luminal pH may be major effects produced by many different strains of certain well-studied *Lactobacillus* and *Bifidobacterium* species. If probiotics are used to support healthy digestion, it may be sufficient to use a variety of probiotic mixtures that contain an adequate number of well-studied species. It is now common practice in the field of probiotics to include multiple strains in systematic reviews and meta-analyses. This approach is possible if the common mechanisms of action of the different strains included allow them to be attributed to the effect obtained.

Probiotics are important biotherapeutic drugs that are advisable to use in many infectious and somatic pathologies. Today, various microorganisms are considered as probiotics: bacteria, fungi and even yeast. *Lactobacilli* and *bifidobacteria* occupy the dominant place. It is imperative to pay attention to the requirements that are put forward to candidates for probiotics, noting the diversity of their action. As biocorrection drugs, drugs based on inactivated microorganisms, prebiotics, synbiotics, metabiotics, metabolite-type drugs, nutraceuticals, etc. also deserve careful study and proof of clinical effectiveness. Further studies are needed on the immunomodulatory activity of probiotics and the correlation of their action with various drugs used to treat major diseases. Considering the medical feasibility of new highly effective probiotics, attention has been drawn to the need to create multiprobiotics.

Probiotics are increasingly being introduced into gastroenterological practice, as the development of some diseases of the digestive system is associated with the activation of opportunistic representatives of the intestinal microflora. The etiological factor of this group of diseases is the autochthonous, weakly virulent and low-contagious microflora, the proliferation of which, in case of eubiosis disorders, in some cases leads to inflammation, changes in the morphofunctional state of organs and other consequences.

SUMMARY

The proven beneficial effects caused by probiotic strains were analyzed, namely: lowering blood cholesterol levels, improving microcirculation,

inactivation of inflammatory mediators, anticarcinogenic and immunomodulatory effects, antibacterial effects, synthesis of enzymes and vitamins, etc. The requirements for strains that can be used for the manufacture of probiotic preparations were systematized. The use of probiotics was justified not only for the correction of digestive disorders and intestinal diseases, but also for a number of somatic diseases, such as allergic dermatoses, diabetes mellitus, obesity, oncological diseases, for the prevention of atherosclerosis, liver diseases. Special attention was paid to the immunomodulatory properties of microorganisms used as the basis of probiotic preparations, their effect on local and general immunity, in particular the effect on mucous membranes and the possibility of using such agents for the prevention of infectious pathologies of the respiratory and intestinal organs. The use of probiotics in pediatrics, gynecology, and gerontology has been announced. Data on the positive effect of these drugs for the prevention of complications during surgical interventions are presented. The creation of stable multiprobiotic communities should be preceded by a detailed study of the biological properties of each strain and the selection of bacterial components that mutually stimulate each other through the synthesis of certain structural and/or energy metabolites-stimulators. In conclusion, it should be recalled that probiotic therapy has shown quite encouraging results in many clinical studies in diarrhea of various etiologies, irritable bowel syndrome, urogenital infections, allergic diseases, surgical infections, oral candidiasis, neoplasms, gingivitis, bleeding gums, high blood pressure, etc. It helps to alleviate anxiety symptoms. However, since probiotics are living microorganisms, it is possible that they may cause infection in the host. Therefore, comprehensive and systematic studies should be conducted to obtain a proper evaluation with confirmed results of the action of these drugs before introducing them into routine use.

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