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PROBIOTICS AND PREBIOTICS – FUNCTIONAL INGREDIENTS FOR THE CONFECTIONERY INDUSTRY

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Abstract

In recent years, along with the widespread "diseases of civilization," the problem of gastrointestinal diseases has emerged. The problem of dysbiosis attracts close attention of many scientists, because almost 90 % of the population suffers from it to some extent, which indicates a very large social and environmental significance of this problem. Prevention and treatment of dysbiosis are associated with the restoration of normal intestinal microflora with the help of pharmacopoeial drugs, biologically active additives, functional foods containing probiotics and prebiotics. Therefore, the modern development of the food industry requires the development of qualitatively new functional foods capable of influencing the normalization of intestinal microbiocenosis. These products will help prevent dysbiosis, maintain and improve health by regulating and normalizing the human body, taking into account its physiological state and age. This article characterizes functional nutrition, considers its place in the structure of modern nutrition, analyzes the feasibility of using pro- and prebiotics as functional ingredients to give confectionery products physiological properties. The modern market of confectionery production with the use of pro- and prebiotics is considered and the prospects of their use as the main functional ingredients in the technology of confectionery products are shown. This approach will allow the development of functional products, the consumption of which will be effective for the normalization of intestinal microflora and prevention of dysbiotic conditions.

Keywords: functional ingredients; probiotics; prebiotics; functional food; gastrointestinal tract; dysbiosis; confectionery products.

ПРОБІОТИКИ ТА ПРЕБІОТИКИ – ФУНКЦІОНАЛЬНІ ІНГРЕДІЄНТИ ДЛЯ КОНДИТЕРСЬКОЇ ПРОМИСЛОВОСТІ

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Анотація

В останні роки поряд з широко розповсюдженими «хворобами цивілізації» загострилась проблема захворювань шлунково-кишкового тракту. Проблема дисбактеріозу привертає пильну увагу багатьох вчених, адже майже 90 % населення в тій чи іншій мірі страждає від нього, й це свідчить про дуже велике соціальне та екологічне значення вказаної проблеми. Профілактика і лікування дисбактеріозу пов'язані з відновленням нормальної мікрофлори кишечника за допомогою фармакопейних препаратів, біологічно активних добавок, функціональних продуктів харчування, що містять пробіотики і пребіотики. Тому сучасний розвиток харчової промисловості вимагає розробки якісно нових функціональних продуктів харчування, здатних впливати на нормалізацію мікробіоценозу кишечника. Ці продукти допоможуть запобігти дисбактеріозу, зберегти та покращити здоров'я, регулюючи та нормалізуючи роботу організму людини з урахуванням її фізіологічного стану та віку. В статті охарактеризовано функціональне харчування, розглянуто його місце в структурі сучасного харчування, проаналізовано доцільність використання про- та пребіотиків як функціональних інгредієнтів для надання кондитерським виробам фізіологічних властивостей. Розглянуто сучасний ринок кондитерської продукції з використанням про- та пребіотиків, показано перспективи їх використання як основних функціональних інгредієнтів у технології кондитерських виробів. Такий підхід дозволить розробити функціональні продукти, споживання яких буде ефективним для нормалізації мікрофлори кишечника та профілактики дисбіотичних станів.

Ключові слова: функціональні інгредієнти; пробіотики; пребіотики; функціональне харчування; шлунково-кишковий тракт; дисбактеріоз; кондитерські вироби.

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Introduction

Today, no one doubts the fact that human health is directly related to the food we eat every day. The equation "health is a function of nutrition" is the basic one for modern nutritional science.

Existing environmental problems, social changes and commonly used drug treatment in the second half of the twentieth century also affected the quality of food consumed, resulting in an increase in the development of diseases associated with unhealthy diet. Due to these facts the terms "diseases of civilization" or "lifestyle diseases" appeared. These includefatigue atherosclerosis, cancer, cardiovascular disease, obesity, diabetes, high blood pressure, and gastrointestinal diseases [1–4]. Therefore, the world community, assessing the increase in the prevalence of chronic non-infectious diseases as an epidemic, is strongly interested to find and implement effective solutions against them. Modern nutrition science requires new approaches to the formation of the human diet in the context of existing issues. These tasks include, first of all, the development of technologies for high-quality, innovative, safe and functional food products that should meet the requirements of the consumers with different age and income. Additionally, these products are expected to be characterised with therapeutic and preventive functions. To address this problem, experts in various areas - nutritionists, bacteriologists, gastroenterologists, food processing engineers, including those in the confectionery industry – are developing products with various functional ingredients in their composition.

In recent years, to prevent dysbiosis and restore normal intestinal microflora, the food industry has been producing food products that contain pro- and prebiotics. Therefore, the aim of this study was to substantiate the prospects of using pro- and prebiotics as functional ingredients to provide confectionery products with a functional purpose.

Functional food and its place in the structure of modern nutrition

In recent years, functional nutrition has become a widespread trend in nutritional science, which is intensively developing in many countries [5; 6]. The term "functional food" implies the use of foods with a pronounced positive effect on the body, which maintain health and reduce the risk of disease. According to the famous economist Paul Pilzer [7], the main trends in this area are related to the fact that "consumers around the world are looking for new opportunities to improve their physical, emotional and mental health, slow down the aging process and increase their working life."

Functional food has three main functions:

- nutritional function – the product affects the nutritional status of a person;
- sensory function – the ability of the product and its ingredients to effect positively on the odorant, taste and other human receptors;
- regulatory function – participation of the immune, endocrine, nervous and other body systems in the process of digestion regulation.

It should be noted, however, that even in the scientific literature and official documents there is no consensus on the definition of functional foods and their scope of application. While in some cases they are positioned as foods that are different from biological supplements and patented medicines, in others, on the contrary, it is stated that they are useful dietary supplements or other therapeutic and prophylactic drugs.

Japan, which is a pioneer in the use of functional foods, has formulated the main criteria for characterizing a product as functional: it contains only substances of natural origin, should not be produced in the form of capsules, tablets, powders or other dosage forms, can and should be part of the diet on a daily basis or for a long time, should have a targeted effect on certain body functions and have a therapeutic and preventive effect. On this basis, functional foods "are recognized as products containing organic substances enriched with vitamins or microelements and having energy, probiotic and other beneficial properties" [8].

Australia's National Center of Excellence for Functional Foods (NCEFF) defines these products as follows: "Functional foods are foods that support human health and well-being by providing health benefits over and above the basic diet".

In our opinion, more scientifically based is the definition provided by European experts on functional foods, presented in the "Scientific Concept of Functional Foods in Europe", which emphasizes that the food industry has an opportunity to improve public health by organizing the production and launching a new category of food products – functional foods that have not only nutritional value in the traditional sense of the word, but also the ability to improve physical and mental health. Functional foods are classified as mass consumption products, i.e. they look like traditional food and are intended to be part of the normal diet of the main population

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groups, but contain functional ingredients that have a biologically significant positive effect on a healthy body during metabolic processes that occur in it.

Consumption of such products is not a therapeutic method in the treatment of diseases, which defines therapeutic foods, but it helps prevent some diseases and aging of the organism living in environmental conditions.

Therefore, in the structure of modern nutrition, functional foods occupy an intermediate position between traditional foods that are consumed based on a person's eating habits and financial capabilities in order to satisfy hunger, and foods that are prescribed to a person, already as a patient, by a doctor as part of a therapeutic diet for the period of treatment and rehabilitation (Fig. 1).

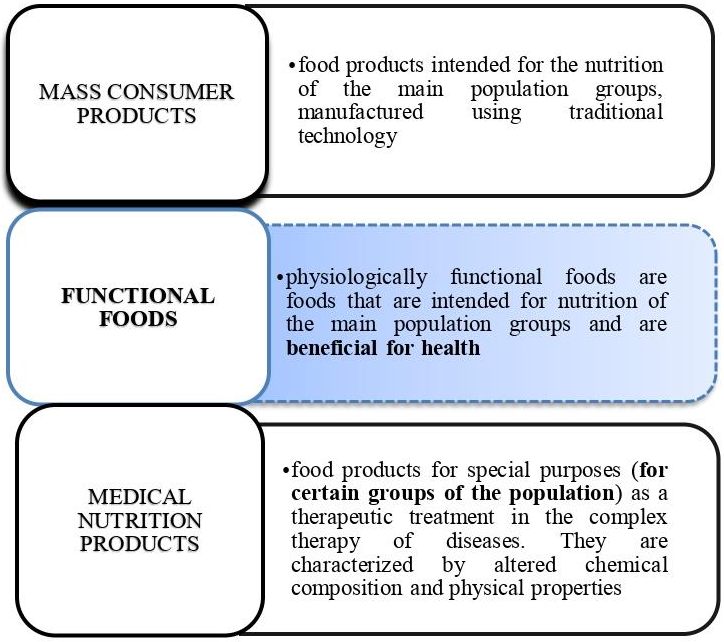

Fig. 1. Functional foods in modern nutrition

There are many objective and subjective reasons that stimulate the growth of production and consumption of functional foods in almost all countries of the world. These include, in particular, the following:

- changes in the structure and quality of nutrition in the context of modern scientific and technological progress. In particular, this tendency is observed in a significant decrease in vitamins, mineral elements, fiber and other vital substances content, which are necessary for the body in food content;
- the real danger of chemical and biological contamination of food products. The most common pollutants are nitrates, nitrites, heavy metal salts, microscopic fungi, pathogenic microorganisms, various dyes, preservatives, etc;
- there are a number of food substances (essential nutrients) that are not produced in the body and therefore must be supplied by the food. These nutrients include some macro- and microelements, vitamins, amino acids, and polyunsaturated fatty acids;
- these changes are due to the decrease of human physical activity, which is combined with the consumption of excessive amounts of refined food and food containing various additives. Scientific studies have shown that by consuming the usual diet for a modern person, the body does not receive 40–60 % of the required amount of vitamins and biologically important macro- and microelements;
- growing attention to personal health, accompanied by a increasing interest to reduce the consumption of drugs by paying more attention to a healthy diet and consumption of functional foods in particular;
- the high prevalence of chronic diseases for which the use of functional foods is very important for treatment and prevention;
- the number of children and adults who are overweight for their age is growing. Obesity significantly increases the risk of heart disease, asthma, diabetes and cancer. The cost of funding programs to prevent obesity is constantly increasing;

- the development of the production and consumption of functional foods is facilitated by the active participation in these processes of various specialized medical associations and foundations for the prevention of cardiovascular, diabetic, orthopedic, oncological and other diseases. The logos of these organizations and some indicators of the products they recommend are often indicated on food labels.

Functional food ingredients

Ingredients play an important role in the creation of functional foods, as they largely determine the properties of the food product. Functional ingredients include physiologically safe food ingredients that have precise physical and chemical characteristics, for which scientifically proven properties useful for maintaining and improving health have been identified and approved, and for which daily consumption rates in food products have been established and approved [9–11].

Initially, according to the classification of Japanese researchers, the main categories of functional ingredients used for the production of functional foods were bifidobacteria and lactic acid bacteria, oligosaccharides, dietary fiber, ω-3 fatty acids [12]. Subsequently, this list was significantly expanded and at the beginning of the twenty-first century included 15 categories [13].

According to Grand View Research (Functional Ingredients Market Size Report, 2020–2027), the most promising ingredients in 2016–2027 will be: maltodextrins, probiotics, polydextrose, modified starch, pectin, omega-3, linoleic acid, rice protein, protein hydrolyzate.

In 2019, the global functional ingredients market was valued at USD 64.13 billion and is expected to grow at a CAGR of 6.4 % between 2020 and 2027. The market growth is attributed to factors such as growing demand for products with environmentally friendly labeling, changing regulatory requirements in the food and beverage market, and increasing consumer awareness [14].

Experts associate the beneficial effects that physiologically functional ingredients in a food product can have on the human body with various types of physiological effects. The main ones are recognized [15; 16]:

- positive effect on the metabolism of various substrates (maintaining energy balance, maintaining body weight, blood glucose and insulin levels, etc;)
- protection against compounds with oxidative activity;
- positive effect on the cardiovascular system;
- positive effect on the physiology of the gastrointestinal tract;
- positive effect on the state of intestinal microflora;
- physiological effect on the state of the immune system.

According to the Codex Alimentarius Commission, the following principles should be taken into account when substantiating the composition, developing medical and biological requirements for a new product and selecting a functional ingredient (essential nutrient) for enrichment (Fig. 2).

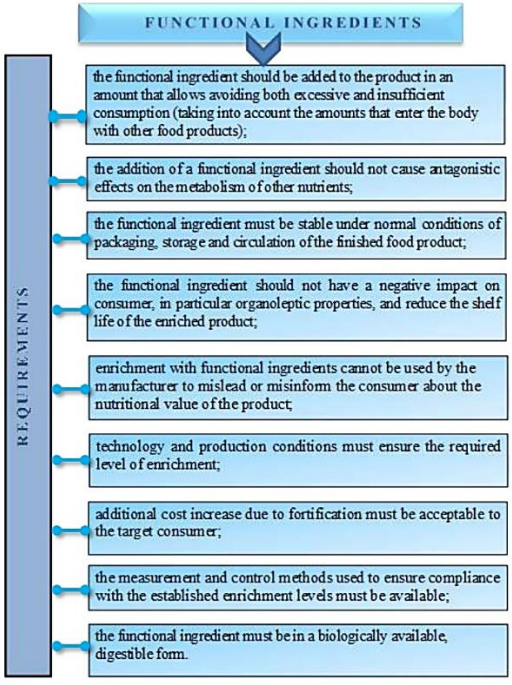

Fig. 2. Requirements for functional ingredients

The enrichment of food products with functional ingredients should be carried out taking into account the need to ensure the safety of the products obtained, the complete absence of possible risks due to the hygienic aspects of the use of enriching ingredients, the technological features of their use in production and the physiological effects in the human body after eating the modified product [10].

When choosing products to be enriched with essential nutrients, it is necessary to take into account the mass and regularity of consumption, the possibility of industrial production, the simplicity of the enrichment technology, the uniform distribution of the additive over the weight of the product, etc.

The choice of a natural functional product as a source of the necessary functional ingredients, the development of technological modes of their preparation and application are carried out taking into account the existing technological capabilities of existing enterprises in order to cause minimal changes in the existing technology and equipment used at the enterprise. This approach avoids a significant increase in the cost of the products. The technologies for obtaining, preparing and adding functional ingredients should be chosen in such a way as to avoid any harmful effects on their quality and ensure the quality of the finished food product familiar to the consumer [17].

Responsibility to the consumer for the quality and efficacy of fortified foods imposes another very important obligation on their developers and manufacturers: they must guarantee not only the safety of the ingredients in the product, but also their availability and bioavailability in the human body during the fortified foods consumption. Therefore, the effectiveness and safety of functional foods must be convincingly confirmed by testing on groups of people, which demonstrates their complete safety, decent taste, good digestibility, ability to significantly improve the supply of functional ingredients included in the original product and guarantee the positive health indicators associated with these substances.

Physiologically functional ingredients that form the human microbiocenosis. The role and importance of probiotics in nutrition

Human health largely depends on the well-being of the intestinal microflora. The participation of the gastrointestinal tract in the overall metabolism of the human body is determined by the presence of microbial associations, the quantitative and qualitative composition of which largely determines the range of synthesized biologically active substances. Normal microflora ensures colonization resistance of the body, that is, the inability to reproduce opportunistic and pathogenic microorganisms on the skin and mucous membranes.

In recent years, problems related to the state of dynamic symmetry between the human body, the microflora in the gastrointestinal tract, and the environment have attracted the attention of modern scientists of various specialties, including confectionery technologists.

The human body is abundantly populated by microorganisms, the number of which is $10^{13\text{-}15}$, which is 1–2 orders of magnitude more than all cells in the human body. The total weight of microorganisms reaches 1–1.5 kg in children and up to 3–4 kg in adults. Moreover, the distribution of this huge number of microbes in the body is different. There are several main habitats (biotopes) and the largest accumulation of bacteria: the gastrointestinal tract, especially the colon (up to 60 % of the total microflora), upper respiratory tract (15–16 %), skin (15–20 %), and vaginal biotope (9–10 %) of microorganisms [18].

The achievements of modern science allow us to consider the totality of human microbiocenoses (microbiomes) as a kind of vital microbial and metabolic multifunctional system that performs a huge number of physiological functions independently and in interaction with other organs and systems that ensure the homeostatic state of the body as a whole [19; 20]. The microbiome protects the human body from harmful microorganisms and compounds, significantly affects the structural and functional state of internal organs, the immune system and the processes of regulating vital functions, and promotes harmonious interaction of the macroorganism with the exogenous microbial world. The participation of biocenoses in the construction of molecular structures of the macroorganism, synthesis of a number of informational and regulatory molecules, accumulation of thermal and free energy, etc. has been experimentally proven [21–23].

The composition of the intestinal microbial population, even in a healthy person, is subject to variability and probably reflects the body's ability to adapt to the peculiarities of nutrition and lifestyle, as well as climatic factors. The intestinal microflora can be normal only in the physiological state of the macroorganism. The quantitative and qualitative composition of the normal microflora, as well as its functions, are easily disrupted, which leads to the development of dysbiosis. Dysbiosis is a state of the

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ecosystem in which the functioning of all its components – the human body, its microflora and the environment, as well as the mechanisms of their interaction- is disturbed, resulting in disease. Intestinal dysbiosis is always secondary and represents a change in the composition of the microflora of a particular biotope, the translocation of its various representatives to uncharacteristic biotopes, as well as metabolic and immune disorders [24–26].

Prevention and treatment of dysbiosis is aimed primarily at restoring normal intestinal microflora. The simplest and most studied method is the introduction of bacteria - representatives of normal microflora in the form of pharmacopoeial preparations into the diet. For the first time, the idea of using live microorganisms - representatives of the normal human microflora to restore the disturbed microecological status was put forward by Nobel laureate Ilya Mechnikov in the early XX century.

The era of probiotics dates back to 1907, when I.I. Mechnikov conceptually substantiated the need to study the normal human intestinal microbiota. The term "probiotics" (from the Latin "pro bio" – "for life") was first proposed to be used in the medical literature by D.M. Lilly and R.H. Stilwell in 1965 [27], as an alternative to the term "antibiotic", which means "against life". Since then, many definitions of the term "probiotics" have been proposed. The current definition of probiotics, given by a working group of the World Health Organization in 2001, is still relevant: "Probiotics are living microorganisms that, when used in adequate amounts, contribute to the health of the host organism" (Report of a Joint FAO/WHO, 2001).

According to the requirements of the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) the microorganisms that make up a probiotic should have the following properties (Fig. 3). The joint conclusion determined that the main strains of probiotics belong to the two genera *Bifidobacterium* and *Lactobacillus* [28].

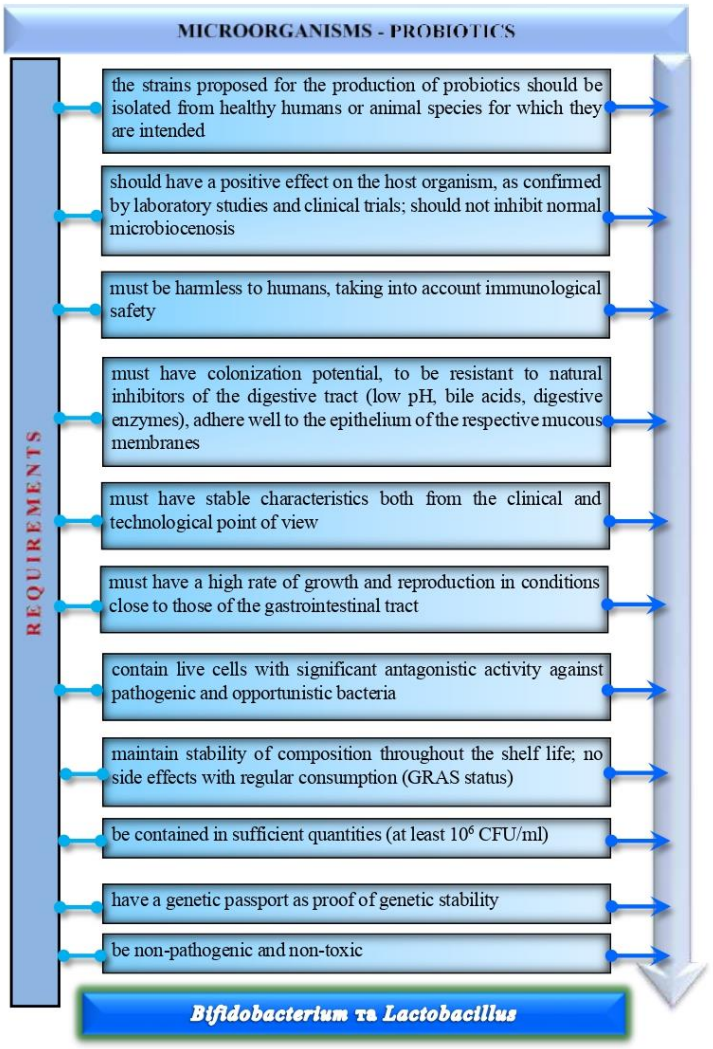

Fig. 3. Properties of probiotic microorganisms

Therefore, when using probiotics as functional ingredients, it is common to use these strains of microorganisms, which are recognized as classical probiotics and are widely used as pharmaceuticals and biologically active ingredients in functional food products.

The main mechanisms of the positive effect of probiotics on the microecological status of humans include competition for adhesion with pathogenic and opportunistic microorganisms, inhibition of the growth of potentially harmful microorganisms through the production of antimicrobial substances and lowering the pH, stimulation of the growth of normal microflora through the production of vitamins and other stimulating substances, neutralization of toxins, restoration and normalization of biofilm functioning, activation of immune cells and stimulation of immunity. The literature review has shown antimutagenic, anticarcinogenic properties of probiotics, cholesterol lowering effect, stimulation of the immune system, and improvement of lactose metabolism during their consumption [29–31]. In recent years, some scientific publications have claimed that probiotics are a potentially effective and safe alternative for the treatment of inflammatory and autoimmune gastrointestinal diseases due to their beneficial modulating effect on the immune response [32; 33].

Prebiotics as factors of growth and development of human microbiocenosis

Currently, food products containing so-called bifidogenic factors or prebiotics, which selectively stimulate the growth and development of primarily bifidobacteria and lactobacilli, occupy a significant place in the global market. As a result, they improve various physiological functions and metabolic reactions associated with the functioning of symbiotic microflora (resistance to infections, reduced risk of malignant tumors in the large intestine, improved bioavailability of calcium and magnesium, colonization of the intestine with beneficial microorganisms, lowering serum cholesterol, etc.)

Prebiotics include substances that must meet the following requirements [34; 35]: they should not be broken down and absorbed in the upper gastrointestinal tract (GIT); they should be broken down by enzymes of microorganisms in the colon and selectively stimulate the growth of bifidus and/or lactobacilli; they should have the ability to improve the composition of the intestinal microflora; their fermentation products should have a beneficial effect and/or systemic effect on the host organism; induce a gastrointestinal or general effect that improves the condition of the macroorganism; induce beneficial effects not only at the level of the gastrointestinal tract but also of the body as a whole, i.e. provide systemic effects; be safe for the macroorganism; be technologically sustainable in food production.

The main types of prebiotic compounds include the substances presented in Table [13].

Table

The main types of prebiotic compounds

The Group	Substance that stimulates growth
Monosaccharides, alcohols	Xylitol, melibiose, xylobiose, raffinose, sorbitol, etc.
Oligosaccharides	Lactulose, lacitol, soybean oligosaccharide, fructooligosaccharides, latito-oligosaccharide, galacto-oligosaccharide, isomaltooligosaccharide, etc.
Polysaccharides	Pectins, pullulan, dextrin, inulin, chitosan, etc.
Enzymes	β-microbial galactosidases, saccharomyces proteases, etc.
Peptides	Soybean, dairy, etc.
Amino acids	Valine, arginine, glutamic acid, etc.
Antioxidants	Vitamins A, C, E, α-, β-carotenes, other carotenoids, glutathione, ubiquinol, selenium salts, etc.
Unsaturated fatty acids	Eicosopentaenoic acid and others.
Organic acids	Propionic, acetic, citric, etc.
Plant and microbial extracts	Carrot, potato, corn, pumpkin, rice, garlic, yeast, etc.
Others	Lecithin, lysozyme, lactoferrin, gluconic acid, starch molasses, etc.

The physiological role of prebiotics cannot be overestimated – their beneficial effects have been proven in numerous studies [36–40]:

- are a nutrient medium for normal intestinal microflora. This ability is largely due to the resistance of prebiotics to digestive juices and enzymes, due to which they are not adsorbed and hydrolyzed in the upper gastrointestinal tract, reaching the habitat of bifidus and lactobacilli without changes;

- inhibit the growth of pathogenic intestinal microflora;

- stimulate intestinal absorption of vital minerals (Ca, Zn, Mg);

- provide immune and antitumor protection of the intestine;

- stimulate the synthesis of vitamins and volatile fatty acids;

- maintain normal blood cholesterol levels;

- improve metabolism and reduce allergic reactions.

Thus, to normalize microflora and develop functional foods, it is advisable to use prebiotics as functional ingredients.

Modern trends in the production of functional confectionery products

The nutrition of the modern consumer plays an important role in shaping his or her healthy lifestyle, providing the body with basic and essential nutrients, minor food components and energy.

Sedentary lifestyles, increasing stress, low life expectancy of the country's population bring to the forefront the solution of the most important set of scientific problems in the development of highly efficient technologies and the creation of a new generation of healthy food products with increased nutritional and biological value on their basis. At the same time, consumers have also seen a shift in emphasis from simply satisfying hunger with food to emphasizing the potential use of food to reduce the risk of chronic disease. This concept has opened up new opportunities in the field of gerontology, dietary and therapeutic nutrition based on modern knowledge in chemistry, biochemistry and molecular biology, supporting the hypothesis that foods can modulate various functions in the body and thus participate in maintaining health by reducing the risk of diseases associated with poor nutrition. This hypothesis is a platform for the development of a whole group of functional foods, including confectionery.

In this century, there has been a growing interest in the consumption of healthy foods and natural food ingredients, which has been facilitated by a number of social and scientific circumstances [41].

Social factors include: capitalization (individualization) of social relations, in which human mental and physical abilities have become a commodity. This has created a natural human need to preserve and increase one's capabilities, i.e. health; an increase in the level of education of society, which contributes to a faster perception of new ideas in science; a change in the demographic situation, which has resulted in an increase in the proportion of people who need to correct their health. In this case, we are talking, first of all, about an increase in the share of elderly people.

The scientific factors include: evidence that the vast majority of the so-called diseases of civilization (cardiovascular diseases, obesity, hypertension, some types of malignant tumors, gastrointestinal diseases, etc.) are nutritionally dependent diseases and can be corrected by appropriate diets; and a change in nutrition paradigms. The new paradigms take into account the ultimate impact of nutrients on health not only depending on their amount (norm), but also depending on possible interactions with other substances that come with food.

This trend is very closely related to the confectionery industry, as confectionery products are becoming increasingly popular in the modern consumer market. They represent a group of food products with a fairly wide range. Despite the fact that they are not essential items and are not part of the "grocery basket", due to their consumer appeal (especially for children) and variety of flavors, they are in great demand among the population and play a significant role in replenishing the energy balance of a person. It is safe to say that humanity's need for sweets, and thus the demand for confectionery products, remains high. It should also be noted that the number of confectionery products produced in Ukraine is growing, as well as their consumption.

Confectionery products are essential component of the diet of people of all ages. It is increasingly being included in the assortment list of school breakfasts, it is very popular among students, and the demand for dietary and "healthy" confectionery products is growing. Thus, it is safe to say that confectionery products are among the products of a diverse assortment that are consumed by almost all segments of the population [42].

Today, the confectionery industry is one of the few parts of Ukraine's food industry that is self-sufficient, developed, highly competitive, saturated, fully formed and holds a successful position in the European market. This is despite the economic crisis, the devaluation of the local currency, the decline in the purchasing power of the population, rising commodity prices, and the Russian military aggression against Ukraine. However, in order to keep up with the trend of modern life, manufacturers need to be aware of the trends in the domestic and global confectionery markets. Consumer needs and tastes change, evolve, and transform. And, of course, this is the case with confectionery, so manufacturers must constantly work on developing and creating new types of products that can meet the demanding needs of consumers.

The global functional confectionery market is still a niche market, but it is growing very fast as sweets producers look for new ways to differentiate their products from competitors' products. Experts believe that this market will continue to grow rapidly in the medium term.

Functional confectionery products combine an element of healthy eating with convenience and pleasure, which is a crucial factor in the development of this product group. "Healthy sweets" - a few years ago, this concept could have been considered as unbelievable. However, since consumers have become more focused on healthy nutrition and lifestyle in general, the production of functional confectionery products is gradually becoming a strategic direction for most food companies. Because of this, producers are trying to meet the demand by creating new innovative, enriched products. That is why the range of food products that have a beneficial effect on the human body is growing steadily. Some products are rich with micronutrients, others improve digestion, and still others have a positive effect on the cardiovascular and nervous systems, etc. However, there is still a gap in the range of products that restore the intestinal microflora. And according to the World Health Organization, not all the world's inhabitants have no disorders of the microecological state of the body. Many factors that lead to the development of dysbiosis and the difficulty in restoring the disturbed microflora of the body in people of different ages make the development of functional food technologies with bifidogenic additives a priority for the food industry. Therefore, today, in the broad scientific and medical circles, there is an increased attention to the problem of disorders and ways to correct microbiocenoses of various biotopes of the human body and, first of all, the gastrointestinal tract (GIT). Pro- and prebiotics by their properties are suitable for solving this problem. That is, one of the promising areas that opens up great opportunities for expanding the range of functional confectionery products is the use of pro- and prebiotics in the technology of confectionery products. And products using these ingredients can be prescribed not only for people suffering from gastrointestinal diseases, but also for anyone who cares about their health. Therefore, it is advisable to analyze the confectionery market for products for the correction of intestinal microflora.

A group of researchers [43] developed a fatty filling for flour confectionery products of increased consumer value using vegetable raw materials: a mixture of vegetable butter and coconut oil, skim milk powder, carob powder, apple powder, cinnamon and ascorbic acid. Studies have shown that the introduction of non-traditional vegetable raw materials into the recipe improves the organoleptic properties of the product - the waffles have a pleasant taste and aroma, and reduce the amount of total sugars and the mass fraction of fat.

A group of scientists [44] has developed chocolate with synbiotics. Flax seeds (Linum usitatissimum L.) were added as a prebiotic. The isolated culture of LAB, which was identified as Leuconostoc mesenteroides on the basis of morphological, biochemical tests, showed the properties of a probiotic culture. In the course of the research, it was found that chocolate with synbiotic has greater antioxidant activity, physiological properties and will be beneficial for human intestinal health, as well as has excellent nutritional value.

Researchers [45] presented confectionery products based on hazelnut paste and probiotics that had a pleasant taste, high nutritional value, and were stable at high ambient temperatures. Different formulations were developed with hazelnut paste, maltitol, bitter cocoa powder, DE12 maltodextrin and tragacanth gum, followed by the addition of bifidobacteria (BB-12). These products were characterized by an extended shelf life and improved nutritional characteristics.

Chocolate is becoming increasingly popular as a carrier for delivering probiotics to the intestines. The popularity of chocolate around the world, combined with the high level of health awareness of the modern consumer, is growing rapidly, and the idea of enriching the composition of various types of chocolate with probiotics has a high market demand [46]. The paper [47] provides an overview of the use of probiotics in chocolate formulations and presents clinical studies on their positive impact on human health. The industrial interest in the use of probiotics and prebiotics in new food and pharmaceutical products is gradually growing. It has been shown that chocolate is one of the most attractive foods among most people and can serve as a suitable carrier for delivering probiotics to the human intestine. In addition, chocolate contains a wide range of powerful antioxidants and other nutrients that can have a positive impact on human health.

Scientists [48] developed chocolate candies enriched with prebiotics from pumpkin seeds. A comparative study of the growth of Lactobacilli and Escherichia coli on nutrient media with the addition of carbohydrates was conducted. Prebiotics obtained from pumpkin seeds were included in chocolate recipe (1 % and 5 %). The quality characteristics (color, texture, and sensory acceptability) of the samples were compared with

a control during twenty-one days to assess stability during shelf life. The expediency of including these prebiotics in the composition of chocolate candies was substantiated.

In Ukraine, the development of confectionery products with prebiotics is devoted to the work of Professor Dorohovič A.N. Thus, in the work [49], the adding of the prebiotic lactulose into the cupcake recipe was investigated and scientifically substantiated. The mass amount of lactulose was determined, and the structural and mechanical characteristics of the dough masses of the control and experimental samples were studied. The experimental cupcakes had a crumb that was evenly porous and compacted, more intensely colored, with a pleasant taste and aroma; in sugar products with the addition of lactulose, a "hump" did not form on the upper surface of the product. New types of products are recommended for people with intestinal microflora disorders. Ukrainian scientists have studied the effect of the prebiotic lactulose on the rheological and structural properties of fruit and berry fillings for muffins. Lactulose is significantly different in composition from sucrose, so it was of interest to determine its effect on the structural and mechanical properties of the filling. For this purpose, fillings with a dry matter content of 70% were prepared under the same conditions. The conducted research makes it possible to develop and produce muffins with functional fillings by using a physiologically functional ingredient - the prebiotic lactulose – in an amount of 30 % of the daily requirement [49].

Based on the analysis of the market for confectionery products for people with impaired microecological conditions, it can be noted that it is currently a niche market. Therefore, the expansion of the product line for "healthy eating" will be of interest to manufacturers and demanded by consumers. And it is advisable to use pro- and prebiotics as functional ingredients.

Conclusions

To summarize, food is a key factor in both preventing and improving human health. And every day, people are becoming more and more demanding about their nutrition. Today, an increasing number of Ukrainians are changing their nutritional orientation, showing increased interest in the healthiest products, i.e. basing their choice not on the quantity of food consumed, but on its quality.

Improving public health, promoting healthy lifestyles, and thus improving the well-being of society as a whole, has always been a pressing issue. Therefore, the key tasks of the food industry, including the confectionery industry, are related to increasing the production of various types of new food products with a given chemical composition and properties.

The development of functional confectionery products is of great interest to the industry. The development of confectionery products with specified functional properties is an integral trend in the development of food technology, driven by the modern requirements of nutrition, economics and marketing. And one of the promising areas that opens up great opportunities for expanding the range of confectionery products with functional properties is the use of pro- and prebiotics as functional ingredients in confectionery formulations, which are able to correct the microecological balance of person and lead to the normalization of his/her microflora.

Therefore, our task for further research will be to substantiate the choice of pro- and prebiotics for inclusion in confectionery recipes, select the assortment group of products, and study the impact of ingredients on the quality of semi-finished and finished products.

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