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THE ROLE OF PROBIOTIC MICROORGANISMS IN ENHANCING FOOD QUALITY AND SAFETY

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Abstract: The beneficial properties of probiotic microorganisms have been known for over a century. However, their industrial and targeted use has only recently begun. This is due to several factors: probiotic microorganisms must be resistant to various technological influences during food production, storage, and consumption. It is essential that probiotic microorganisms remain viable when they enter the human body. Currently, the consumer market offers a variety of food products made with probiotics.

Keywords: probiotics, food products, meat products

Introduction

Modern consumers have become more conscious about their food choices, leading to a more open and consumer-oriented market in the 21st century. This, in turn, has fueled increased competition among producers and led food manufacturers to constantly seek new competitive advantages [1,2,3]. At the same time, inadequate consumer information about certain products, food additives, and ingredients leads to consumers mistrusting manufacturers who use various food additives in their production. These manufacturers, in turn, are neglecting to educate their target audiences and instead seeking new formula ingredients [4,5,6,7]. In recent years, probiotic microorganisms have attracted increasing interest from both the scientific community and manufacturers.

We inhabitants of the gastrointestinal tract, but they should have a positive effect. Currently, this is the most popular approach.The term "probiotics" was most likely first coined. Probiotic microorganisms.

The beneficial function of microorganisms was discovered quite a long time ago; as early as 1900, I.I. Mechnikov noted that due to the consumption of large quantities of fermented milk products, residents of the Caucasus had fewer health problems and were distinguished by longevity [8,9,10,11]. At the same time, Mechnikov believed that intestinal microflora was detrimental to health and needed to be replaced with lactic acid microorganisms. Somewhat later, it was discovered that yogurt contains microorganisms that protect the intestines from the destructive effects of other microorganisms[12,13]. According to materials prepared and published by Lee, Nomoto, Salminen, and Gorbach Lee in 1999, various microorganisms have been used as probiotics due to their ability to prevent and treat various diseases. Probiotic microorganisms are available for sale in dried or frozen form. Currently, they have several possible uses: as a recipe ingredient in industrial or personal/home food production, or as dietary supplements for daily consumption.

The consumption of probiotic microorganisms with food, rather than as a dietary supplement, was first proposed by Vergiou in 1954, when he compared the effects of antibiotics and other antimicrobial agents on the intestinal microbial population containing microorganisms that have a beneficial effect on the intestinal microflora in his manuscript, Anti- und Probioti-ka. Lilly and Stillwell in 1954 defined "probiotics" as microorganisms that promote the growth of other microorganisms. Currently, there is a general consensus that "probiotics" are microorganisms that promote the development or maintain the existing balance of the autochthonous microbial population of the gastrointestinal tract (GIT). Such microorganisms

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may not be permanent for human or animal health [14,15,16,17]. Later, the World Health Organization

Probiotics are live organisms that, when administered in appropriate amounts, confer a health benefit on the consumer [18]. The current concept of prebiotics, proposed by Cummings, Macfarlane, and Englyst (2001), is based on the assumption that certain intestinal flora, such as bifidobacteria and lactobacilli, which are considered beneficial to human health, can be selectively stimulated by non-digestible but fermentable carbohydrates, now called prebiotics. Of course, to study the impact of probiotics on human health and well-being, it is necessary to study the gastrointestinal tract as a system[19,20,21].

Probiotic Microorganisms. Main Representatives

According to existing information, the main representatives of probiotics in both the food and pharmaceutical markets are lactic acid microorganisms. Lactic acid microorganisms are common in a variety of environments, particularly those rich in nutrients, such as various food substrates, manure, soil, water, and others. Some strains of lactic acid microorganisms are present in the human oral cavity, intestinal tract, and other mucous membranes and exert a beneficial effect on these human ecosystems.

Scientists note that the creation of probiotic food products is a rather complex process, as the microorganisms used must have stable characteristics of technological and clinical efficacy, clear genetic and physiological-biochemical markings, and the ability to "survive" in the product and enter the host organism viable [22,23].

For a long time, dairy products were considered the only food products offering an optimal environment for probiotic development. According to Yu. M. Markova and S. A. Sheveleva, in 2009, the most common food products enriched with probiotic microorganisms were bioyogurts (35% of the total probiotic food market), smoothies and fermented drinks (35.4%), biokefir (11.3%), and cheeses (6%) [24,25].

The range of this type of product continues to grow. Vicensuto and Castro considered the possibility of developing a new probiotic dairy product with improved antioxidant properties using mango peel as a fermentation substrate. According to the results obtained, the use of these components made it possible to obtain a product with improved antioxidant and probiotic properties [26,27]. Scientists have studied the possibility of producing probiotic yogurt from a mixture of cow's and sheep's milk. They note that the highest ratio of sheep's to cow's milk (3:1) had a positive effect on the physicochemical properties [28,29].

For example, fermented vegetable and fruit juices are gaining particular popularity. In their research, Mousavi et al. developed fermented pomegranate juice; Yoon et al. - cabbage juice; Oliveira Vieira et al., as well as Masahiro et al., examined the production of probiotic orange juice; Hashemi, S. Hashemi, Jafarpour, and Jouki - peach juice. The obtained results demonstrated the possibility of using different juices as a food matrix for a probiotic drink [30,31].

Ice cream is an equally popular dessert. Sarwar et al. examined the development of a synbiotic—Saccharomyces boulardii and inulin—in ice cream, which ensured longer shelf life and improved the product's physicochemical properties [32]. Hekmat and McMahon also demonstrated in their study that ice cream can be a suitable source of probiotic microorganisms such as L. acidophilus and B. bifidum. These microorganisms can remain viable during storage and grow in large numbers in ice cream mix [33].

Besides being a delicacy, this product is a source of serotonin, tryptophan, and dopamine. Chocolate contains cocoa butter, which is rich in unsaturated and saturated fatty acids, antioxidants, and vitamins [18]. Due to this composition, scientists have considered the possibility of using probiotics in this type of product. Research by Lalicic-Petronijevic, Popov-Raljic, Lazic, and others demonstrated that a combination of three probiotic microorganism strains encapsulated in chocolate candies yielded a positive effect. The candies had the same functional properties and shelf life as their standard counterparts [34].Probiotic Microorganisms

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in Meat Products.The use of probiotic microorganisms in meat production is not yet widely developed. This is because meat products are complex, multicomponent systems, where pH, temperature, water activity, and the presence of various chemicals (salt, sugar, flavorings, etc.) vary during production. Probiotics are most commonly used in the production of dry-cured sausages, as their production technology does not involve high-temperature heat treatment, which does not promote microbial activity. The choice of probiotic strain is an important aspect that determines not only the viability of microorganisms in the fermented meat matrix and the delivery of probiotics to the large intestine, but also that they must be able to withstand all technological aspects during the production of meat products, as well as those arising directly during its consumption in the upper gastrointestinal tract [35,36].

This requires the isolation or immobilization of heat-resistant microorganisms. The following methods facilitate the delivery of probiotics to the large intestine: encapsulation by extrusion, emulsion, spray drying, freeze-drying, and entrapment of gel dispersions. These methods demonstrate the best stability of the strains. The choice of method depends on the type of meat product, processing conditions, storage time, and the consumer's preparation method [37].

In addition to the above methods, scientists are considering probiotics as starters for cured meat products. According to Rubio, Jofré, Martín, Aymerich, and Garriga, the isolated microorganisms L. casei/paracasei CTC1677, L. casei/paracasei CTC1678, and L. rhamnosus CTC1679 may be potential probiotic starters for fermented sausages [38].

The resulting "synbiotic" integrated well into the meat matrix—no changes in the organoleptic properties of the product were observed, and lactic acid content increased, which has a positive effect on the product's texture and a negative effect on pathogenic microorganisms. Chestnut flour, in addition to acting as a prebiotic, also enriched the product with polyphenols and dietary fiber [39]. In a study on the fermentation of low-fat Italian-type salami with fructooligosaccharides, Silva Barretto showed that the concentration of sodium nitrite/nitrate and fructooligosaccharides, temperature, pH, and salt levels negatively affected the growth of probiotic strains. The most resistant strains were L. casei SJRP66 and L. casei SJRP169 with the addition of fructooligosaccharides, but slight changes in the texture of the resulting product were noted [40].

The probiotic was added to a meat matrix containing commercial starter cultures. The microbial performance was assessed during fermentation, maturation, and storage at 4 and 12°C. The researchers noted that this strain competed well with other starter cultures (S. carnosus and P. pentosaceus) and performed well at both 4 and 12°C. In terms of organoleptic properties, the resulting sausages produced with this strain exhibited equal or superior performance [41,42].

In addition to finished products, the researchers (Imen Trabelsia, Ben Slima, and Ktari) examined the use of the probiotic strain in ground beef (L. plantarum TN8). No additional food ingredients were added to the control sample. L. plantarum TN8 was added to the test sample at a concentration of 108 CFU/g. The raw minced meat was stored for 10 days at 4°C after production. The results of the study showed that this strain had a positive effect on color characteristics; improved the oxidative stability of lipids and proteins; and improved textural characteristics during storage; and also increased the microbiological stability of minced meat samples during storage [43].

Conclusion

However, a large number of research studies have been devoted to the use of probiotic microorganisms in dairy production due to the specific technological processing techniques used to create optimal conditions for their growth and development. They have not yet found widespread use in meat production, due to a number of technological and formulation factors. In the production of certain groups of meat products, starter cultures containing lactic acid microorganisms (e.g., L. plantarum) are used to improve the technological process, allowing for the consideration of increasing their efficiency. Therefore, research is needed to explore the

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feasibility of using starter cultures containing certain types of microorganisms as probiotic cultures in meat production[44].

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