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Microorganisms and their Role in Yogurt Preparation

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Annotation: This article examines the role of microorganisms in yogurt production, covering historical aspects of its origin, chemical composition, and impact on human health. The key technological stages of yogurt production are described, including pasteurization, homogenization, and fermentation, in which Lactobacillus bulgaricus and Streptococcus thermophilus play a crucial role. A comparative analysis of the chemical composition of different types of yogurts is presented, detailing protein, fat, carbohydrate, vitamin, and mineral content. Both the positive effects associated with probiotic properties and the potential risks of bacterial contamination are considered. The relevance of further research on the impact of regular yogurt consumption on metabolic processes and disease prevention is discussed.

Keywords: yogurt, lactic acid bacteria, Lactobacillus bulgaricus, Streptococcus thermophilus, chemical composition, fermentation, probiotics, health, dairy production.

The study of microorganisms involved in the production of yogurt remains relevant, as this product occupies an important place in the diet of millions of people. Yogurt is not only a source of nutrients, but also a potential functional product that can have a positive effect on health due to the presence of probiotic bacteria. Modern technologies make it possible to improve the properties of yogurt, but it is important to preserve the biological activity of microorganisms. Additional research is also needed to confirm its benefits and minimize possible risks.

The history of the discovery and origin of yogurt. Analysis of the genome of L. delbrueckii, subspecies Bulgaricus, indicates that the bacterium could have appeared on plants, and milk could have been exposed to it through contact with plants or from the udder (an organ of the mammary gland in female mammals, more often in farm animals such as goats, sheep) of domestic animals [1]. The origin of yogurt is unknown, but it was probably discovered by Neolithic people in Central Asia and Mesopotamia around 5000 BC.[2]

In ancient Greece, there was a dairy product called oxygala, a type of yogurt [3]. Galen mentioned that oxygala was consumed with honey, just as Greek yogurt is eaten today. Pliny the Elder wrote about the "condensed milk" of the "barbarians" [4]. Yogurt is also mentioned in the books of the 11th century by the Turks [5]. The first yogurts were probably fermented in goatskin bags [6].

In 1905, Stamen Grigorov studied the microflora of Bulgarian yogurt and isolated the bacterium Bacillus bulgaricus, now known as Lactobacillus delbrueckii subsp. bulgaricus. Ilya Mechnikov hypothesized the connection between yogurt consumption and longevity of Bulgarian peasants [7].

The industrialization of yogurt began with Isaac Carasso, who in 1919 opened a business in Barcelona under the Danone brand, later known as Dannon in the USA [8]. Yogurt with fruit jam was patented in 1933 by Radlická Mlékarna [9]. Yogurt became popular in the United States at the beginning of the 20th century after Ilya Mechnikov's publication and was popularized by John Harvey Kellogg [10]. In 1929, Armenian immigrants founded the Colombo and Sons Creamery company in the USA [13].

Discovery of microorganisms. The microflora of Bulgarian yogurt was first studied by Stamen Grigorov [11]. In 1907, the bacteria Lactobacillus bulgaricus and Streptococcus thermophilus were named [12]. Mechnikov supported the research and linked yogurt with longevity. The production process includes separation, pasteurization, homogenization, fermentation, addition of fillers and packaging [13]. Yogurt is made using the bacteria Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus. Sometimes other lactobacilli and bifidobacteria are added. In some countries, such as China, yogurt must contain at least 1 million CFU (colony-forming unit is a measurement of the number of living microorganisms in a sample, such as in water, food, or biological material) per milliliter. In other countries, for example, in France, a product can be called "yaourt" or "yogurt" only if fermentation has occurred exclusively with Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus, which corresponds to the Codex Alimentarius international standard (CXS 243-2003) for fermented milk [14].

The bacterial culture is maintained at a temperature of 30-45°C (86-113 °F) for 4-12 hours for fermentation. Higher temperatures accelerate the process, but can lead to the formation of lumps and separation of serum [15].

The chemical composition of yogurt. The composition depends on the technology, type of milk and additives. Below is a table with averaged data [16].

Importance for human health.

Yogurt contains live cultures and is associated with probiotics, which have a positive effect on the immune system, cardiovascular system and metabolism.

1. Gut Health: Yogurt contains probiotics that help improve the balance of the gut microbiome and normalize digestion. Studies show that regular consumption of yogurt promotes gum health and slows down the growth of bacteria that cause tooth decay (17).

2. Immunity: Probiotics in yogurt stimulate the production of antibodies and improve the function of immune cells (18).

3. Reducing inflammation: Probiotics and anti-inflammatory compounds found in yogurt can reduce the level of inflammation in the body, which is associated with chronic diseases.

4. Protein Source: Yogurt is a good source of protein, which plays a key role in repairing and building body tissues (19).

5. Bone health: Yogurt is rich in calcium and vitamin D, which helps maintain healthy bones and prevent osteoporosis.

6. Weight loss: Yogurt, consumed with fruits as part of a balanced diet, promotes satiety and reduces total calorie intake (19). Research shows that regular consumption of yogurt can help in controlling body weight.

7. Reducing the risk of chronic diseases: Regular consumption of yogurt is associated with a lower risk of type 2 diabetes, cardiovascular disease, and certain cancers. A meta-analysis showed that consuming 1 serving of yogurt per day reduces the likelihood of developing diabetes by 18%. In addition, yogurt helps reduce the risks of hypertension and cardiometabolic diseases (20).

8. Kidney and liver diseases: Eating yogurt can slow the progression of chronic kidney disease, as well as improve liver health in patients with non-alcoholic fatty liver disease.

9. Mental health: The probiotics contained in yogurt have a positive effect on mental health, which has been confirmed in studies among workers in the petrochemical industry (21).

10. Pregnancy: Eating yogurt helps reduce oxidative stress in pregnant women by increasing levels of glutathione peroxidase.

11. Dental Health: Regular consumption of yogurt helps maintain dental health by reducing the risk of tooth loss due to gum disease.

Component	Proteins	Fats	Carbohydrates	Calcium	Energy value
Natural yogurt	3,0–4,5 gramm	1,5–3,5 gramm	4,0–6,5 gramm	120–160 milligram	60–90 calories
Yogurt with filling	2,5–3,5 gramm	1,0–2,5 gramm	10,0–14,0 gramm	100–130 milligram	90–120 calories

Although high-quality clinical studies are insufficient [22], meta-analyses show a reduced risk of type 2 diabetes and hip fractures [23,24]. The 2021 review confirms the association with improved digestion, bone health, reduced risk of cancer, and metabolic syndrome [25]. Yoghurts made from raw milk may contain dangerous bacteria (including Listeria, Cryptosporidium, Campylobacter, Brucella, Escherichia coli, and Salmonella) and aflatoxins [26,27], with infection more common at home. Moldy yogurt is unsuitable for consumption. If dairy products, such as yogurt, become mildewed, they can develop harmful bacteria that can cause diarrhea. At the same time, most of the toxins produced by mold cannot be destroyed during the cooking process [28].

Conclusion. Yogurt is not only a product with deep historical roots, but also a valuable source of nutrients and probiotics, which has a significant impact on human health. Lactic acid bacteria such as Lactobacillus bulgaricus and Streptococcus thermophilus play a key role in the fermentation process and ensure the maintenance of healthy intestinal microflora, which helps improve digestion and strengthen the immune system. Yogurt also has a number of additional health benefits, such as maintaining healthy bones, reducing inflammation, improving mental health, and controlling body weight.

If all technological standards are met, yogurt is safe for consumption and can be recommended as part of a healthy diet. However, despite the obvious benefits, it is necessary to continue research

aimed at clarifying the effects of yogurt on metabolism and disease prevention, as well as improving the safety of its production. Special attention should be paid to monitoring the quality of milk and bacterial risks in order to avoid possible complications associated with the consumption of a low-quality product. Thus, yogurt is a multi-functional product that, with regular consumption, can have a complex positive effect on health, however, for maximum benefit, it is necessary to take into account both the technological features of production and the possible risks associated with bacterial contamination.

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