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IMPROVEMENT OF THE PRODUCTION TECHNOLOGY OF COTTAGE CHEESE ENRICHED WITH PUMPKIN SEEDS AND STUDY OF ITS IMPACT ON QUALITY INDICATORS

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Abstract: *The article addresses the issues of improving the production technology of cottage cheese enriched with pumpkin seeds. During the research, the process of obtaining cottage cheese through milk fermentation under laboratory conditions was studied, and its technological and calculated indicators were determined. According to the obtained results, the yield of cottage cheese amounted to 37.64%, and the efficiency of the process was evaluated.The conducted studies analyzed the effect of adding pumpkin seeds on the nutritional and biological value of the product. The research results showed that due to the proteins, unsaturated fatty acids, vitamins, and minerals contained in pumpkin seeds, the functional properties of the product were enhanced. In addition, positive changes were observed in the organoleptic and structural characteristics of the product.As a result, the production technology of cottage cheese enriched with pumpkin seeds was substantiated as a promising approach for creating functional food products with high nutritional value.*

Keywords*: cottage cheese, dairy products, pumpkin seeds, functional food, fermentation process, protein, biological value, technological indicators, antioxidants, whey, organoleptic properties, nutritional value*

INTRODUCTION

In the modern era, the production of functional food products is recognized as one of the priority directions in the food industry. In the context of the growing demand for healthy nutrition among the population, the development of products enriched with natural components and possessing high biological value is of great scientific and practical importance.

From this perspective, dairy products, particularly cottage cheese, are widely consumed due to their richness in protein, calcium, and other essential nutrients required for the human body. However, in order to enhance the functional properties of traditional cottage

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cheese products, their enrichment with plant-based raw materials is considered a relevant and promising approach.[5,7,1]

Conducted scientific studies indicate that enriching food products with plant-based components can significantly enhance their nutritional and biological value. In this regard, pumpkin seeds are of particular importance as a rich source of protein, unsaturated fatty acids, vitamins, minerals, and biologically active compounds. According to scientific sources, the protein content of pumpkin seeds ranges from 24% to 36%, and this indicator increases further after processing, while remaining rich in essential amino acids. In addition, the presence of antioxidant compounds in their composition contributes to increasing the biological activity of food products.

Furthermore, the use of pumpkin seed–based ingredients is considered an important factor in improving the functional properties of food products. Research findings show that the application of this raw material enhances antioxidant activity, slows down oxidation processes, and improves the storage stability of products. At the same time, the incorporation of plant components into dairy products may lead to certain changes in their structure, consistency, and organoleptic characteristics.

Taking these considerations into account, improving the production technology of cottage cheese enriched with pumpkin seeds, determining optimal technological parameters, and comprehensively evaluating their effects on the physicochemical, organoleptic, and functional properties of the product constitute an important scientific task.

LITERATURE REVIEW

Scientific research aimed at developing functional food products is rapidly advancing in the modern food industry. In particular, the issue of increasing the biological value of dairy products by enriching them with plant-based components has been widely studied by many foreign researchers. The results of studies conducted in this area indicate that the combination of animal and plant proteins not only enhances the nutritional value of products but also improves their functional properties.

Studies conducted by Fereidoon Shahidi and his colleagues have revealed that plant seeds, including pumpkin seeds, contain high levels of antioxidant compounds. These compounds are capable of slowing down lipid oxidation processes and extending the shelf life of food products. These findings substantiate the potential of pumpkin seeds as a natural functional additive. [1,2,4]

Studies conducted by Jianping Wu investigated the amino acid composition and biological value of plant proteins, demonstrating that their combination with milk proteins provides high nutritional efficiency. According to the author, such combinations ensure a balanced spectrum of essential amino acids required for the human body.. [2,4,6]

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Experimental studies conducted by M. A. Hassan and colleagues examined the physicochemical and organoleptic properties of dairy products supplemented with pumpkin seeds. The results showed that the addition of pumpkin seeds increased the nutritional value of the product while positively influencing its taste and aroma characteristics.

In addition, scientific studies carried out by several other researchers, including A. M. El-Sayed, revealed that the incorporation of pumpkin seed powder into yogurt and cottage cheese leads to an increase in protein and fat content, as well as a significant enhancement in antioxidant activity. At the same time, certain changes in the consistency and rheological properties of the products were observed.

In the research of R. A. M. Saleh, the structural and mechanical properties of dairy products enriched with plant components were analyzed. It was found that with an increase in the amount of added plant material, the density and water-holding capacity of the product also increased. This is considered one of the key factors directly affecting product quality indicators.[2,4,5]

Furthermore, studies conducted by A. S. Kaur have shown that the use of plant-based raw materials in the development of functional food products not only enhances their nutritional value but also has a positive impact on human health, including reducing the risk of cardiovascular diseases and oxidative stress.

The analysis of the above-mentioned scientific studies indicates that the development of dairy products enriched with pumpkin seeds is one of the promising directions. At the same time, existing research has mainly focused on yogurt and other dairy products, while the technology of using pumpkin seeds specifically in cottage cheese has not been sufficiently studied. This situation highlights the need for further scientific research in this area. [3,4,6]

Results and Discussion. In the course of the conducted research, laboratory experiments were carried out to improve the production technology of cottage cheese enriched with pumpkin seeds. During the experiment, milk and yogurt were used as the main raw materials, while sugar and pumpkin seeds were used as additional components. All measurements were performed using laboratory-grade precision instruments. [5,4]

Figure 1. Measurements of raw materials obtained under laboratory conditions

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Initially, the tare weight of the laboratory flask was determined and taken into account in subsequent calculations. Then, 60 g (≈60 ml) of milk was measured and subjected to heat treatment by boiling in order to ensure microbiological safety and create optimal conditions for the fermentation process. After boiling, the milk was cooled to a certain temperature, and 0.73 g of yogurt was added as a starter culture. The mixture was then thoroughly stirred until a homogeneous consistency was achieved.

During the fermentation process, milk proteins underwent coagulation, and the mass began to separate into solid (cottage cheese) and liquid (whey) fractions. The coagulation process was observed for 5–6 minutes, and its dynamics were recorded. The resulting cottage cheese mass was then separated from the whey in the next stage. According to the measurement results, the amount of obtained cottage cheese was 0.4466 g, while the amount of separated whey was 0.7400 g.

In the next stage, 0.1312 g of sugar was added to improve the organoleptic properties of the product, and the mass was mixed until a uniform consistency was achieved. As a result, the taste of the product became softer and more acceptable for consumption.

As an important stage of the study, the enrichment of cottage cheese with plant-based raw material was carried out. For this purpose, 0.1310 g of pumpkin seeds were предварительно cleaned, dried, and ground into a fine dispersed form. The prepared component was added to the cottage cheese mass and thoroughly mixed to ensure uniform distribution. As a result, the structural properties of the product improved, and a characteristic mild nutty taste and aroma were formed.

All results obtained during the experiment were summ arized and, based on the relevant calculations, are presented in Table 1.

Table 1

Technological and Calculated Indicators of the Cottage Cheese Production Process

No.	Name of Indicators	Quantity	Description
1	Amount of milk	60 ml (~60 g)	Initial raw material
2	Amount of yogurt (starter)	0.73 g	For fermentation
3	Amount of obtained cottage cheese	0.4466 g	Solid fraction
4	Amount of separated whey	0.7400 g	Liquid fraction
5	Amount of added sugar	0.1312 g	To improve taste
6	Amount of added pumpkin seeds	0.1310 g	Enriching component
7	Total mass (cottage cheese + whey)	1.1866 g	Calculated value
8	Cottage cheese yield (%)	37.64%	(0.4466 / 1.1866) × 100
9	Whey proportion (%)	62.36%	(0.7400 / 1.1866) × 100

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The obtained results showed that the addition of pumpkin seeds increases the nutritional and biological value of cottage cheese. In particular, the combination of animal proteins present in cottage cheese with plant proteins from pumpkin seeds improves the overall protein balance of the product. Moreover, the unsaturated fatty acids, vitamins, and minerals contained in pumpkin seeds, especially zinc and magnesium, enhance the functional significance of the product.

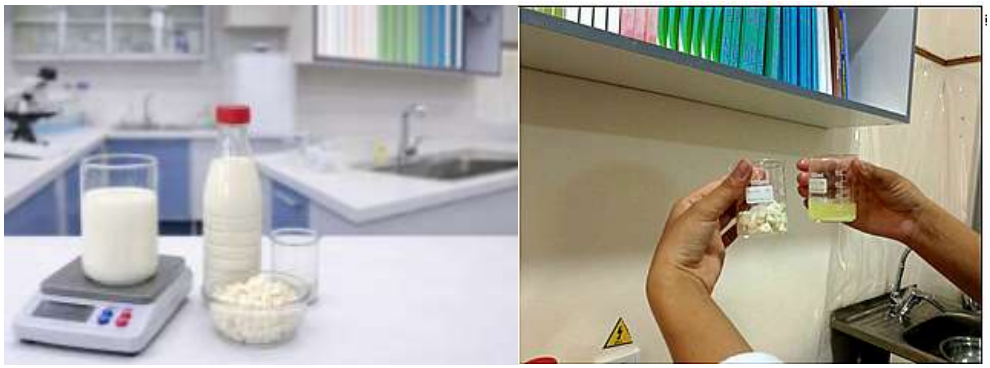

Figure 2. Cottage cheese samples obtained under laboratory conditions

The results of the preliminary laboratory studies demonstrated the potential for improving the production technology of cottage cheese enriched with pumpkin seeds and substantiated the need for further in-depth investigation of the physicochemical, rheological, and microbiological properties of the product in subsequent stages.

Conclusion. The conducted research determined the scientific and practical foundations for improving the production technology of cottage cheese enriched with pumpkin seeds. Laboratory experiments demonstrated the effective progression of the process of obtaining cottage cheese through milk fermentation. During the process, protein coagulation led to the separation of the mass into solid (cottage cheese) and liquid (whey) fractions. According to the calculations, the yield of cottage cheese was 37.64%, while the whey fraction accounted for 62.36%, confirming the technological efficiency of the process.

The study revealed that the addition of pumpkin seeds not only improves the organoleptic properties of the product but also enhances its nutritional and biological value. In particular, the combination of animal and plant proteins optimizes the amino acid balance, allowing the product to be classified as a functional food. Moreover, the presence of unsaturated fatty acids, vitamins, and minerals (especially zinc and magnesium) in pumpkin seeds increases the biological activity of the product.

In addition, the incorporation of pumpkin seeds positively affects the structural and mechanical properties of the product, improving its consistency and increasing its water-holding capacity. This is one of the key factors ensuring the quality stability of the final product.

The technology for producing cottage cheese enriched with pumpkin

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seeds has been evaluated as a promising direction. This approach enables the development of new types of dairy products with high nutritional value and enhanced functional properties. In future research, it is recommended to conduct more in-depth studies of the physicochemical, microbiological, and rheological properties of the product, as well as to determine the optimal amount of additional components.

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