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Innovative technologies for the creation of low-calorie dairy products using plant components

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Abstract. The development of low-calorie dairy products using plant-based ingredients is becoming increasingly relevant due to the growing demand for healthy eating and alternatives to traditional dairy products. The study background was based on the need to develop functional products with a reduced calorie load that combine high nutritional value with attractive organoleptic

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properties. The study aimed to develop low-calorie products based on plant-based raw materials using innovative technologies such as protein extraction, fermentation and ultrafiltration, ensuring a reduction in calories without losing texture, taste and shelf life. High-quality plant-based ingredients (soya, almonds, oats) and probiotic cultures were used, and the methodology included the isolation of protein isolates through extraction, further fermentation to improve flavour and enrich beneficial microorganisms, and ultrafiltration to help concentrate proteins, remove sugars and ensure product stability. The results showed that the developed products, namely fermented soya yoghurt (55 kcal/100 g), almond milk (30 kcal/100 ml) and oatmeal cream dessert (80 kcal/100 g), demonstrated a significant reduction in calories by 20-50% compared to traditional dairy analogues. All samples maintained a stable texture, homogeneity and high organoleptic characteristics for 7 days at +4°C, with an average score of 4.8 out of 5 according to the expert panel. Additionally, the study determined that the use of ultrafiltration ensured long-term product stability, while fermentation contributed to improved flavour characteristics and increased biological value. The study results confirmed the effectiveness of innovative technologies in creating competitive low-calorie products from plant components. The practical significance of the study is determined by possibility of implementing the results obtained in industrial production to meet the needs of the modern market focused on healthy eating

Keywords: food industry; healthy food; fermentation; ultrafiltration; protein extraction; probiotic cultures

Introduction

Interest in healthy eating and informed food choices is growing globally. One of the key trends is to reduce the consumption of high-calorie foods, which reduces the risks of obesity, cardiovascular disease and diabetes. In this context, low-calorie dairy products with plant-based ingredients are gaining more and more attention from producers, scientists and consumers. Dairy products are an important source of nutrients such as protein, calcium and vitamins (Ruban & Danshin, 2023). However, the growing demand for lower-calorie alternatives is driving the use of plant-based ingredients such as soya, almonds, oats or coconut. They can be used to create products that retain high nutritional value and organoleptic properties while remaining low in calories. The research relevance is determined by several factors: growing interest in veganism, increased demand for products with improved nutritional properties, and the need to optimise production technologies. Despite the advances in the dairy industry, many questions remain unanswered about the creation of high-quality low-calorie dairy products with plant-based ingredients (Moroz, 2023).

Scientific research in the dairy industry mainly aims to improve production technologies and preserve the health benefits of products. For instance, A. Minorova *et al.* (2022) studied the technology of low-calorie milk ice cream production, focusing on innovative approaches to improving production efficiency. Emphasis was devoted to functional ingredients that provide the required organoleptic characteristics. Another example is the monograph by R. Nikiforov *et al.* (2022), which discussed the introduction of innovative technologies in the production of dessert products based on protein-carbohydrate semi-finished products. The authors presented the results of research on improving the composition, structure and properties of such desserts, considering the requirements for reducing calorie content. The study by L. Peshuk *et al.* (2023) addressed the development of innovative algae products that are gaining popularity as an alternative to traditional products. The review describes in detail the technological features of such products and their positive impact on health.

M. Arshad *et al.* (2024) analysed innovative technologies that extend the shelf life of plant-based products. This is especially relevant for alternatives to dairy products, where it is important to preserve functional properties. S. El-Aidie & G. Khalifa (2024) examined new ways of using whey protein in the dairy industry. The emphasis is on the environmental and technological prospects of this ingredient for creating sustainable innovative products. A study of the impact of lipoxygenase inactivation on flaxseed protein quality confirms that controlling oxidative processes improves the sensory characteristics and stability of plant components in food systems (Belinska *et al.*, 2024). An analysis of new ingredients and ultrasonic processing methods was presented by C. Rudke *et al.* (2023). These approaches improve dairy production by promoting innovation in food technology. Advances in reducing sugar content in food were described by G. Zhang *et al.* (2022). The use of innovative technologies and ingredients allows to preserve the taste characteristics while reducing their calorie content. Lastly, modern approaches to the development of low-calorie foods enriched with resistant starch were discussed by S. Karunarathna *et al.* (2024). The authors analysed its beneficial properties and potential impact on consumer health. The use of whey in the creation of innovative food products and its importance for the circular economy was studied by M. Tita *et al.* (2024). The study addressed ultrafiltration as a method of concentrating proteins and their further use in products. The functional properties of cereal beverages as an alternative to dairy products were reviewed by K. Kouamé *et al.* (2023). Scientists have investigated the potential of protein extraction and fermentation to improve the nutritional value, texture, and organoleptic characteristics of these products.

Existing technologies do not always produce a product that not only meets the requirements of reduced calories but also retains high nutritional value and organoleptic properties, which are important for consumers (Dymchuk & Ponko, 2023). Accordingly, the need for new approaches to the production of low-calorie dairy products using plant-based ingredients is becoming even more apparent. This includes the development of new technologies that allow for achieving optimal product parameters, such as texture, taste and aroma, which are important for the consumer experience. The study aimed to substantiate and apply innovative technologies to create low-calorie dairy products based on plant components that would provide an optimal balance between reduced calorie content, nutritional value and organoleptic characteristics. The study solved three key tasks: evaluated the effectiveness of innovative technologies, such as protein extraction, fermentation and ultrafiltration, in the production of low-calorie dairy products; studied the impact of various plant ingredients, including soy, almonds and oats, on the organoleptic properties, stability and nutritional value of finished products; developed an optimised production technology that ensures reduced calorie content, balanced composition, long-term stability and high consumer appeal of products.

Literature Review

Protein extraction is one of the key technologies used in the production of low-calorie dairy products from plant-based ingredients. This process allows for the extraction of highly concentrated protein fractions from plant materials such as soya, peas, almonds and oats. Protein isolates obtained by extraction act as substitutes for part of the milk protein, which can significantly reduce the calorie content of the final product while maintaining its nutritional value (Hewage *et al.*, 2024). Protein extraction technology involves the separation of protein components from other macronutrients, including fats and carbohydrates, which helps to reduce the energy value of the product by 10-15%. For instance, soy protein isolates provide a structure and texture similar to traditional dairy products such as yoghurt or cheese (Ortega *et al.*, 2024). Similarly, pea proteins are used due to their high stability and ability to form a creamy consistency. Almonds and oats add a mild flavour to products and provide an increased concentration of dietary fibre, which has a positive impact on the functional properties of dairy substitutes. Protein extraction also has a positive effect on the texture of the final product, making it thicker and more stable (Alimardanova *et al*., 2021). In addition, this technology helps to improve the organoleptic properties, creating products that taste and texture similar to traditional dairy products.

Fermentation is another innovative technology used in the production of low-calorie dairy products from plant-based ingredients (Oleksy-Gębczyk *et al.*, 2024). The fermentation process involves the use of probiotic cultures that break down complex carbohydrates in plant materials, reducing their calorie content and improving the nutritional value of the products. The use of probiotic cultures in fermentation not only reduces the content of energy-saturated substances but also contributes to the enrichment of products with beneficial microorganisms (Chen *et al.*, 2024). This increases their biological value and improves their functional properties, such as maintaining the health of the intestinal microflora. For instance, the fermentation of soya or oat milk can create products similar to traditional fermented milk products such as yoghurt or kefir (Tu *et al.*, 2025). Fermentation also plays a key role in improving the organoleptic characteristics of products. This process reduces the bitterness associated with some plant-based ingredients and results in a richer, more pleasant, fermented milk flavour. Additionally, fermentation results in a stable product texture, which is an important factor for consumers (Prasath *et al.*, 2024).

Ultrafiltration is a modern technology that removes low molecular weight compounds such as sugars and concentrates proteins, vitamins and minerals (Hashmi *et al.*, 2024). This process can be used to create products with a high nutrient content while reducing the calorie content of the final product. In the production of plant-based milk products, such as oat or almond, ultrafiltration is used to achieve the creamy consistency of traditional dairy products. This process can reduce the calorie content of the product by 10-15% without losing important nutritional properties (Akshit *et al.*, 2023). For example, ultrafiltrated almond milk retains the natural flavour of almonds but has improved texture and stability. In addition, ultrafiltration prevents the stratification of herbal beverages and allows for the creation of products with a long shelf life, which is important for industrial production (Sağcan *et al.*, 2024).

The combined use of protein extraction, fermentation and ultrafiltration creates a synergy that significantly improves the quality of low-calorie dairy products made from plant-based ingredients. The combination of these technologies not only reduces calorie content but also ensures optimal texture, rich flavour and high nutritional value. For instance, the use of fermentation after protein extraction from soybeans can be used to create thick, creamy yoghurts with a low-calorie content and enriched with beneficial microorganisms (Ismayilov *et al.*, 2023). In turn, the use of ultrafiltration to purify and concentrate protein components ensures the stability and long shelf life of such products. Comparison with traditional dairy products shows that plant-based substitutes created using innovative technologies can provide similar organoleptic properties while maintaining health and environmental benefits. The integrated approach allows producers to meet the growing demands of consumers seeking a healthy diet without compromising on taste and texture.

Materials and Methods

The study was conducted over a period of 6 months (from July 2024 to January 2025) in the laboratory of food technology and biotechnology of the Institute of Food Resources of the National Academy of Agrarian Sciences of Ukraine (Kyiv, Ukraine). The study complied with the requirements of current national and international standards governing the quality of raw materials, methods of analysis, technological processes and final characteristics of the products. The quality control of the selected raw materials was conducted per DSTU 4964:2008 (2010), DSTU 4963:2008 Oats (2010) and UNECE DDF-06:2007 Almond kernels (2008). Sampling for analysis was done following DSTU 4601:2006 Oilseeds (2007). The physicochemical parameters of the raw materials, such as protein, fat and moisture content, were determined as per DSTU ISO 20483:2016 Cereals and legumes (2017), DSTU ISO 659:2007 Oilseeds (2009) and DSTU ISO 712:2015 Cereals and products made from them (2016). The main technological processes, including protein extraction, fermentation and ultrafiltration, were conducted based on international standards. The extraction of protein components is done following the requirements of ISO 1871:2009 (2009). The fermentation process was regulated by ISO 7889:2003 (2003). The final characteristics of the products were assessed following DSTU 2212:2003 Dairy Industry (2004), which sets out the requirements for the organoleptic and physicochemical properties of fermented milk products, and DSTU 8552:2015 Milk and Dairy Products (2017), which regulates the determination of moisture and dry matter content in milk and dairy products.

Three main types of plant material were used in the study: soya beans (*Glycine max*), almonds (*Prunus dulcis*) and oats (*Avena sativa*). All raw materials were purchased from certified suppliers and met the requirements of the DSTU for food safety. The soya beans were of the “Annushka” variety, a high-protein variety recommended for food purposes. The producer was Agro-Soyuz Limited Liability Company (Ukraine). Before the experiment, the soybeans were mechanically cleaned of impurities, soaked in distilled water in a ratio of 1:3 at a temperature of +20°C for 12 hours. After soaking, they were blanched in water at +80°C for 2 minutes to reduce the content of anti-nutritional compounds such as trypsin inhibitors and lectins. The almonds were of the “Nonpareil” variety, one of the most widely used varieties for food purposes. The manufacturer was Blue Diamond Growers (USA). Before use, the almonds were immersed in hot water (+90°C) for 30 seconds to facilitate peeling. After that, the skin was removed by hand, the kernels were dried to 5% moisture content at +50°C and ground to a particle size of <0.5 mm using a laboratory mill. The oats belonged to a naked-grain variety recommended for food. The manufacturer was Grain Company LLC (Ukraine). The oats were mechanically dehulled, washed with distilled water to remove residual impurities, dried at +50°C to a moisture content of 10%, and ground to particles <0.8 mm in size.

Before the experiment, the main quality indicators were monitored. The protein content was determined by the Kjeldahl method (36-38% for soybeans, 21-23% for almonds, and 10-12% for oats), the fat content by the Soxhlet method (18-20% for soybeans, 48-52% for almonds, and 6-8% for oats), and the moisture content did not exceed 8% for soybeans, 5% for almonds, and 12% for oats. Protein extraction was conducted for soya and oat raw materials using the alkaline method. A 0.1 M NaOH solution was used to maintain the pH of the medium at 8.5. The ratio of raw material to solution was 1:10 (g:ml), and the process temperature was maintained at +50°C. The extraction time was 60 minutes under constant stirring with a magnetic stirrer at 250 rpm. After extraction, the proteins were precipitated when the isoelectric point (pH 4.6) was reached, which was set by adding 1 M HCl. The precipitate was separated by centrifugation at 4,000 rpm for 10 minutes, after which the protein isolates were washed with distilled water and used in further technological steps.

Fermentation was conducted for soy protein isolate and oat cream using probiotic cultures *Lactobacillus acidophilus* (strain LA-5) and *Bifidobacterium bifidum* (strain BB-12). Both strains were provided by Chr. Hansen (Denmark). The lyophilised powder was stored at -18°C in an airtight container. Before use, the cultures were activated in a sterile milk medium at +37°C for 2 hours. The inoculum concentration was 10^7 CFU/ml. The process was carried out at +37°C for 8 hours in a thermostatically controlled incubation chamber Binder BD 56. The pH was monitored using a Hanna HI 2211 pH meter, with the final pH value reduced to 4.4-4.6, which ensured the development of the fermented milk characteristics of the products and contributed to the improvement of organoleptic properties.

Ultrafiltration was used to reduce calories and stabilise the products. The process was carried out on a Sartorius Vivaflow 200 with membranes made of polyethersulfone with a pore size of 10 nm. This separated low molecular weight compounds such as residual sugars and increased concentration of protein components. The process was conducted at a pressure of 1.5 bar with a flow rate of 50 ml/min. The total volume of the final concentrate was 30% of the initial volume. The process temperature was maintained at +10°C to prevent protein denaturation, and the total ultrafiltration time did not exceed 2 hours. The calorific value was assessed by bomb calorimetry using an IKA C200 device. Measurements were made in triplicate, and the results were expressed in kcal/100 g of product. The measurement error did not exceed ±2%. The texture characteristics were analysed using a TA.XTplus Texture Analyzer. The test parameters included a compression test with a probe penetration rate of 1 mm/s and a penetration depth of 5 mm. Characteristics such as elasticity, cohesion, and viscosity were determined, which were used to assess the structure homogeneity and texture stability of the resulting products.

The organoleptic evaluation was conducted by an expert panel of 10 tasters. The tasters evaluated the samples according to four main criteria: taste (balance, fermented milk and nutty notes), texture (uniformity, creaminess), aroma (proneness, absence of foreign odours) and overall attractiveness. The evaluation was conducted on a 5-point scale, and the results were analysed statistically. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) v.26 software. The reliability of the results was determined by the method of one-factor analysis of variance (ANOVA), and the significance level was $p < 0.05$.

The quality of the products was compared with five similar commercial products purchased in retail chains. These included plant-based yoghurts, almond milk and oatmeal cream desserts from three manufacturers. In addition, to evaluate the effectiveness of calorie reduction and organoleptic characteristics, a comparison was also made with traditional dairy products: cow's milk yoghurt, cow's milk and milk cream dessert. The analysis was based on the following parameters: caloric content (determined by bomb calorimetry), texture characteristics (measured with a textrometer) and organoleptic evaluation (average score of the expert panel).

The first stage involved a thorough selection and evaluation of raw materials. Selected samples of soybeans, almonds and oats were preliminarily tested for compliance with such indicators as protein, fat and carbohydrate content, as well as their organoleptic properties. Only raw materials with a high protein and fibre content were used for the experiment (Table 1).

Table 1. *Characteristics of the selected raw materials for the experiment*

Type of raw material	Protein content (%)	Fat content (%)	Carbohydrate content (%)	Fibre content (%)	Amount of raw materials sampled (kg)	Exclusion criteria
Soybeans	36.5	18.3	30.5	4.8	50	Protein content <34%, fat content >20%, impurities >2%.
Almonds	21.8	49.2	21.6	12.5	40	Fat content <45%, damaged kernels >5%, bitter taste
Oats	11.2	6.5	55.4	10.3	60	Protein content <10%, moisture content >12%, impurities >3%

Source: compiled by the authors

Protein extraction was conducted using alkaline hydrolysis, which dissolved protein molecules in an environment with an elevated pH. After that, the proteins were precipitated at the isoelectric point (pH 4.5-4.8) and subjected to filtration to obtain pure isolates. The resulting protein concentrates were used as the basis for the creation of low-calorie dairy products. Fermentation was conducted by adding probiotic cultures to the prepared protein mixtures. This process lasted 8 hours at 37°C, which created optimal conditions for the growth of microorganisms and the breakdown of complex carbohydrates. In the last stage, the fermented mixtures were subjected to ultrafiltration to remove residual sugars and increase the concentration of proteins. This stage also ensured the long-term stability of the product's texture during storage.

Results

The pilot study resulted in the development of three types of low-calorie dairy products made using plant-based raw materials. Fermented soya yoghurt is produced by using the probiotic cultures *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. It was produced using 1,000 g of soya protein isolate obtained from 2,500 g of "Annushka" soya beans. The final product yield was 1,800 g after fermentation and stabilisation. The concentration of probiotic cultures in the final product was 10^7 CFU/ml. As determined, the developed sample is characterised by a creamy texture, typical for fermented milk products, and a balanced fermented milk taste. The almond milk, enriched with protein fractions, was produced by ultrafiltration. It was produced using 1,500 g of peeled "Nonpareil" almonds, which were extracted in 5,000 ml of water after grinding. The resulting emulsion was subjected to ultrafiltration, resulting in a final milk volume of 4,000 ml. As determined, this drink has a homogeneous texture, a pronounced nutty flavour and reduced calorie content compared to similar products on the market. The oatmeal cream dessert was developed using ultrafiltration to concentrate proteins and remove low molecular weight compounds. The production process used 1,200 g of oat flour obtained by grinding 2,000 g of hulled oats. The final product yield after ultrafiltration and stabilisation was 2,200 g. The prepared suspension in a ratio of 1:5 was subjected to fermentation using *Lactobacillus acidophilus*, followed by ultrafiltration. It was found that the resulting product has a thick, stable consistency without signs of stratification or precipitation. As determined, it is characterised by a rich taste with a natural sweetness inherent in oats and a reduced calorie content.

All samples had a stable, creamy texture with no signs of stratification or sedimentation throughout the shelf life. This was made possible by a combination of protein extraction and ultrafiltration, which ensured the homogeneity of the products. The organoleptic evaluation conducted by the expert panel demonstrated the high consumer appeal of the samples. The average score of all the samples was 4.8 out of 5, based on criteria such as aroma, texture and balance of taste. The products also showed stability during storage. For 7 days at +4°C, the samples retained their organoleptic and physicochemical properties. The texture remained stable, the taste did not change, and there were no signs of delamination or spoilage (Table 2). This highlights the potential of the developed products for commercial production and long-term storage.

Table 2. *Comparative characteristics of the products obtained*

Product	Calorie content (kcal/100 g or ml)	Calorie reduction compared to traditional dairy analogues (%)	Texture	Taste (score out of 5)	Stability (days)
Fermented soya yoghurt	55	21%	Creamy, stable	4.8	7
Almond milk	30	50%	Light, homogeneous	4.8	7
Oatmeal cream dessert	80	33%	Thick, stable	4.9	7

Source: compiled by the authors

The results of the study demonstrated the significant potential of the developed products as an alternative to traditional dairy products. Fermented soy yoghurt was lower in calories compared to traditional yoghurt based on cow's milk (70 kcal/100 g). Almond milk had a lower calorie content compared to cow's milk (60 kcal/100 ml). Oatmeal cream dessert had a lower calorie content than traditional dairy cream desserts (120 kcal/100 g). Fermented soya yoghurt, almond milk and oatmeal cream desserts were characterised by low-calorie content, stable texture and high organoleptic properties. A 21-50% reduction in calories compared to traditional dairy products and a 10-25% reduction compared to commercial plant-based analogues confirms the effectiveness of the technologies used, such as protein extraction, fermentation and ultrafiltration.

Protein extraction, fermentation and ultrafiltration provided a comprehensive approach to achieving high-quality products with optimal organoleptic characteristics and reduced energy value. Each technology has a defined functional role at individual stages of production. The separation of protein isolates contributed to the formation of a stable texture and reduced fat content in the products, which is important for ensuring low-calorie content. The fermentation process using probiotic cultures not only improved the taste properties but also increased the biological value of the products. Ultrafiltration made it possible to remove up to 40-60% of residual sugars, increase the concentration of protein components by 15-25% and ensure product stability for 7 days of storage at +4°C. In particular, in the process of almond milk production, the content of mono- and disaccharides decreased from 4.2 g/100 ml to 1.7 g/100 ml (a 59.5% decrease), and the concentration of proteins increased from 1.2 g/100 ml to 1.5 g/100 ml (a 25% increase). Fermented soya yoghurt showed a decrease in sugars from 5.5 g/100 g to 3.3 g/100 g (40%), while the protein component increased from 3.8 g/100 g to 4.6 g/100 g (21%). The oatmeal cream dessert after ultrafiltration had a sugar content of 2.9 g/100 g (against the initial 6.8 g/100 g, i.e., a 57% decrease), and the protein component increased from 2.5 g/100 g to 3.1 g/100 g (by 24%) (Table 3).

Table 3. *Impact of the technologies used on the quality of the products developed*

Technology	Effect on product quality	Application examples
Protein extraction	Provided a thick, stable texture and reduced fat content. Create a homogeneous consistency that is not inferior to traditional dairy products.	The extraction of protein isolates from soya, almonds and oats to form the basis of reduced-calorie products.
Fermentation	Improved the organoleptic properties of the products, providing a characteristic fermented milk aroma and taste. The breakdown of complex carbohydrates reduces calories and increases the biological value.	The use of probiotic cultures (*Lactobacillus acidophilus, Bifidobacterium bifidum*) to produce soya yoghurts.
Ultrafiltration	Concentrate protein fractions, reduce calories and remove residual sugars. Ensured product stability and long-term texture uniformity during storage.	Processing of almond milk and oatmeal cream dessert to ensure stability and long shelf life.

Source: compiled by the authors

The developed samples showed significant advantages over popular commercial analogues. One of the key advantages is texture stability. While some commercial products based on plant-based ingredients often experience stratification or sedimentation during storage, the developed samples retained their homogeneity and thick consistency. This is the result of the optimal use of ultrafiltration and protein extraction technologies. The developed samples had 21-50% lower calorie content compared to traditional dairy products (fermented soy yoghurt 55 kcal/100 g vs. 70 kcal/100 g, almond milk 30 kcal/100 ml vs. 60 kcal/100 ml, oatmeal cream dessert 80 kcal/100 g vs. 120 kcal/100 g). The organoleptic characteristics of the developed samples received high marks from the expert committee, which included the aroma, balance of taste and texture. The taste and aroma of the samples were found to be richer and more natural compared to commercial analogues (Table 4).

Table 4. *Comparison of the characteristics of the developed products with commercial analogues*

Characteristic	Developed samples	Commercial products
Calorie contents (kcal/100 g)	55 (yoghurt), 30 (milk), 80 (dessert)	70 (yoghurt), 60 (milk), 120 (dessert)
Texture	Thick, homogeneous, stable	Often delamination or sedimentation
Taste	Rich, natural fermented milk or nutty flavour	Sometimes overly sweetened or artificial
Stability	Retains properties for 7 days at +4°C	May lose uniformity during storage

Source: compiled by the authors

The obtained results demonstrated that the developed products have a stable texture, pronounced natural flavour characteristics and reduced calorie content compared to commercial analogues. Thanks to the use of protein extraction, fermentation and ultrafiltration technologies, an optimal balance between nutritional value and organoleptic properties was achieved. In addition, the stability of the products during storage is ensured, which is an important criterion for their further use in production.

Discussion

The results of the study demonstrated the effectiveness of innovative technologies of protein extraction, fermentation and ultrafiltration in the creation of low-calorie dairy products from plant components. The obtained indicators of caloric content, texture, stability and organoleptic characteristics indicate the feasibility of using these technologies in industrial production. A comparison of the results with previous scientific studies concluded the innovativeness and practical significance of the study. The results of the study were compared with the data of other scientists, which made it possible to assess their compliance with current trends in the creation of low-calorie products. H. Ijaz & S. Sun (2025) discussed structured lipids as fat substitutes that help reduce the calorie content of foods. These conclusions are consistent with the effectiveness of the applied ultrafiltration, which reduced the fat content, ensuring texture stability and preservation of organoleptic characteristics. I. Monroy-Rodríguez *et al.* (2024) noted that protein microparticles can be used as an effective fat substitute in low-calorie foods. A similar effect was observed in the developed samples, where the use of protein isolates from soy, almond and oat provided a thick consistency and high stability, which correlates with the trends described in this study. The study by Q. Xu *et al.* (2024) addressed the functional properties of emulsion gels used to replace fats in dairy products. The conclusions drawn by these authors confirm the effectiveness of technologies aimed at improving texture and reducing calorie content, which was achieved in the developed samples through protein extraction and ultrafiltration. In addition, O. Kovalova *et al.* (2024) demonstrated that the use of cold plasma makes it possible to intensify the process of lentil germination, increasing its biological value by increasing the content of essential amino acids (by 3.6%) and B vitamins (B1, B2, B5, B9), PP and C. Also, the authors note that cold plasma-derived ribbon malt has improved nutritional characteristics and can be used in the production of functional foods, including reduced-calorie dairy products.

R. Munteanu-Ichim *et al.* (2024) highlight the benefits of using plant ingredients and probiotics to create functional non-dairy yoghurts. The high organoleptic and functional characteristics obtained during the study of fermented soy yoghurt are consistent with the results described in the above work, which confirms the effectiveness of fermentation with probiotic cultures. The results of the study were compared with modern scientific developments in the field of low-calorie products from plant components. M. Tosif *et al.* (2025) investigated the properties of mucilage substances that act as functional fat substitutes in vegan products. The authors' conclusions confirm the effectiveness of the use of innovative fat substitutes, which is consistent with the results obtained, where ultrafiltration was used to reduce calorie content without losing textural characteristics.

The safety and quality of dairy products based on cow's and mare's milk with the addition of plant components was studied in the study by M. Iztileuov *et al.* (2024). The identified positive changes in organoleptic properties due to plant ingredients correlate with the results of the study, where the use of protein isolates from soy, oats and almonds ensured high stability and attractiveness of the developed samples. I. Nyambayo *et al.* (2024) studied consumer acceptance of plant-based milk and dairy products. The authors emphasise the growing interest in products with reduced calorie content and functional properties, which confirms the importance of the low-calorie products developed in this study. The high evaluation of the organoleptic characteristics confirms that they meet the consumer expectations described in the study. The study by T. Zhang *et al.* (2023) analysed the use of plant-based fat substitutes with functional and health-promoting properties. The technologies used in this study, such as protein extraction and ultrafiltration, confirm the effectiveness of the proposed approach to reducing the fat content in products without losing their texture and taste.

M. Alam *et al.* (2025) analysed the integration of sensor technologies into the food industry, which contributes to improving product quality and meeting modern consumer requirements. The introduction of modern methods of quality control and improvement of production processes in this study also corresponds to these trends. The results of the study were compared with modern scientific developments related to the creation of low-calorie products with plant components. A. Gupta *et al.* (2025) examined the physicochemical and sensory characteristics of plant milk for coffee drinks. The authors noted the importance of a stable texture and flavour, which coincides with the findings of a study in which stability and organoleptic characteristics were achieved using ultrafiltration. S. Shaheen *et al.* (2023) highlighted the functional and metabolic properties of fat substitutes. Their analysis confirms the possibility of reducing the calorie content of products without losing functional properties, which is consistent with the results of the study, where protein extraction contributed to a reduction in fat content and preservation of texture.

D. McClements *et al.* (2021) examined the introduction of innovative technologies in the food industry to create a sustainable and healthy food system. The results obtained in this study, such as the use of protein extraction, fermentation and ultrafiltration, confirm the promise of innovative technologies to meet modern consumer requirements. S. Chen *et al.* (2023) studied colloidal strategies for inhibiting lipid degradation in the development of low-calorie foods. Their findings on the importance of controlling lipid components are consistent with the results of a study where ultrafiltration and fermentation reduced fat content and ensured product stability. The findings confirm the effectiveness of innovative technologies for creating low-calorie products, demonstrating their compliance with current scientific trends.

Conclusions

As a result of the study, the main goal was achieved: innovative technologies for the creation of low-calorie dairy products based on plant components that combine reduced calories with high organoleptic characteristics and nutritional value were substantiated and developed. The use of protein extraction, fermentation and ultrafiltration technologies has made it possible to produce products that meet modern consumer requirements for healthy eating and quality. The study confirmed the effectiveness of using plant ingredients such as soya, almonds and oats in the production of low-calorie dairy products. The resulting protein isolates from plant-based raw materials provide a stable texture that is not inferior to traditional dairy products. Fermentation reduces calorie content by breaking down complex carbohydrates and further improves the taste due to the fermented milk flavour. Ultrafiltration ensured the concentration of protein components, reduced calorie content and long-term texture stability of the products.

The results of the study showed that the developed products, such as fermented soya yoghurt (55 kcal/100 g), almond milk (30 kcal/100 ml) and oatmeal cream dessert (80 kcal/100 g), had 20-50% lower calorie content compared to their traditional counterparts. The organoleptic evaluation showed high consumer appeal, with an average score of 4.8 out of 5 for taste and texture. The products also demonstrated stability for 7 days of storage at +4°C. The practical significance of the results includes the possibility of introducing these technologies into commercial production. The developed products can meet the demand in the functional and dietary food market, providing consumers with a healthy alternative to dairy products. Further research should optimise technologies for production costs reduction, expanding the product range by using new plant-based ingredients (such as algae proteins and chia seeds), and studying the long-term stability of products under different storage and transportation conditions, which in general creates the basis for further development of the low-calorie dairy products segment with plant-based ingredients.

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Conflict of Interest

None.

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Інноваційні технології створення низькокалорійних молочних продуктів із використанням рослинних компонентів

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Анотація. Створення низькокалорійних молочних продуктів із використанням рослинних компонентів набуває дедалі більшого значення через зростання попиту на здорове харчування та альтернативи традиційним молочним виробам. Бекграунд дослідження базувався на необхідності розробки функціональних продуктів зі зниженим калорійним навантаженням, які поєднують високу поживну цінність і привабливі органолептичні властивості. Метою дослідження було розробити низькокалорійні продукти на основі рослинної сировини із застосуванням інноваційних технологій, таких як екстракція білків, ферментація та ультрафільтрація, забезпечуючи зниження калорійності без втрати текстури, смаку та стабільності під час зберігання. У роботі використовувалися високоякісні рослинні інгредієнти (соя, мигдаль, овес) і пробіотичні культури, а методологія включала виділення білкових ізолятів шляхом екстракції, подальшу ферментацію для покращення смаку та збагачення корисними мікроорганізмами, а також ультрафільтрацію, що сприяла концентрації білків, видаленню цукрів і забезпеченню стабільності продуктів. Результати показали, що розроблені продукти – ферментований соєвий йогурт (55 ккал/100 г), мигдальне молоко (30 ккал/100 мл) та вівсяний крем-десерт (80 ккал/100 г) – продемонстрували суттєве зниження калорійності на 20-50 % у порівнянні з традиційними молочними аналогами. Усі зразки зберігали стабільну текстуру, однорідність і високі органолептичні характеристики протягом 7 днів при температурі +4°C, отримавши середній бал 4,8 із 5 за оцінкою експертної комісії. Додатково було встановлено, що використання ультрафільтрації забезпечило тривалу стабільність продуктів, а ферментація сприяла покращенню смакових характеристик і підвищенню біологічної цінності. Висновки дослідження підтвердили ефективність інноваційних технологій у створенні конкурентоспроможних низькокалорійних продуктів із рослинних компонентів. Практична значимість полягає у можливості впровадження отриманих результатів у промислове виробництво для задоволення потреб сучасного ринку, орієнтованого на здорове харчування

Ключові слова: харчова промисловість; здорове харчування; ферментація; ультрафільтрація; екстракція білків; пробіотичні культури