

VEGETABLE INGREDIENT IN CHEESE PRODUCT

Marina Ivanovna Slozhenkina, Ivan Fiodorovich Gorlov, Vera Vasilievna Kryuchkova, Anastasia Evgenievna Serkova, Anastasia Dmitrievna Ryaskova, Svetlana Nikolaevna Belik

ABSTRACT

Sesame seeds are a functional food ingredient with vasoprotective, antioxidant, prebiotic, chondro- and osteoprotective characteristics. In this study, sesame seeds were used to enrich a cheese product. The dose, method and technological production stage of the cheese product in which to add sesame seeds were determined, in addition to the effect of sesame seeds on the product's quantitative indicators. The nutritional value of sesame seeds, their total amino acid and fatty acid compositions and microbiological parameters were evaluated, depending on the method of the filler temperature treatment. The appropriate heat treatment method was holding the functional component in milk at 73 ± 2 °C for 25 min, followed by cooling to 30 ± 2 °C. Adding the filler into the cheese mass before moulding the cheese head was determined as the appropriate technological step to introduce the previously prepared sesame seeds. The cheese product was found to have the best sensory characteristics at the 3% sesame seed dose compared with the doses of 1% and 5%. The cheese product enriched with sesame seeds can be recommended as a functional product for systematic consumption without restrictions for all groups in a healthy population.

Keywords: cheese product; sesame seed; nutritional value; functional product

INTRODUCTION

One of the promising directions in the development of the dairy industry is the creation of functional products that provide food rations with nutrients and energy for improving physiological functions in various population groups (Gorlov et al., 2014). In the production of functional dairy products, plant raw materials (seeds, berries, fruits, vegetables and spices) are attractive ingredients that are nutritionally-valuable, primarily due to the specific combination of biologically active components (Klimenko et al., 2017; Kryuchkova et al., 2015).

At present, a healthy lifestyle and proper nutrition are gaining popularity. Followers of such a diet often add various seeds, for example, chia, flax, sunflower and sesame seeds (SS) to habitual dishes (Suprunova et al., 2010). These additives and toppings positively affect the nutritional value of the dish and its benefits in general. Of great interest are SS because of their sweet taste, nut aroma and wide range of valuable macro- and microelements and vitamins (Sanzharovskaya, Sokol and Khrapko, 2018).

Sesame (*Sesamum indicum* L.) is an oilseed plant that is grown everywhere in the East. In the countries of the Commonwealth of Independent States, sesame is grown mainly in India. SS are rich in manganese, copper and calcium, but also contain B vitamins and vitamin E (tocopherol) (Katserikova and Lipatova, 2009). Sesame exerts diverse health benefits attributed to the biologically

active components, including phytosterols, tocopherols, polyunsaturated fatty acids and lignans. The main SS lignans are sesamin, sesamol and sesaminol – a group of phenolic compounds of plant origin (Martinchik, 2011). Phenolic compounds exhibit pronounced antioxidant activity, bind heavy metal ions and serve as free radical acceptors (Kumar and Singh, 2015). When exposed to moderately high temperatures, sesamin and sesaminol are converted to a more powerful antioxidant – sesamol (Gerstenmeyer et al., 2013).

Research on the antibacterial activity of sesame lignans has revealed that the antimicrobial spectrum of sesamol, sesamol and sesamin includes most pathogenic Gram-positive and Gram-negative microorganisms (Kumar and Singh, 2015). Moreover, an *in vitro* fermentation study of sesaminol triglucoside by human intestinal microbiota showed a marked increase in the number of lactobacilli, enterococci and bifidobacteria, without stimulating the growth of *Eubacterium rectale*, *Clostridium coccooides* and *Clostridium histolyticum* (Zhu et al., 2013).

As a dietary component, sesame helps the blood vessel endothelium to restore its functional state. This action is due to the antioxidant activity of its lignans and vitamin E, as well as recovery of the blood lipid spectrum (Asgary et al., 2013). In addition, sesamin induces endothelium-dependent vasorelaxation, which is one of the important mechanisms of the anti-hypertensive effect of sesame lignans (Nakano et al., 2006).

Substantial evidence has been collated to suggest that sesamol has chemopreventative potential *in vitro* and *in vivo* (Majdalawieh and Mansour, 2019). When administered for 9 weeks in the diets (500 mg.kg⁻¹) of mice with induced polyposis of the small intestine, sesamol reduced the number of polyps in the middle part of the small intestine to 66.1%, compared with the control group (Shimizu et al., 2014). Sesamol inhibited the synthesis of melanin in melanoma in mice by 63%, besides inducing apoptosis and limiting the proliferation of tumour cells (Kumar et al., 2011). This same bioactive compound demonstrated chondroprotective effects in IL-1 β -induced inflammation in an osteoarthritis model *in vitro* (Kong et al., 2016). Sesamin, another major bioactive component in sesame, inhibited ROS-induced apoptosis of primary osteoblasts in the femoral head of rats (Deng et al., 2018). The stimulated differentiation of osteoblasts and inhibition of osteoclastogenesis, by sesamin has also been investigated (Wanachewin et al., 2017).

As exemplified by these cited experimental, clinical and epidemiological studies of the biological properties of bioactive SS components, sesame is a functional food ingredient that maintains the cardiovascular system and bone tissue and normalises the intestinal microflora and antioxidant activity.

In this context, it is valuable to investigate the effect of functional plant ingredients in the production of dairy products. Therefore, this study aimed to use SS to develop an enriched cheese product.

Scientific hypothesis

We assumed that the dose, method and technological production stage of the cheese product in which the SS were added would have a significant effect on the quality of the cheese product.

MATERIAL AND METHODOLOGY

Cheese product samples incorporated with different doses of SS were prepared, using various strategies to improve the nutritional and sensory qualities of the product. The fat mass-fraction was evaluated empirically by the Gerber method, as detailed in the **Government Standard (GOST) R ISO 2446-2011:2012**, which provides the mass fraction of fat. Briefly, milk was placed in the test bottle and centrifuged to separate the fat after dissolution of the protein with sulfuric acid, and the addition of a small amount of isoamyl alcohol. The value of the indicator was measured by the calibration of the test bottle.

The mass fraction of protein was determined by the Kjeldahl method, in accordance with **GOST 34454-2018:2019**. In brief, the organic matter in the analysed product sample was mineralised by the addition of concentrated sulphuric acid in the presence of a catalyst. Ammonium sulphate was formed and converted to ammonia that was distilled into a boric acid solution and quantified by the titrimetric method for calculation of the protein mass fraction.

The mass fractions of moisture and solids were ascertained based on **GOST R 8.894-2015:2016**, using an Evlas-2M moisture analyser. An infrared

thermogravimetric method to determine the mass fractions of moisture and dry matter was applied, which involved measuring the weight of the sample before and after it was dried under the infrared radiation. Sensory properties were assessed by a group of experts by adhering to the requirements of **GOST R ISO 22935-2-2011:2011**. Microbiological properties were analysed based on **GOST 32901-2014:2016**. The amino acid content was determined by capillary electrophoresis using a Kapel-105M system. A deuterium lamp was applied as a light source in the system, and a diffraction monochromator with a spectral range of 190 – 380 nm and a spectral interval width of 20 nm was used as a dispersing element. Fatty acids were determined on a Tsvet-164 gas chromatograph, using the polar liquid phase, polydiethylene glycol adipam.

Statistic analysis

Statistical data were processed using the Statistical program (Statistica, version 6.0 (Dell, USA)). The data are presented as averages. The differences between the samples were assessed using unpaired t-test. Correlation analysis with calculation of pair correlation coefficient, for establish the dependence of parameters was used. The significance of differences was determined by the Student's criterion (t). The level was considered significant at $p \leq 0.05$. The study was repeated three times.

RESULTS AND DISCUSSION

One of the most important steps in determining the quality of SS as a phyto-enriching component of a cheese product is the analysis of its chemical components. The quantitative analysis of the protein, fat and fatty acids were important because of their association with the potential contribution of SS to satisfying the physiological needs of these substances in the human body. After a series of tests using conventional methods, the nutritional SS values were obtained (Table 1).

From the data, it was evident that SS had a high content of vegetable protein and fat per 100 g of the product. The integration of plant-based bioactive ingredients in dairy products to provide a source of not only healthy fats but also dietary protein would allow creating complete protein-rich cheese products that are considerably cheaper compared with products consisting entirely of expensive animal protein. Due to its high nutritional value, sesame is used as a filler in various food products: sweets, bakery products, dairy products and others (Poddubny and Zhurbenko, 2019; Koneva et al., 2017; Ovchinnikov et al., 2016; Pashchenko et al., 2008).

For a deeper understanding of the value of SS in the formulation, the total content of amino acids and fatty acids was analysed. Amino acids are the “building” material for a healthy organism (Singelot et al., 2018) and structural, chemical units that form proteins, and, in turn, the structure of the tissues of the human body. The amino acids are important for the body because proteins play an essential role in all life processes. There are 20 essential amino acids. To construct the vast majority of human body proteins, all 20 amino acids are required in certain proportions (Lysikov, 2012).

Table 1 Nutritional value of sesame seeds, per 100 g.

Indicator	Value
Weight fraction of fat, %	49.7
Weight fraction of protein, %	19.7
Weight fraction of carbohydrates, %	16.0
incl. weight fraction of dietary fibre, g	5.6
Weight fraction of minerals, g	3.8
Weight fraction of moisture, g	5.2
Calories, kcal	590.1

Table 2 Total content of amino and fatty acids in sesame seeds.

Acids	Content, g.100g ⁻¹	Percentage of daily amount, %
Proteins and amino acids		
<i>Total protein content</i>	19.70 ±0.3	25.6
<i>Essential amino acids</i>	8.6 ±0.06	26.8
<i>Non-essential amino acids</i>	11.03 ±0.1	16.2
Fats and fatty acids		
<i>Total fat content</i>	49.7 ±0.4	56.4
<i>Unsaturated fatty acids:</i>	41.1 ±0.2	66.7
<i>Monounsaturated fatty acids:</i>	20.8 ±0.01	139.4
<i>Polyunsaturated fatty acids</i>	20.2 ±0.4	101.8
<i>Saturated fatty acids</i>	8.6 ±0.3	32.6

Table 3 Microbiological properties of sesame seeds depending on the temperature-time modes of treatment.

Indicator	Weight of product (g), where not allowed	Characteristic/Temperature (T)–time (τ) mode		
		T = 65 ±2 °C τ = 25 min	T = 73 ±2 °C τ = 25 min	T = 85 ±2 °C τ = 25 min
QMAFAnM, CFU/cm ³ (g), not less than	1 × 10 ⁷	2 × 10 ⁶	–	–
<i>Listeria monocytogenes</i>	–	–	–	–
<i>Enterobacter sakazaki</i>	–	–	–	–
<i>Yersinia</i> bacteria	–	–	–	–
Mould, cfu per g	50	15	–	–
Yeast, cfu per g	50	12	–	–

Note: QMAFAnM: quantity of mesophilic aerobic and facultative anaerobic microorganisms.

The human body's capacity to conserve individual amino acids varies considerably, so the proportions of the amino acids needed in the diet to match their catabolic rates are not directly proportional to the composition of body protein. An imbalance in the amino acid composition of dietary protein leads to a disruption in the synthesis of body proteins and shifts the dynamic equilibrium of protein anabolism and catabolism towards the predominance of the breakdown of the body's proteins, including enzyme proteins (**Stepuro and Khaprova, 2010**). The lack of an essential amino acid limits other amino acids being used in the protein biosynthesis.

Fatty acids form the basis of cell membranes and participate in the synthesis of the most important hormone-like substances, so they are vital for the body. Correct results in analysing amino and fatty acid compositions depend on the reliability of the qualitative identification of the components analysed. The total content of amino acids and fatty acids is presented in Table 2. The percentage of the normal daily intake of protein and fatty nutrients was calculated for an average person aged 30 – 39 years, group II of physical activity, and provides for 2650 kcal of a daily diet (**Federal Center for Hygiene and Epidemiology of Rospotrebnadzor, 2009**).

A detailed analysis of the chemical composition of SS found that they contain a considerable amount of essential amino acids and unsaturated fatty acids. Essential amino acids include valine, phenylalanine, lysine, leucine, tryptophan, threonine, arginine, histidine, isoleucine and methionine. These amino acids are not synthesised in the human body or formed in insufficient quantities for sustaining a healthy life. Both types are essential for health. According to the **FAO WHO (1974)** recommendations, the daily requirement for essential and non-essential amino acids is 32 and 68 g.100⁻¹g of protein, respectively. We found that 100 g of sesame protein accounts for 43.6% of the essential amino acids, which corresponds to 2.9% of the daily requirement. Unsaturated fats are divided into monounsaturated and polyunsaturated fats. In percentage terms, the unsaturated fatty acids accounted for 82.6% of the lipid portion of the seeds, composed by 41.8% monounsaturated and 40.8%, polyunsaturated fatty acids, respectively (Figure 1).

In the manufacture of dairy products, any ingredient added must be heat-treated, while preserving its nutritional value to the fullest extent, besides preventing the destruction of biologically active substances and all the necessary vitamins (**Mazhaeva, Kozubskaya and Sinitsyna, 2017**). The heat treatment is one of the most important steps in the technological food preparation process. Effective processing preserves the taste and nutritional characteristics of the product, destroys the pathogenic microflora and thus, ensures the sanitary and epidemiological safety of the product.

Raw peeled sesame seeds have a slightly bitter taste and a mild nutty flavor. Heat treatment positively affects the color change of sesame seed, enhances aroma, improves taste, improves digestibility. Seeds acquire the taste inherent in nuts. The known parameters of heat treatment of sesame seeds in the production of cottage cheese desserts 65 – 70 °C for 6 – 7 min (**Katserikova, Solopova and Lipatova, 2011**). We proposed various temperature

treatments of SS in pre-warmed milk: 65 ±2 °C for 25 min, 73 ±2 °C for 25 min and 85 ±2 °C for 25 min. After the treatment, SS were cooled to 30 °C. Then the microbiological properties and sensory qualities of the treated SS were determined (Table 3). The qualitative and quantitative compositions of the microflora of the product are of great importance for establishing its purity and sanitary condition. The microbiological control of the raw materials and finished products allowed us to timely identify the source of contamination of products with microorganisms that cause their spoilage, as well as judge the possible presence of foodborne infections and poisoning pathogens.

The temperature treatment of SS was followed by analysis of the microbiological properties that indicated their high rates at 73 ±2 °C for 25 min and no foreign microflora. Moreover, SS acquired a pleasant, pronounced taste of pasteurised milk, complemented by the sour-milk taste of the cheese base. When SS were processed in milk below this temperature, the cheese product was likely to be contaminated with microorganisms, such as mesophilic aerobic and facultative anaerobic microorganisms (MAFAnM), coliform bacteria, yeast and mould (fungi), which is not permissible in the cheese production. It was not economically feasible to apply the higher temperature of 85 ±2 °C for 25 min due to the destruction of the B vitamins and 30 – 50% decrease in their properties during heat treatment. Therefore, it was necessary to use the minimum temperature modes that ensured the destruction of foreign microflora of SS.

In the production of fortified dairy products, the method, process step and dose of adding plant materials into the base product are important. The experimental samples were developed according to the same technology and differed in the stage of manufacture when the SS treated at 73 ±2 °C for 25 min were added into the product. To determine the method and technological stage of the SS application, two additional options were tested, followed by an examination of the sensory qualities of the cheese product. Sample I was added into the milk base before coagulation, that is, the coagulation process of the milk mixture was evaluated in the presence of SS. Sample II was added to the cheese mass before forming the head, that is, SS did not affect the coagulation of milk and, therefore, the quality of cheese grain. The results of the experimental study are presented in Table 4.

It was found that the SS added to the milk base before coagulation (Sample I) caused a part of the filler being lost with whey, which reduced the quality of the product, its nutritional value and functional efficiency. The emergence of seeds on the surface of the milk base led to economic loss in production. Adding the SS to the cheese mass before forming the head (sample II) was the appropriate approach. This method caused the SS to swell, soften, and become evenly distributed throughout the cheese mass. It also led to high sensory characteristics and eliminated the technological loss of SS. Studies are also known that confirm the effectiveness of making fillers in the cheese mass after the formation of cheese grain (**Aravina and Arsenyeva, 2016; Ryabkova et al., 2011; Kharenko et al., 2010**).

Table 4 Sensory characteristics of the cheese product of sesame seeds (SS) depending on the method of adding SS.

Method of SS addition	Appearance and consistency	Taste and smell	Colour
<p>Sample I</p> <p>SS were added to milk at 73 ±2 °C, held for 25 min, cooled to 30 ±2 °C and added to the milk base until coagulated</p>	SS swelled, softened and floated to the surface of the milk base	Moderately-expressed cheese taste, complemented with pleasant SS taste and aroma	Milky-white, heterogeneous, interspersed with white SS
<p>Sample II</p> <p>SS were added to milk at 73 ±2 °C, held for 25 min, cooled to 30 ±2 °C and added to the cheese mass before moulding the cheese head</p>	SS swelled, softened and distributed evenly throughout the cheese mass	Moderately-expressed cheese taste, complemented with pleasant SS aftertaste and aroma	Milky-white, homogeneous, interspersed with white SS

Table 5 Sensory characteristics of the cheese product depending on the dose of sesame seeds (SS).

SS weight fraction	Appearance and consistency	Taste and smell	Colour
Sample I (1% SS)	Soft, spreading and slightly fluffy consistency, with single, white SS	Clean cheese taste with a slightly pronounced flavour of SS	Milky-white, with single interspersed white SS evenly distributed throughout the mass
Sample II (3% SS)	Soft, spreading and slightly fluffy consistency, with single SS	Clean cheese taste with a pronounced SS flavour complemented by the cheese base	Milky-white, with single interspersed white SS evenly distributed throughout the mass
Sample III (5% SS)	Soft, spreading and slightly fluffy consistency, with SS	Cheese taste with a predominant pronounced flavour of SS	Milky-white, interspersed with white SS distributed throughout the mass

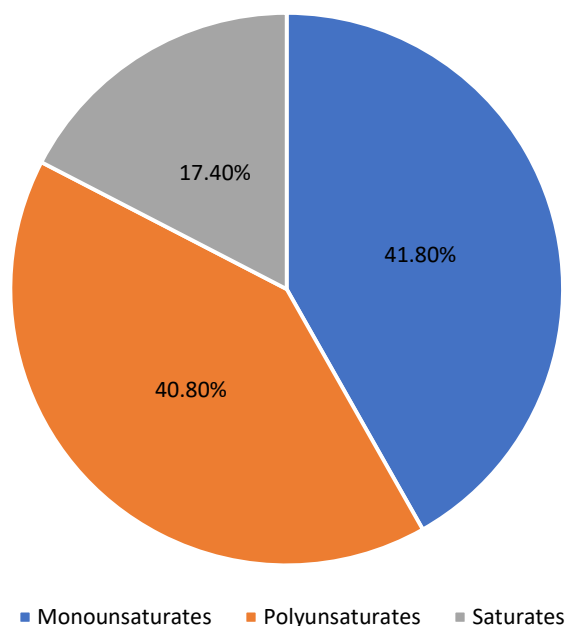


Figure 1 Ratio between fatty acids and fatty part of sesame seeds, %.

To determine the appropriate dose of SS, the cheese products were produced with a seeds weight fraction of 1%, 3% and 5%. For this purpose, after being standardised by fat, milk was pasteurised at 72 – 75 °C for 2 – 3 min and cooled to 32 – 34 °C. Then, a culture (its composition contained *Lactococcus lactis* subsp. *cremoris*, *Lactococcus lactis* subsp. *lactis*, *Leuconostoc mesenteroides* subsp. *cremoris* and *Lactococcus lactis* subsp. *Lactis biovar diacetylactis*), CaCl₂ and rennet were added. After thorough mixing for 15 min, the mixture was fermented at 32 ± 2 °C for 40 – 45 min until a dense curd formed and the whey separated. After cutting, the curd was gently kneaded, the whey was removed, and various doses of SS were added to the cheese mass. Then, the cheese heads were moulded by filling and self-pressing for 1.5 – 2.0 h, with turning every 15 – 20 min at 12 – 14 °C. Afterwards, the cheese heads were held in 10% salt brine at the same temperature for 10 – 12 h, and dried. The results are presented in Table 5.

According to the data obtained, it was found that Sample I and III did not have appropriate sensory characteristics. Addition of Sample I (1% SS) to the cheese mass led to a filler with weak flavour. Sample III (5% SS) had a cheese flavour with a predominant and strong specific seed flavour that not everyone would like. Sample II, with 3% weight fraction of SS, was established to have the most balanced taste and smell. This sample had a clean cheese taste with a pronounced SS flavour that complemented the cheese base. Its sweetish, nutty flavour and aroma perfectly complemented the taste of the cheese base. Known studies of the dose of sesame in the production of dairy products (Titov et al., 2018). The authors of the studies also believe that with an increase in concentration of 3%, sesame flavor prevails, which was evaluated as extraneous and undesirable based on the objectives of the experiment.

CONCLUSION

The study found that SS are a highly effective functional ingredient with high nutritional value and high content of essential amino acids and unsaturated fatty acids. The appropriate method of the heat treatment and technological stage of addition involved holding the SS in milk at 73 ± 2 °C for 25 min, cooling to 30 ± 2 °C and adding to the cheese mass before moulding the head of cheese. The dose of SS was established as 3% of the filler. The cheese product enriched with SS can be recommended as a functional product for systematic consumption without restrictions for all groups of a healthy population.

REFERENCES

- Aravina, K. I., Arsenyeva, T. P. 2016. Razrabotka sostava i tehnologii mjagkogo syrnoogo produkta s ispol'zovaniem vysokobelkovej muki amaranta (Development of the composition and technology of a soft cheese product using high-protein amaranth flour). *Scientific journal NRU ITMO*, no. 4, p. 17-25. (In Russian). <https://doi.org/10.17586/2310-1164-2016-9-4-17-25>
- Asgary, S., Rafieian-Kopaei, M., Najafi, S., Heidarian, E., Sahebkar, A. 2013. Antihyperlipidemic effects of *Sesamum indicum* L. in rabbits fed a high-fat diet. *The Scientific World Journal*, vol. 2013, p. 5. <https://doi.org/10.1155/2013/365892>
- Deng, S., Zhou, J. L., Fang, H. S., Nie, Z. G., Chen, S., Peng, H. 2018. Sesamin protects the femoral head from osteonecrosis by inhibiting ROS-induced osteoblast apoptosis in rat model. *Frontiers in Physiology*, vol. 9, p. 8 <https://doi.org/10.3389/fphys.2018.01787>
- FAO WHO. 1974. Energy and White Requirements: Report of the FAO/WHO Ad Hoc Joint Committee of Experts. Available at: http://apps.who.int/iris/bitstream/10665/92451/1/WHO_TRS_522_rus.pdf
- Federal Center for Hygiene and Epidemiology of Rospotrebnadzor. 2009. The physiological requirements for energy and nutrients for various groups of the population of the Russian Federation. Docket no. 2.3.1.2432-08. Available at: <https://files.stroyinf.ru/Data2/1/4293756/4293756229.pdf>
- Gerstenmeyer, E., Reimer, S., Berghofer, E., Schwartz, H., Sontag, G. 2013. Effect of thermal heating on some lignans in flax seeds, sesame seeds and rye. *Food Chemistry*, vol. 138, no. 2-3, p. 1847-1855. <https://doi.org/10.1016/j.foodchem.2012.11.117>
- Gorlov, I. F., Nelepov, J. N., Slozhenkina, M. I., Korovin, E. J., Simon, M. V. 2014. Razrabotka novyh funktsional'nyh produktov na osnove ispol'zovanija proroshhennogo nuta (Development of new functional products based on the use of sprouted chickpea). *All about Meat*, vol. 17, no. 1, p. 28-31. (In Russian).
- GOST 32901-2014: 2016. *Milk and dairy products. Methods of microbiological analysis (as amended) - Government Standard.*
- GOST 34454-2018: 2019. *Dairy products. Determination of the mass fraction of protein by the Kjeldahl method) - Government Standard.*
- GOST R 8.894-2015: 2016. *State system for ensuring the uniformity of measurements. Milk and milk products. Infrared thermogravimetric method for determining the mass fraction of moisture and dry matter) - Government Standard.*
- GOST R ISO 22935-2-2011: 2011. *Milk and milk products. Sensory analysis. Part 2. Recommended methods for sensory evaluation - Government Standard.*
- GOST R ISO 2446-2011: 2012. *Milk. Method of determination of fat content - Government Standard.*
- Katserikova, N. V., Lipatova, Y. S. 2009. Kunzhut kak istochnik kal'cija v racione lic pozhilogo vozrasta (Sesame as a source of calcium in the diet of the elderly). *Food Industry*, no. 2, p. 44-49. (In Russian).
- Katserikova, N. V., Solopova, A. N., Lipatova, Yu. S. 2011. Razrabotka tvorozhnyh izdelij s kunzhutom gerodieticheskogo napravlenija (Development of curd products with sesame seeds of the herodietic direction). *Technique and technology of food production*, vol. 22, no. 3, p. 97-101. (In Russian).
- Kong, P., Chen, G., Jiang, A., Wang, Y., Song, C., Zhuang, J., Xi, C., Wang, G., Ji, Y., Yan, J. 2016. Sesamin inhibits IL-1β-stimulated inflammatory response in human osteoarthritis chondrocytes by activating Nrf2 signaling pathway. *Oncotarget*, vol. 7, p. 83720-83726. <https://doi.org/10.18632/oncotarget.13360>
- Kumar, M. C., Sathisha, U. V., Dharmesh, S., Appu Rao, A. G., Singh, S. A. 2011. Interaction of sesamol (3,4-methylenedioxyphenol) with tyrosinase and its effect on melanin synthesis. *Biochimie*, vol. 93, no. 3, p. 562-569. <https://doi.org/10.1016/j.biochi.2010.11.014>
- Kumar, M. C., Singh, S. A. 2015. Bioactive lignans from sesame (*Sesamum indicum* L.): evaluation of their antioxidant and antibacterial effects for food applications. *Journal of*

Food Science and Technology, vol. 52, no. 5, p. 2934-2941.

<https://doi.org/10.1007/s13197-014-1334-6>

Lysikov, Y. A. 2012. Aminokisloty v pitanii cheloveka (Amino acids in human nutrition). *Clinical and Experimental Gastroenterology*, vol. 88, no. 2, p. 88-105. (In Russian).

Majdalawieh, A. F., Mansour, Z. R. 2019. Sesamol, a major lignan in sesame seeds (*Sesamum indicum*): anti-cancer properties and mechanisms of action. *European Journal of Pharmacology*, vol. 855, p. 75-89.

<https://doi.org/10.1016/j.ejphar.2019.05.008>

Martinchik, A. N. 2011. Pishhevaja cennost' semjan kunzhuta (Nutritional value of sesame seeds). *Voprosy Pitaniia*, vol. 80, no. 3, p. 41-43. (In Russian).

Mazhaeva, T. V., Kozubskaya, V. I., Sinitsyna, S. V. 2017. Current issues of the implementation of hazard analysis critical control point (haccp) principles in public catering facilities. *Hygiene and sanitation*, vol. 96, no. 12, p. 1151-1154.

<https://doi.org/10.18821/0016-9900-2017-96-12-1151-1154>

Nakano, D., Kwak, C. J., Fujii, K., Ikemura, K., Satake, A., Ohkita, M., Takaoka M., Ono, Y., Nakai, M., Tomimori, N., Kiso, Y., Matsumura, Y. 2006. Sesamin metabolites induce an endothelial nitric oxide-dependent vasorelaxation through their antioxidative property-independent mechanisms: possible involvement of the metabolites in the antihypertensive effect of sesamin. *The Journal of Pharmacology and Experimental Therapeutics*, vol. 318, no. 1, p. 328-335. <https://doi.org/10.1124/jpet.105.100149>

Patent for the invention of the Russian Federation. *Fruit candies with honey and sesame*. Patent owner: Poddubny, I. E., Zhurbenko, E. V. Int.A23G3/00, A23G3/48. Russian Federation. Patent no. 2699191C1, 03-09-2019.

Patent for the invention of the Russian Federation. *Ice cream composition*. Patent owner: Ovchinnikov, A. S., Drevin, V. E., Venetian, A. S., Dolgov, A. I., Pimkina, L. E. Int.A23G9/32. Russian Federation. Patent no. 2589793C1, 10-07-2016.

Patent for the invention of the Russian Federation. *Method for producing cheese product*. Patent owner: Ryabkova, D. S., Gavrilova, N. B., Rybchenko, T. V., Molyboga, E. A. Int.A23C19/055. Russian Federation. Patent no. 2431409C1, 20-10-2011.

Patent for the invention of the Russian Federation. *Method for producing soft cream-acid cheese «Caviar»*. Patent owner: Kharenko, E. N., Novikov, A. V., Sviridenko, Yu. Ya., Mordvinova, V. A. Int.A23C19/068, A23C19/076. Russian Federation. Patent no. 2403793C1, 20-11-2010.

Patent for the invention of the Russian Federation. *Method for the production of a fermented milk product enriched with phyto-components and probiotic*. Patent owner: Klimenko, A. I., Kryuchkova, V. V., Skripin, P. V., Druker, O. V., Kontareva, V. J., Gorlov, I. F., Mosolova, N. I., Belik, S. N., Mishhenko, A. A. Int.A23C23/00 (2006.01), A23C19/076 (2006.01). Russian Federation. Patent no. 2681291, 15-12-2017.

Patent for the invention of the Russian Federation. *Method for the production of enriched curd product*. Patent owner: Kryuchkova, V. V., Verovskij, A. A., Pavlenko, V. A., Mosolova, N. I., Belik, S. N., Kokina, T. J., Skripin, P. V. Int.A23C9/13. Russian Federation. Patent no. 2601121, 24-06-2015.

Patent for the invention of the Russian Federation. *Method for the production of biscuit cake mix*. Patent owner: Koneva, M. S., Bugaets, N. A., Kaloeva, A. K. Int.A21D13/80. Russian Federation. Patent no. 2631693C1, 26-09-2017.

Patent for the invention of the Russian Federation. *Method for the production of butter crackers*. Patent owner:

Pashchenko, L. P., Ostroborodova, S. N., Pashchenko, V. L. Int.A21D13/08. Russian Federation. Patent no. 2315480C1, 27-01-2008.

Sanzharovskaya, N. S., Sokol, N. V., Khrapko, O. P. 2018. Ispol'zovanie netradicionnogo syr'ja v tehnologii syr'covykh prjanikov (The use of non-traditional raw materials in raw gingerbread technology). *Vestnik KrasGAU*, no.1, p. 147-154. (In Russian).

Shimizu, S., Fujii, G., Takahashi, M., Nakanishi, R., Komiya, M., Shimura, M., Noma, N., Onuma, W., Terasaki, M., Yano, T., Mutoh, M. 2014. Sesamol suppresses cyclooxygenase-2 transcriptional activity in colon cancer cells and modifies intestinal polyp development in *Apc^{Min/+}* mice. *Journal of Clinical Biochemistry and Nutrition*, vol. 54, no. 2, p. 95-101. <https://doi.org/10.3164/jcfn.13-91>

Singelot, B., Landry, S., Sirohi, S., Al-Dahir, S. 2018. Vitamins, amino acids and drugs and formulations used in nutrition. In Ray, S. D. *Side Effects of Drugs Annual*. Elsevier : Cambridge. 650 p. ISBN: 978-0-444-64119-9. <https://doi.org/10.1016/bs.seda.2018.08.008>

Stepuro, M. V., Khaprova, E. N. 2010. Sravnitel'naja ocenka biologicheskoy cennosti belkov rastitel'nogo syr'ja (Comparative evaluation of the biological value of plant-based proteins). *News of higher educational institutions. Food technology*, no. 4, p. 34-35. (In Russian).

Suprunova, I. A., Chizhikova, O. G., Kalenik, T. K., Samchenko, O. N. 2010. Polufabrikaty iz maslichnyh semjan kak istochnik funkcional'nyh ingredientov dlja hlebobulochnykh izdelij (Semi-finished products from oilseeds as a source of functional ingredients for bakery products). *Vestnik TSEU*, no. 3, p. 82-89. (In Russian).

Titov, E. I., Ionova, I. I., Krasnova, I. S., Volokitina, Z. V., Kozlov, N. S. 2018. Strukturno-mehaniicheskie pokazateli kislomolochnykh produktov s gidrolizatom belka iz kozhi ryb (Structural and mechanical properties of fermented milk products with protein hydrolyzate from fish skin). *Nutrition Issues*, vol. 87, no. 5, p. 243-244. (In Russian) <https://doi.org/10.24411/0042-8833-2018-10355>

Wanachewin, O., Pothachareon, P., Kongtawelert, P., Phitak, T. 2017. Inhibitory effects of sesamin on human osteoclastogenesis. *Archives of Pharmacal Research*, vol. 40, no. 10, p. 1186-1196. <https://doi.org/10.1007/s12272-017-0926-x>

Zhu, X., Zhang, X., Sun, Y., Su, D., Sun, Y., Hu, B., Zeng, X. 2013. Purification and fermentation *in vitro* of sesaminol triglucoside from sesame cake by human intestinal microbiota. *Journal of Agricultural and Food Chemistry*, vol. 61, no. 8, p. 1868-1877. <https://doi.org/10.1021/jf304643k>

Contact address:

Marina Ivanovna Slozhenkina, Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Rokossovsky Str. 6, Volgograd, 400131 Russia; Volgograd State Technical University, Lenin Avenue, 28, 400050 Volgograd, Russia, Tel.: +79047729999,

E-mail: niimmp@mail.ru

ORCID: <https://orcid.org/0000-0001-9542-5893>

Ivan Fiodorovich Gorlov, Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Rokossovsky Str. 6, Volgograd, 400131 Russia; Volgograd State Technical University, Lenin Avenue, 28, 400050 Volgograd, Russia, Tel.: +78442391048,

E-mail: niimmp@mail.ru

ORCID: <https://orcid.org/0000-0002-8683-8159>

Vera Vasilievna Kryuchkova, Skolkovo Innovation Center, Skolkovo, Russia, Tel.: +79882509672,

E-mail: kverav@yandex.ru

ORCID: <https://orcid.org/0000-0003-2058-2370>

*Anastasia Evgenievna Serkova, Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Rokossovsky Str. 6, Volgograd, 400131 Russia, Tel.: +793772-0927,

E-mail: serkova.anastasiya@gmail.ru

ORCID: <https://orcid.org/0000-0002-6440-0244>

Anastasia Dmitrievna Ryaskova, Volgograd State Technical University, Lenin Avenue 28, 400050 Volgograd, Russia, Tel.: +79610660754,

E-mail: ryaskova98.98@mail.ru

ORCID: <https://orcid.org/0000-0001-8887-2900>

Svetlana Nikolaevna Belik, Rostov State Medical University, 344022, 29 Nakhichevansky Lane, Rostov-on-Don, Russia, Tel.: +79885508929,

E-mail: superbelik@mail.ru

ORCID: <https://orcid.org/0000-0002-7743-4144>

Corresponding author: *