The influence of functional ingredients on quality of cheese

V V Lodianov¹, P V Skripin², I F Gorlov³, N I Mosolova³, E Yu Anisimova³ and O Yu Mishina³

¹ Don state technical University, Rostov-on-Don, Russian Federation
² Don state agrarian University, Persianovsky, Russian Federation
³ Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Volgograd, Russian Federation

E-mail: lodjanov@yandex.ru

Abstract. The use of additives of plant origin can increase the nutritional and biological value, improve the quality and organoleptic characteristics of the finished product. Carrots are a useful non-calorie vegetable, which contains vitamins b, PP, C, E, K, it contains carotene—a substance that is converted into vitamin a in the human body. Vitamin A is a fat-soluble vitamin. This means that it is better absorbed by the body when consumed together with fats. Milk thistle is traditionally used in the complex therapy of many diseases. The main biologically active substances of milk Thistle are flavonoids and flavolignans, which are known by the common name silymarin. Milk Thistle powder is rich in vitamins and minerals. Black sesame is considered to be a valuable oil-yielding plant. The seeds contain many vitamins and minerals, as well as dietary fiber, which bring invaluable benefits to the human body. The aim of the research was to develop the technology of cheese enriched with functional ingredients of feta "Aphelia", to study the properties and composition of carrots, black sesame and milk Thistle powder, their influence on quality indicators, to determine its quality and biological value. In addition, an experiment was conducted to determine the vitamin, mineral and amino acid composition of feta Afelia brine cheese and a control sample. Cheese with filling makes it possible to enrich and diversify the diet of consumers.

1. Introduction

The use of various fillers of natural origin to improve the quality properties of products is one of the key trends in the food industry today. This popularity is due to the fact that additives of plant origin have a high biological value, as well as meet the safety requirements.

Cheese is one of the products most frequently consumed by Russians. According to research, the proportion of people who consume hard and soft cheeses at least once in three months is almost three-quarters (about 75%) of the total population of Russia, while the majority (about 65%) eat it at least once a week. In fact, cheese belongs to the category of everyday products.

Carrots are a low-calorie vegetable. In 100 g of the product only 35 calories. Root vegetables are 89% water. It contains 6% carbohydrates, 1.2% protein, 0.2% fat. The remaining percentage consists of plant fibers, organic acids, and ash elements. Carrots contain many vitamins. They are well absorbed, have a beneficial effect on the metabolism and digestive tract. One of the main elements of the root crop is carotene. It is considered the main source of vitamin A, which is very important for visual acuity.
Rich in vitamin A gives carrots a variety of useful properties. It normalizes metabolic processes, cleanses the blood and gives energy. The vitamin A contained in the root vegetable is useful not only for vision. It protects the body from pathogens, slows down skin aging, strengthens and heals hair and nails. Retinol has a great influence on growth processes. Therefore, carrots are useful for children whose body needs a large number of micro- and macronutrients [1].

The product contains almost no fat, up to 1.5 g of protein and about 7G of carbohydrates. Carrots are also rich in valuable dietary fiber, which is well processed by the body and helps to cleanse. In addition, carrots are valuable for their mineral composition. It contains all the micro- and macronutrients necessary for the body, the most necessary of which are potassium, magnesium and sodium, phosphorus and calcium, iron, zinc, iodine, and fluorine. Root vegetables contain valuable compounds for the body—lycopene and anthocyanins, useful for regulating blood pressure, b vitamins in almost full composition, vitamins A, C, E, K, P, as well as phytoncides, pectin and other substances necessary for the body. [2]

Milk Thistle is one of the famous medicinal plants. Milk Thistle seeds contain about 200 different components that are valuable to humans: vitamins, micro- and macronutrients, and silymarin. Also, oil is extracted from the fruit (its content reaches 32%). The content of macronutrients per 1 g of vegetable raw materials reaches in mg/g: calcium-16.6, potassium-9.2, magnesium-4.2, iron-0.08. trace Elements per 1 g in mcg/g: manganese-0.1, copper-1.16, zinc-0.71, chromium-0.15, selenium-22.9, iodine-0.09, boron-22.4, etc. Also, milk Thistle seeds contain almost the entire range of vitamins a, D, F, E, K and b vitamins, which are especially valuable for restoring the nervous system [3].

Due to the presence of silymarin in milk Thistle and a lot of other useful substances, it can be successfully used for the treatment and prevention of a very large number of diseases.

Black sesame is the raw seeds of the sesame plant (Sesamum), have a small size, differ from white ones in greater nutritional value. Black color indicates pronounced antioxidant qualities.

Sesame seeds contain more calcium than most conventional foods. This makes it extremely useful for mineralizing the bones of the skeleton. Raw sesame (black and brown) contains 1,474 mg of calcium in 100 g, and 100 grams of white sesame, which is most commonly sold, contains 60 mg of calcium [4].

The caloric content of black sesame is 565 kcal per 100 grams of product. The chemical composition of black sesame includes: choline, vitamins A, B2, B5, B6, B9, B12, C, E, K and PP, as well as potassium, calcium, magnesium, zinc, selenium, copper and manganese, iron, phosphorus and sodium. Black sesame is a recognized antioxidant, it slows down the aging of the body, promotes hematopoiesis, and has anti-cancer properties. It normalizes metabolic processes and helps cleanse the body of toxins, which contributes to slow weight loss [5].

2. Goals and objectives

The goal is to study Afelia feta cheese, enriched with carrots, black sesame and milk thistle powder. In connection with this goal, it is necessary to solve the following tasks

- analysis of literature sources in the field of study;
- determination of the dose of the introduced plant components;
- development of the technological process for the production of feta cheese with vegetable components;
- evaluation of consumer characteristics of the finished product;
- determination of microbiological indications;
- study of the mineral composition;
- study of the storage capacity of the developed product;
- evaluation of the effectiveness of the developed product formulation

3. The experimental procedure

The sequence and relationship of the stages of the study of enriched plant components are shown in the flowchart in figure 1.
To complete the tasks and achieve the goals of the experimental study, the following steps must be performed:

- optimization of the formulation

For experimental development of cheese samples, the recipe is processed taking into account the introduction of new components

- determining the dose of plant components

For the production of samples, the dose of introduced plant components is determined in the amount of 1.5%, 0.5% and 0.37%;

- production of cheese samples

Four samples of feta cheese are produced. Sample #1 - control, sample #2 - feta Afelia brine cheese with 1.5% addition of components, sample #3 - feta Afelia brine cheese with 0.5% addition of components. Sample #4 - pickled feta cheese "Afelia" with 0.37% addition of components. Evaluate the organoleptic characteristics of experimental samples containing plant components in the amount of 1.5%, 0.5%, 0.37%

- determination of physical and chemical indications

Determined for comparison of physical and chemical parameters of the control sample and a sample of cheese with vegetable fillers.

- determination of microbiological indicators

Determined to detect the content of toxic elements, mycotoxins, antibiotics, pesticides and radionuclides in samples

- determination of the vitamin composition

It is determined for comparison of the vitamin composition in the control sample and the sample enriched with plant components.

- determination of mineral composition

It is determined for comparison of the mineral composition in the control sample and the sample enriched with plant components.

- determination of the amino acid composition

It is determined for comparison of the amino acid composition in the control sample and the sample enriched with plant components.
4. Research results, discussion

The goal of optimizing the recipe is to identify a combination of ingredients that would allow you to achieve high taste characteristics and an attractive appearance of the product. The following recipe was used to prepare 1000 kg of Afelia feta brine with carrots, black sesame and milk thistle powder.

Table 1. Recipe for pickled feta cheese «Aphelia».

| Ingredients                                         | The amount of product excluding losses, kg by 1.2 kg | per 1 ton |
|-----------------------------------------------------|---------------------------------------------------|-----------|
| Cow’s milk                                          | 4 l                                               | 3333 1    |
| Goat’s milk                                         | 4 l                                               | 3333 1    |
| Calcium chloride solution 10%                       | 0.008 l                                           | 6.66 1    |
| Dry mesophilic-thermophilic starter culture farm    | 0.001                                             | 0.83  кг  |
| Liquid rennet (veal)                                | 0.0025                                            | 2.08 1    |
| Flour and milk Thistle                              | 0.009                                             | 7.5       |
| Carrot                                              | 0.009                                             | 7.5       |
| Black sesame                                        | 0.009                                             | 7.5       |
| TOTAL                                               | 8.0385                                            | 6698.07   |
| Brine:                                              |                                                   |           |
| medium-ground sea Salt                              | 12                                                | 1000      |
| Water                                               | 5.5 l                                             | 4583.31   |
| Calcium chloride 33%                                | 0.018 l                                           | 15.1      |
| White vinegar 3%                                    | 0.005 l                                           | 4.16 1    |
| YIELD                                               | 1.2                                               | 1000      |

The production of Afelia feta cheese consisted of the following operations:
- pasteurization, normalization;
- the preparation of ingredients;
- preparation of milk for cheese production, introduction of functional additives;
- clotting of the milk, obtaining and treatment of the clot;
- cheese forming;
- self-pressing and pressing of cheese;
- preparation of brine;
- cheese salting;
- cheese drying;
- maturation of cheese;
- packaging, labeling, transportation and storage of the product.

4.1. Determination of organoleptic parameters

Organoleptic indicators of the developed brine cheese were evaluated by employees of the departments of "food production Techniques and technologies" of the don state technical University and "Food technologies" of the don state agrarian University.

At the same time, we were guided by the scale of assessment of organoleptic indicators proposed by the industry standard. According to the scale, the product is evaluated on a 20-point system, including taste and smell-10 points, consistency-5 points, color-2 points, packaging and labeling-3 points. When evaluating the proposed products, points for packaging and labeling were not taken into account. The average evaluation results are shown in figure 2 [6].

Sample 1 – control, sample 2 – brine feta cheese "Afelia" with 1.5% plant components, sample 3 – pickled feta cheese "Afelia" with 0.5% plant components, sample 4 – the brine of feta cheese "Afelia" with 0.37% plant components. Samples 1 and 3 received the highest ratings.

![Figure 2. Organoleptic evaluation of feta brine cheese samples.](image-url)
Table 2. Organoleptic characteristics of the finished product.

| Indicator                  | Characteristic                                      | Sample 1                                      | Sample 3                                      |
|----------------------------|-----------------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Taste and smell            | sour-milk, salty                                   | sour-milk, salty, with a taste of added additives |
| Consistency and appearance| soft plastic, dense, slightly elastic, with no eyes and voids. | slightly brittle, crumbling, with a small number of eyes and voids of irregular shape, with the presence of additives. |
| Colour                     | cylinder, small cubes                               | cylinder, small cubes                         |

It was found that samples 2 and 4 are inferior to sample 3 in taste. Thus, sample 3 stands out from the others with a pleasant, more saturated sour-milk taste, with a taste of added additives, as well as color. For further research, sample 3 was selected with 0.5% addition of components, as it received the highest rating of organoleptic parameters.

4.2. Determination of physical and chemical parameters

In accordance with the goals and objectives of the research, the analysis of physical and chemical parameters of feta Afelia brine cheese was carried out. The research was conducted in the Rostov regional veterinary laboratory [7].

Table 3. Physical and chemical parameters of the finished product.

| Indicator                        | The norm of the product | Sample 1 | Sample 3 |
|----------------------------------|-------------------------|----------|----------|
| MF of fat not less, %            |                         | 42       | 43       |
| including vegetable fat, % not more |                     | 8        | 6.2      |
| mass fraction of moisture not less, % |                   | 55       | 55       |
| Mass fraction of sodium chloride not more than, % |               | 2.5      | 2.5      |
| Mass fraction of carrots, %      |                         | -        | 0.5      |
| Mass fraction of milk Thistle powder, % |              | -        | 0.5      |
| Mass fraction of black sesame oil, % |                    | -        | 0.5      |
| Active acidity, pH               |                         | 6.05     | 5.85     |
| Titratable acidity of oil plasma, °T |                      | 20       | 19       |

The mass fraction of additives is: feta cheese 0%, feta cheese "Aphelia" 0.5%. The fat phase contains milk fat from cow's and goat's milk. Afelia feta cheese also contains vegetable fats. Thus, the content of carrots, milk Thistle powder and black sesame was revealed in the sample of feta cheese "Aphelia", which increased the nutritional and biological value of the product, as well as its medicinal properties.

4.3. Determination of microbiological parameters

In accordance with the goals and objectives of the research, the microbiological indicators of feta Afelia brine cheese were analyzed. The research was conducted in the Rostov regional veterinary laboratory.
Table 4. Microbiological indicators of the finished product.

| The name of product     | QMAFAnM, CFU / cm³ (g), no more | Volume (mass) of the product, cm³ (g), which is not allowed | Pathogenic, including | Yeast (D), mold (P), CFU / cm (g), no more |
|-------------------------|---------------------------------|----------------------------------------------------------|----------------------|-----------------------------------------------|
| feta cheese             | -                               | 0.001                                                    | 25                   | -                                             |
| feta cheese Afelia      | -                               | 0.001                                                    | 25                   | -                                             |

The content of toxic elements, mycotoxins, antibiotics, pesticides, and radionuclides in feta Afelia brine cheese does not exceed the standards established by the regulatory legal acts of the Russian Federation [8]. Pickled feta cheese Afelia can be intended for direct consumption in food or for use in culinary purposes.

4.4. Study of vitamin composition

In accordance with the goals and objectives of the research, a vitamin analysis of feta Afelia brine cheese was performed. The research was conducted in the Rostov regional veterinary laboratory [9]. The vitamin composition of the developed product was determined for the final expected shelf life. The research results are shown in figure 3.

![Figure 3. Vitamin composition of the test product and control sample.](image)

Analyzing the data of the figure, it can be noted that the developed brine feta cheese "Afelia" differs from the control in quantitative composition. Vitamin C was not detected in the control, and the developed product contains it in the amount of 0.05-0.012 mg/100g. The vitamin content increased by 10-14% in the developed product compared to the control.

4.5. Mineral composition research

Studies of the mineral composition of brine feta cheese "Afelia" were conducted in the Rostov regional veterinary laboratory and are shown in figure 4 [10].
Analyzing the data in the figure, it can be noted that the content of micro- and macronutrients in the developed product increased in comparison with the control. The calcium content increased by 6.02%, and the potassium content by 20.69%. The amount of magnesium increased by 34.4%, iron by 27.23% and zinc by 19.86%. These indicators indicate that the developed product differs significantly from the control in quantitative composition. The biological value of a food product reflects its ability to meet the body's need for essential amino acids.

4.6. Research of amino acid composition

The amino acid composition of food products is currently determined exclusively by ion exchange chromatography. The research was conducted in the Rostov regional veterinary laboratory and is shown in figure 5 [11].

The analysis of the conducted studies showed that the developed product is rich in both quantitative and qualitative amino acid content. As can be seen from the figure, both the content of individual amino acids and their total amount in feta Afelia brine cheese is 1.06 times higher than in the control. For example: the content of L-form-isoleucine increased 1.5 times compared to the control (1.212 g / 100 g vs. 0.803 g / 100 g of the product); L-form-phenylalanine increased 1.31 times compared to the control g/100 g (0.887 g / 100 g vs. 0.675 g / 100 g of the product); L-form-glycine increased 2.28 times compared to the control (0.222 g / 100 g vs. 0.097 g / 100 g of the product); L-form-tyrosine increased 0.98 times compared to the control (0.675 g/100 g vs. 0.668 g/100 g of the product).

Thus, the results of the conducted research allow us to conclude that brine cheese has a high biological value and can be recommended for the treatment and prevention of various pathologies.

The energy value of a food product characterizes its digestible energy, that is, the share of the total energy of chemical bonds of proteins, fats and carbohydrates that can be released during biological oxidation and used to provide physiological functions of the body. The amount of this energy depends mainly on the degree of assimilation of the nutrients of this food product. The absorption of nutrients from animal products is higher than from plant products.
Table 5. Energy value of the produced product.

| Sample                          | by fat, kcal | by protein, kcal | by carbohydrates, kcal | Total  |
|---------------------------------|--------------|------------------|------------------------|--------|
| Feta Afelia brine cheese        | 20.45        | 7.2              | 5.2                    | 240.25 |
| Control sample                  | 20           | 7                | 5                      | 230    |

The nutritional value of a food product provides the most complete picture of all its useful properties, including energy and biological value. A measure of the nutritional value of a product is the integral score, which is a number of calculated values expressed as a percentage that characterize the degree of compliance of the evaluated product with an optimally balanced daily diet, taking into account the energy content and the most important quality indicators. The integral score is usually determined based on the mass of the product that provides 10% of the energy of the daily diet. Determining the integral score of food products significantly expands information about their chemical composition, helps to identify and quantify the advantages or disadvantages of individual food products. It is known that food substances are absorbed by the body in different ways. The digestibility of food components is affected by their form of connection in the product, the state of the human body, and many other factors, including the presence or absence of a number of vitamins [12]. The assessment of the degree of satisfaction of the daily requirement for nutrients (according to A. A. Pokrovsky) is presented in table 6 [13].

Table 6. The daily requirement of nutrients.

| Name of the component                  | Daily allowance | Pickled feta cheese «Afelia» | Degree of satisfaction, % |
|----------------------------------------|-----------------|-------------------------------|--------------------------|
| Water, l                               | 1800            | 56                            | 3.1                      |
| Protein, g                             | 85              | 7.2                           | 8.47                     |
| Carbohydrates                          | 76              | 5.2                           | 6.84                     |
| Fat, g                                 | 90              | 20.45                         | 22.72                    |
| **Mineral substances**                 |                 |                               |                          |
| Potassium, mg                          | 2500            | 78.17                         | 3.12                     |
| Calcium, g                             | 1000            | 524.61                        | 52.461                   |
| Magnesium, mg                          | 400             | 28.982                        | 7.24                     |
| Iron, g                                | 18              | 0.897                         | 4.98                     |
| Zinc, mg                               | 15              | 3.594                         | 23.96                    |
| **Vitamins**                           |                 |                               |                          |
| Vitamin B1 (thiamine), mg              | 1.6             | 0.167                         | 10.43                    |
| Vitamin B2 (riboflavin), mg            | 1.8             | 0.848                         | 47.1                     |
| Vitamin B3 (nicotinic acid), mg        | 20              | 1.113                         | 5.565                    |
| Vitamin C (ascorbic acid), mg          | 100             | 0.05                          | 0.05                     |
| Vitamin B5 (pantothenic acid), mg      | 5               | 0.969                         | 19.38                    |
| Vitamin B6 (pyridoxine), mg            | 2               | 0.425                         | 21.25                    |
| Vitamin B9 (folic acid), mcg           | 0.5             | 0.032                         | 6.4                      |
| Vitamin B12 (cyanocobalamin), mg       | 3               | 1.69                          | 56.3                     |
| Vitamin E (tocopherol), mg             | 10              | 0.184                         | 1.84                     |
| Vitamin A (retinol), mg                | 1               | 0.145                         | 14.5                     |
| **Essential amino acids**              |                 |                               |                          |
| Arginine, g                            | 6               | 0.489                         | 8.15                     |
| Valine, g                              | 4               | 1.074                         | 26.85                    |
| Histidine, g                           | 2               | 0.402                         | 20.1                     |
| Isoleucine, g                          | 5               | 1.212                         | 24.24                    |
| Leucine, g                             | 5               | 1.41                          | 28.2                     |
| Leasing                                | 5               | 1.224                         | 24.48                    |
| Methionine, g                          | 4               | 0.373                         | 9.325                    |
### Nonessential amino acid

| Amino Acid | Value (g) | Energy (kcal) |
|------------|-----------|---------------|
| Threonine, g | 3 | 0.645 | 21.5 |
| Phenylalanine, g | 4 | 0.887 | 22.17 |
| Alanine, g | 3 | 0.647 | 21.56 |
| Aspartic acid, g | 6 | 0.797 | 13.28 |
| Glycine, g | 2 | 0.222 | 11.1 |
| Glutamic acid, g | 16 | 2.462 | 15.38 |
| Proline, g | 5 | 1.385 | 27.7 |
| Serine, g | 3 | 1.178 | 39.26 |
| Tyrosine, g | 4 | 0.675 | 16.87 |

### 5. Summary and conclusions

As a result of the analysis, it can be concluded that the brine feta cheese "Aphelia" has a high energy, biological and nutritional value. The possibility of using carrots, black sesame, milk Thistle powder in the production of functional feta cheese product "Aphelia" in order to increase its nutritional and biological value is scientifically and experimentally justified.

The dependence of changes in the structural-mechanical and organoleptic characteristics of the product depending on the introduction of various concentrations of functional additives to the mass of the components of carrot -0.5%, black sesame -0.5%, milk Thistle powder - 0.5% by weight of the finished product was determined. The energy value of feta cheese "Aphelia" is 240 kcal, which means that the product has a good nutritional value and has a balanced composition. When developing the recipe for feta cheese "Aphelia", the optimal amount of plant components was determined, due to which the nutritional and biological values of the finished product increased. The added herbal components have medicinal properties. Thanks to this, feta cheese "Aphelia" can be used in the prevention of various diseases. Industrial testing of the developed technology was carried out in the conditions of LLC Semikarakorsky cheese factory in Semikarakorsk, Rostov region.

### Acknowledgement

This work was carried out under the grant of the Russian Science Foundation 19-76-10010, SSI NIIMMP. Grant sponsors were not directly involved in the development, analysis, or writing of this article.

### References

1. Drevin V E, Shipaeva T A and Komarova V I 2012 Use of plant components in the food industry *Food industry* 12 62-3
2. Solodova S V, Slozhenkina M I et al. 2020 Statistics of food quality as a factor in the dynamics of development of nutritionally dependent diseases in Russia *IOP Conference Series: Earth and Environmental Science* **548**(8) 82033
3. Babich M A, Korotkova A A, Hramova V N, Slozhenkina M I and Bikus D S 2020 Practical and scientific basis for development of fermented bioproduct with dietary properties *IOP Conference Series: Earth and Environmental Science* **548**(8) 82079
4. Gorlov I F, Slozhenkina M I et al. 2020 Analysis of cheese suitability of raw milk and quality of cheese products enriched *Izvestia of the lower Volga agrodiversity complex: Science and higher professional education* 3(59) 258-67
5. *Carrot* Retrieved from: https://vitamita.net/vitaminy/v-produktakh/vitaminy-v-morkovi.html
6. Kurkin V A and Zapesochnaya G G 2010 Milk Thistle spotted *Etching* 55-8
7. *Black sesame* Retrieved from: https://www.ayzdorov.ru/tvtravnik_kynyiit_cherniy.php
8. Artemova E N and Vasilenko Z V 2011 *Vegetable additives in food technology* (Orel: OrelSTU) p 211
9. Lamazhapova G P 2016 *Physiology of nutrition* (Moscow: World of science) p 146
10. Pokrovsky A A 1976 *Chemical composition of food products* (Moscow: Food industry) p 154