Development of soft cheese of functional orientation

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Abstract. Traditional soft cheese production technology is characterized by the use of one type of farm animal in the milk formulation. Introduction to the recipe of soft cheese made from raw cow's milk, a functional ingredient of spirulina (Spirulina plantesis), rich in water-soluble vitamins and essential amino acids, and dry mare's milk, which is close in its composition to mother's milk, allowed us to form a new functional food product. A technological feature of the production of soft cheese recipes of a functional orientation is determined by the addition of freeze dried mare's milk at the stage of forming a cheese clot and kneading the grain to preserve the whey protein albumin of mare's milk, which begins to coagulate at a temperature of +60°C, and adding spirulina powder, which creates an original patternby aggregating on cheese grains. According to the results of evaluating the organoleptic and physico-chemical parameters of the finished cheese, it is recommended to add 200g of spirulina. The resulting cheese is distinguished by the appearance of a delicate spicy taste with a refreshing mint flavor. There is an increase in the yield of cheese by 1.30-1.31% to 17.92-17.93% and reduced milk consumption for the production of 1 kg of cheese by 7.3%. In the samples of soft cheese produced with the addition of dry mare's milk and spirulina, the fat content is 0.1% lower, the protein content did not change significantly, while the ratio of albumin to casein improved and the content of lactose related to bifidogenic substances increased by 0.4%. The practical significance of introducing dry mare's milk into the formulation of soft cheese is defined by the extended application features of valuable dairy raw materials regardless of the places of development of dairy horse breeding.

Key words: milk, farm animal, spirulina, Spirulina plantesis, casein, albumin, soft cheese.

1 Introduction

The consumer market is actively forming a segment of food products that differ in their functional orientation, the effectiveness of which in, accordance with GOST R 5349-2009 "Food products. Functional food products. Terms and definitions",is defined as a set of characteristics or properties of a functional food product to reduce the risk of developing nutrition-related diseases and /or replenish, as well as prevent nutrient deficiencies, preserve and improve health. For food industry enterprises, the production of functional products is a diversification of production activities that allows them to improve their competitive positions and increase the efficiency of business processes, for retail enterprises–expanding and deepening the range, creating a new target audience and increasing sales, for consumers – meeting demand and improving the quality of life.

Currently, yoghurts, curd products and processed cheeses are most often enriched with natural ingredients from food products,for which milk serves as their main raw material. Cheese producers, which are among the most high-calorie and nutritious products due to the high concentration of easily digestible proteins and fats (digestibility of 95 and 96%, respectively), the presence of essential amino acids, calcium, phosphorus, salts and vitamins [1], along with the production of cheeses according to the classic recipe, develop new products with the addition of functional ingredients. Soft cheese production technology, non-maturing cheeses, such as Adyghe, Belarusian, and Krestyansky, are distinguished by their traditional recipe and allow the introduction of functional phytonutrients to impart distinctive (original) organoleptic characteristics and form new sensory characteristics. Thus, the addition of parsnip root and cumin seeds to the recipe of Adyghe cheese gives the cheese a pleasant taste and spicy aroma of cumin, contributes to the formation of an original pattern and bifidogenic properties due to dietary fibers, note [2]. Based on the results of research, a number of authors suggest expanding the range of soft cheeses and strengthening their functional orientation as a result of introducing valuable food ingredients into the recipe composition: rosehip fruit Rosa cinnamomea L. and brown seaweed Fucus vesiculosus with hydrolyzed collagen-containing raw materials obtained from cod skin [3], vanilla, cocoa, basil with dill, turmeric with seasoning for Korean carrots [4], white sesame [5], dried fruits, nuts and herbs [6], etc. It is important that the production of soft cheeses can be carried out at small and medium-sized businesses and existing dairy processing enterprises thanks to low capital intensity, short payback periods, features of the technological process

organization and reduced consumption of raw materials per unit of finished product.

Traditionally soft cheeses are produced from cow's milk, and goat's or sheep's milk or mixtures of farm animal milk are less commonly used [7]. By the content of dry matter, fat and protein in milk of different types of farm animals, sheep's milk is in the first place, followed by goat's, cow's and mare's milk, and by the content of milk sugar is mare's milk, sheep's, goat's and cow's milk. Cow's and goat's milk belong to the casein group with a casein content of up to 80% of all proteins, while donkey's and mare's milk contain up to 50% of casein. The high casein content contributes to the formation of a good cheese clot. Mare's milk is similar in chemical composition and biochemical properties to human breast milk and has unique antibiotic properties. A number of authors [8] suggest functional soft cheese technology based on three-component raw materials consisting of mare's, goat's and cow's raw milk with an optimal ratio (40:40:20) at pasteurization temperature from +72-75 °C. As rational modes of heat treatment, it is possible toapply a two-stage heat treatment of mare's milk, including thermization at +58°C with an exposure of 20 minutes and subsequent cooling to +6°C for 4 hours, then pasteurization at +72°C with an exposure of 15 seconds [9]. In our opinion, pasteurization of mare's milk or milk mixture at atemperature of +72 °C eliminates the value of mare's milk as a source of whey proteins as a result of their thermal stability, and to preserve the valuable qualities of mare's milk, it is proposed to implement freeze (lyophilized) drying as one of the high-tech methods of raw milk processing [10-15]. Currently, dry mare's milk is used in the production of encapsulated products: milk, koumiss and dietary supplements. At the same time, there is no information in the available literature about the use of freeze-dried mare's milk on an industrial basis in the production of soft cheese.

The presentation of a wide range line of soft cheeses with fillers is due to the consumer preferences of the population in the new taste characteristics of a traditional product of high quality, which is confirmed by the results of research conducted by a number of authors [3]: 13% of respondents prefer soft cheeses, of which 30% prefer food ingredients of marine origin, 28% prefer vegetable origin, 23% prefer legumes, nuts and bran, and 19% prefer animal origin, respectively. When choosing food products, notes [16], modern consumers pay attention to the so-called consumer quality and the price-quality ratio. In the Russian Federation, the consumption of seafood rich in nitrogenous substances and trace elements is uneven across regions and does not meet the established standards of 22 kg per capita according to the Strategy for the Development of the Fisheries Sector of the Russian Federation for the period up to 2030. In this regard, the use of water-based biological raw materials may be a promising direction in the production of soft cheese. Expansion of the range of soft cheeses is possible as a result of the use of not widely used dairy raw materials–mare's milk, which is close in its properties to mother's milk, and enrichment with a valuable aquatic biological raw material–spirulina (Spirulina plantesis). The purpose of the study is to evaluate the quality indicators of soft cheese with the functional additive spirulina, made from raw cow's milk with the addition of freeze-dried mare's milk. The choice of the object of the study is determined by the fact, that the soft cheeses are produced mainly from the most affordable dairy raw materials – cow's milk, and are presented without additives and by smoked cheese. The introduction into the formulation as a component of dry mare's milk was carried out to increase the nutritional value of cheese.

2 The purpose of the study

Providing full-fledged nutrition for different categories of consumers in accordance with the principles of healthy nutrition determines the need to develop functional food products. A distinctive technologicalfeature is the use of dry (freeze-dried) mare's milk, which eliminates the limited opportunities for using raw mare's milk, determined by the regional nature of the distribution of dairy horse breeding. The aim of the research was to evaluate quality indicators of the resulting soft cheese with a functional spirulina additive, made from raw cow's milk with the addition of freeze-dried mare's milk. Mare's milk belongs to the albumin group with a casein-to-albumin ratio of 1:1. Albumin from mare's milk is easily absorbed by the human body. It is used as a functional additive spirulina, it belongs to the class of filamentous blue-green algae and is one of thefamous ancient plants on the planet. Its taxonomic position is defined as: species Arthrospiraplatensis, genus Arthrospira, order Oscillatoriales, group Cyanobacteria, class Oxyphotobacteria, division Gracilicutes, domain Bacteria, kingdom Prokaryotae. Spirulina is a spiral-shaped microscopic cyanobacteria with a unique balanced biochemical composition and a high content of high-grade protein and beta-carotene. Spirulina promotes the formation of immunity as a result of the production of cytokines, eliminates the negative effects of free radicals, and has an anti-inflammatory effect. Spirulina is extracted both in the world's oceans and cultivated in specially equipped outdoor ponds or pools in greenhouses.

3 Materials and methods

The 5 groups of cheese samples have been formed: the control group (samples of soft cheese of the Adyghe type), 1st, 2nd, 3rd and 4th experimental groups (cheese developed from cow's milk with the introduction of 3 kg in the formulation of dry mare's milk, dried by the freeze-drying method proposed by authors [15], based on 300 liters of raw cow's milk with a fat content of 4.1%. In the formulation of the 2nd, 3rd and 4th experimental groups cheese added spirulina powder in the amount of 100g, 200g and 300g (trademark "SpirulinaFood", manufactured in China). Spirulina was studied according to generally accepted methods: chemical composition (protein by Kjeldahl, fat by Soxlet

method, fiber by Veende method, sugar by photocolometric method), amino acid composition and vitamin content – by high-performance liquid chromatography, carotene content – by photometric method. The mass fraction of moisture and dry matter in the finished soft cheese was determined by drying the sample
at (102±2) °C, mass fraction of protein by the Kjeldahl method, mass fraction of fat–by the acid method, acidity–as a result of neutralization of the acids contained in the product with a solution of sodium hydroxide in the presence of a phenolphthalein indicator. The quality assessment of the finished cheese was carried out according to organoleptic and physico-chemical parameters in accordance with the requirements of GOST 32263-2013 "Soft cheeses. Technical specifications". The studies were carried out in 5-fold repetition. The obtained experimental results were processed using standard statistical methods of analysis.

4 Discussion of the results

At the first stage of the experiment, the chemical composition of spirulina was studied: the mass fraction of dry matter was 93.78±0.02%, the content of crude protein was 58.76±0.02%, crude fat–1.32±0.02%, crude fiber–6.38±0.05%, crude ash–11.61±0.2%, sugars–13.97±0.04%. According to the content of water-soluble vitamins, the norms of physiological needs are fully covered in accordance with the Methodological Recommendations MR 21.3.1.0253-21"Norms of physiological requirements for energy and food substances for various groups of the population of the Russian Federation" (based on 100g of product): thiamine – 2.4 times, riboflavin–12.5 times, pyridoxine–5.5 times, nicotinic acid–2 times, carotene–more than 28 times and reaches 143.57±3.75 mg / 100g with a physiological requirement for adults of 5 mg per day. The content of ascorbic acid covers the daily requirement for vitamin for 1/3, beta-carotene–7-8% of the daily requirement. A high content of essential amino acids was found–56.5-58.8% of the total amino acid content.

The soft cheese production technology is traditional for Adyghe cheese. Freeze-dried mare's milk was added at the stage of forming a cheese clot and kneading the grain. This approach is due to the importance of preserving the valuable properties of mare's milk, since albumin begins to coagulate at temperatures from +60°C and, accordingly, it is undesirable to add mare's milk at the pasteurization stage. Dry mare's milk, partially absorbing moisture from the whey, turns into reconstituted mare's milk based on whey, enveloping the cheese grains; spirulina powder is aggregated on the cheese grains, creating an original pattern in the future. In Table 1 presents the main physical and chemical indicators of cheese.

Table 1. Physical and chemical parameters of soft cheese.

Indicators	Control	Experimental groups			
		1st	2nd	3rd	4th
Mass fraction of moisture, %	56.6±0.6	56.8±0.2	56.8±0.4	56.8±0.3	56.8±0.2
Mass fraction of sodium chloride, %	1.8±0.1	1.8±0.1	1.8±0.1	1.8±0.1	1.8±0.1
Cheese acidity, °T	54.6±0.7	52.8±0.5	52.8±0.7	52.8±0.8	52.9±0.6
Milk consumption per 1 kg of cheese, kg (in terms of dry mare's milk and raw milk)	6.02	5.58	5.58	5.58	5.58

The analysis of experimental data presented in Table 1 showed that when adding dry mare's milk, milk consumption per 1 kg of cheese decreases by 0.44 kg. The yield of cheese in the samples of the control group was 16.62±0.03%, in the 1st experimental group–17.92±0.04%, in the 2nd experimental group–17.92±0.03%, in the 3rd experimental group–17.93±0.02%, in the 4th experimental group–17.93±0.01%. Physical and chemical parameters of all samples meet the requirements of GOST 32263-2013.

At the second stage, an organoleptic assessment of cheese samples was carried out in accordance with GOST 32263-2013: according to appearance – in all samples, the cheese has no crust, the surface is wrinkled; by the consistency–in the samples of the control group is dense, elastic, in the samples of the experimental groups is dense, elastic, more tender; by the taste and smell in the samples of the control group is pure, characteristic of Adyghe cheese, in the samples of the 1st experimental group–a barely perceptible sweet aroma appeared, in the samples of the 2nd, 3rd and 4th experimental groups–an aroma similar to mint appeared; by thecolor–in the samples of the control group and the 1st experimental group groups – off white, in the samples of the 2nd and 3rd experimental groups–white with minor greenish inclusions, in the samples of the 4th experimental group–white with multiple greenish inclusions, which led to an intense green color of cheese. In the samples of the control group and the 1st experimental group, there is no drawing, in the samples of the 2nd, 3rd and 4th experimental groups, a drawing appeared in the form of green inclusions. Visualization of the cheese pattern in the 3rd experimental group is presented in Fig. 1.

Fig. 1. Appearance of the surface of the cheese of the 3rd experimental group.

Based on the results of the organoleptic assessment, it was found that the prototypes meet the requirements of GOST 32263-2013, the cheese pattern is most acceptable in the samples of the 3rd experimental group: spirulina inclusions are uniform on the surface and on the cheese section, unlike the samples of the 2nd experimental group, where rare inclusions are observed, in the samples of the 4th experimental group – veryfrequent inclusions.

At the subsequent stage, we investigated chemical composition of soft cheese samples, which are shown below in Table 2.

Table 2. Chemical composition of soft cheese, %.

Indicators	**Control**	**Experimental groups**			
		1st	**2nd**	**3rd**	**4th**
Fat	19.8± 0.2	19.7± 0.3	19.7± 0.2	19.7± 0.3	19.7± 0.3
Protein	19.7± 0.3	19.6± 0.4	19.6± 0.3	19.7± 0.3	19.7± 0.4
Carbohydrates	1.6± 0.1	2.0± 0.1	2.0± 0.1	2.0± 0.1	2.0± 0.2
Energy value, kcal	263.4	263.7	263.7	264.1	264.1

In cheese produced from cow's milk with the addition of dry mare's milk, an increase in the content of milk sugar by 0.4 % was found. The protein content decreases by 0.1 % in samples of the 1st and 2nd experimental groups, in samples of the 3rd and 4th experimental groups it is comparable to samples of the control group, which can be due to the addition of more protein-rich spirulina powder. In experimental samples of soft cheese, an increase in the content of the albumin fraction and a change in the ratio of casein to albumin from 6:1 to 5:1 were found.

Thus, as a result of the introduction of dry mare's milk into the formulation at the stage of forming a cheese clot, the lactose content increased, which performs an energy function and affects the normalization of calcium metabolism and the absorption of water-soluble B vitamins; increasing the content of the albumin fraction, a source of the essential tryptophan amino acid and easily absorbed by the human body; involvement in the technologicalprocess of whey with a residual content of lactose, minerals and vitamins. The consistency of this cheese is characterized by a more delicate and slightly smearing structure and a barely perceptible sweet note. Thanks to the enrichment of cheese with a functional additive of vegetable origin Spirulina plantesis a change in the taste characteristics of cheese, the appearance of a pleasant spicy taste and mint aroma, and a slight increase in the protein content in the samples of the 3rd and 4th experimental groups were revealed. In accordance with the conducted expert sensory assessment, the optimal amount of added spirulina was determined in the samples of the 3rd experimental group, which correspond to the high consumer advantages of soft cheese in aroma, taste and appearance.

5 Conclusion

Organoleptic and physico-chemical parameters of control and experimental samples of soft cheese meet the requirements of GOST 32263-2013. In the cheese made from cow's milk with the addition of dry mare's milk, an increase in the content of milk sugar related to bifidogenic substances by 0.4 % was found. The protein and fat content did not change significantly. The practical significance of the obtained research results is due to the fact that in the formulation is used cow's milk in raw form and freeze-dried mare's milk, which has a short shelf life in raw form, and which preserves the nutritional value of raw mare's milk, close to mother's milk. Accordingly, the possibility of using freeze-dried mare's milk in the production of soft cheese for industrial purposes has been established. The output of cheese has increased, while milk consumption per 1 kg of cheese has been reduced. Symbiotic use of functional ingredients of animal and vegetable origin (freeze-dried mare's milk and spirulina) has led to the formation of a valuable easily digestible human food product, enriched with macro-and micronutrients. The studies in this area require further research.

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