

Розроблено технологію плавленого сиру з використанням криопорошку «Амарант». Встановлено, що додавання криопорошку «Амарант» приводить до перерозподілу складових рецептури плавленого сиру. Також вивчено органолептичні та фізико-хімічні характеристики дослідних зразків плавленого сиру. При внесенні криопорошку «Амарант» у плавлені сири їх біологічна цінність зростає. Встановлено поліпшення якісних показників дослідних зразків порівняно з традиційними зразками

Ключові слова: сир плавлений, криопорошок, енергетична цінність, фізико-хімічні характеристики, біологічна цінність

Разработана технология плавленого сыра с использованием криопорошка «Амарант». Установлено, что добавление криопорошка «Амарант» приводит к перераспределению составляющих рецептуры плавленого сыра. Также изучены органолептические и физико-химические характеристики опытных образцов плавленого сыра. При внесении криопорошка «Амарант» в плавленые сыры их биологическая ценность росла. Установлено улучшение качественных показателей опытных образцов по сравнению с традиционными образцами

Ключевые слова: сыр плавленный, криопорошок, энергетическая ценность, физико-химические характеристики, биологическая ценность

1. Introduction

Treatment of diseases with medicinal plants has a very long history and has existed since the time the human civilization had been born [1]. The plants were practically the first raw materials for the preparation of drugs. Phyto therapy is characterized by soft, gradual, versatile action of biologically active components of certain medicinal plants on the human body without side negative effects [2]. Biologically active components of plants actively contribute to the normalization of the vital processes in the human body, improve metabolism, provide the body with the necessary vitamins, mineral substances [3].

The manufacture of a wide range of functional foods, including dairy products, dictates the need to search for the new sources of raw materials [4]. In addition, the adverse environmental situation necessitates the creation of products, including molten cheese, with plant fillers and bio supplements in the form of cryopowders [5].

The healing properties of medicinal plants are due to the presence of biologically active substances in them, including a variety of vitamins, micro-, macroelements, and various enzymes [6]. These substances are also contained in the cryopowders made from medicinal plants in significant quantities, and they positively influence the human organ-

ism. The relevance of the use of medicinal plants in the form of cryopowders has grown considerably over recent years [7]. Cryogenic technology makes it possible to effectively process plants while saving the maximally possible amount of biologically active substances in natural proportions. In this case, their concentration increases tenfold resulting in the enhanced level of their absorption by the body [8].

Introducing the cryopowders in proper combination as bio supplements to the “milk” base holds a great promise both in technological and social terms. Cryopowders based on medicinal plants are useful both for adults and children [9, 10].

Considering the above, we propose studying the possibility of using the cryopowder “Amaranth” as a phyto additive in the technology for producing molten cheese of functional purpose.

Thus, it appears relevant and timely to develop a technology for producing molten cheese using the cryopowder “Amaranth”, which would be of considerable social significance.

2. Literature review and problem statement

The task of providing people with rational and balanced nutrition is very important. Given today's ecological con-

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EFFECT OF THE CRYOPOWDER "AMARANTH" ON THE TECHNOLOGY OF MOLTEN CHEESE

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ditions, the diet of a human must include natural biologically active substances, which are capable of improving the resistance of the body [11, 12]. Over the past 10 years the industry of production and application of biologically active additives when manufacturing functional food products has been developing intensively [13]. Creation of new food products that, in contrast to traditional food, produce a targeted effect allows preventing and correcting the consequences of human diseases [15]. Production of dairy products has changed, as well as, accordingly, the needs and preferences of consumers for a such range of dairy products. That is why, when manufacturing dairy products, the role of fillers, both of animal and vegetable origin, is becoming more important. The main objective is to improve the biological, nutritional and technological value [16, 17].

Natural plant bio additives deserve special attention because, owing to their natural properties, they render functional properties to these dairy products [6]. The use of such additives makes it possible to replenish the deficiency of nutrients, to increase nonspecific resistance of the body to the effect of adverse environmental factors [18].

Full preservation of the quality of raw materials, including the content of BAS (bio active substances) and antioxidants, is ensured in the powders obtained by the sublimation drying. Cryogenic grinding of sublimated plant raw materials at temperatures of minus 10 °C and lower contributes not only to preserving, but also to enriching the powders from plant raw materials with vitamins, phenolic compounds with P-vitamin activity [19]. The cryopowders obtained by the cryogenic grinding are better, by 10–75 %, biologically enriched than the original plant raw materials. The content of useful substances, included in the cryopowders, is 6–10 times larger than that in the canned fruits or vegetables. Cryopowders considerably enhance the biological value of food products, as well as improve their chemical composition [7]. Addition the cryopowders to butter and margarine makes it possible to prolong the storage duration by almost 4.0 times [6]. These data allow us to recommend using cryopowders in the technologies for producing dairy products.

In terms of nutrition management, the prime role belongs to dairy products. This fully applies to cheese whose nutritional value is predetermined by the high concentration of dairy proteins and fat in it, the presence of essential amino acids, salts of calcium and phosphorus, which are necessary for the normal development of the human body. Cheese protein is easier to digest than the milk protein [4].

Many authors propose a wide range of dairy products with plant components, the application of which enables obtaining the products with assigned structure and quality indicators [5]. A technology was developed for producing functional concentrates from dried whey enriched with plant supplements [8, 11, 13].

We found reports that describe manufacturing of molten cheese and homemade cheese with a different mass fraction of fat with a variety of herbal spices [6, 16]. The application of phyto supplements of spirulina and elamine in the technology of molten cheese is proposed in [20]. The formulation of molten cheese “Ivano-Frankivsk spicy” is developed using plant bio supplements of spices “10 vegetables” and a mixture of spices “Curry” [6]. The formulations for both sweet and salt cottage cheese desserts with a treatment-prophylactic purpose that contain the cryopowder “Garbuz” are proposed for practical implementation [1]. The formulations for salt cottage cheese desserts with a functional purpose that

include the cryopowders “Morska kapusta” and “Broccoli” were also developed for large-scale production [6].

Thus, manufacturing molten cheese implies the development of formulations that include a polyfunctional supplement, specifically the cryopowder “Amaranth” made from the natural plant raw materials. The variety of properties of such powders may compromise the quality of a product. Given this, there is a necessity to study the properties of cryopowders with the aim of preparing further recommendations on their use in the production of molten cheese, and on the evaluation of their effect on the quality of the original raw materials [21].

An analysis of the scientific literature revealed [1, 2, 5] that the application of cryopowders based on plant raw materials in the food industry is rather limited, while there is no any information regarding the use of the cryopowder “Amaranth” in the technology of molten cheese.

3. The aim and objectives of the study

The aim of present study was to examine effect of the cryopowder “Amaranth” on the technology of molten cheese.

To accomplish the aim, the following tasks have been set:

- to substantiate the expediency of using the cryopowder “Amaranth” in the technology of molten cheese;
- to explore organoleptic indicators of the molten cheese prepared with the cryopowder “Amaranth”;
- to study basic physical-chemical indicators of the molten cheese prepared with the cryopowder “Amaranth”;
- to study the amino acid composition of the molten cheese prepared with the cryopowder “Amaranth”.

4. Material and methods of research

The experiments were conducted in the scientific laboratory of the Department of Technology of Milk and Dairy Products at the Stepan Gzhytskyi Lviv National University of Veterinary Medicine and Biotechnologies, Ukraine. The experiments were also performed under industrial conditions. In the course of research we used a unified bio additive, the cryopowder “Amaranth”, which was assigned and calculated based on the preventive-therapeutic dosage. The formulation of molten cheese was recalculated for industrial production, specifically, per 1,000 kg of the finished product.

Materials and methods applied in the course of present study are described in more detail in paper [22].

5. Results of research into using the cryopowder “Amaranth” in the technology of molten cheese

Based on the conducted research, we selected the best samples of molten cheese with different quantities of the cryopowder “Amaranth”.

Table 1 gives different types of formulations with the addition of different amounts of the cryopowder “Amaranth” (OOO “Center of cryogenic technologies”, Ukraine), and changes in the ratio of remaining components.

The highest organoleptic score was received by the second formulation whose composition contains (as calculated per 1,000 kg of the finished product): 360 kg of rennet cheese “Rossiyskiy”; 354 kg of cheese “Gollandskiy”; 24.6 kg of

the dry cow milk; 52.0 kg of butter “Selianske”, mixture of sodium tripolyphosphate and sodium pyrophosphate 102 kg; 102.8 kg of drinking water, and 24.6 kg of the cryopowder “Amaranth” (Table 2)

Table 1

Formulations for molten cheese with a cryopowder (calculated in kg per 1 ton)

No.	Name of raw materials of the components of the mixture	Formulation number		
		No. 1	No. 2	No. 3
1	Fine rennet cheese «Rossiyskiy»	360	360	360
2	Fine rennet cheese «Golandskiy»	354	354	354
3	Butter «Selianske» with MP AV 75 % MPF 72.5 %	52.0	52.0	52.0
4	Dry cow fat-free milk with MP AV 96 %	36.9	24.6	32.9
5	Cryopowder	12.3	24.6	16.3
6	Mixture of sodium tripolyphosphate and sodium pyrophosphate trisubstituted with MP AV 20 %	102.0	102.0	102.0
7	Drinking water	102.8	102.8	102.8
8	Total	1,020	1,020	1,020
9	Yield	1,000	1,000	1,000

Table 2

Recommended formulations of the molten cheese “Rossiyskiy” and the cheese with a cryopowder

No.	Raw materials for producing traditional molten cheese and the cheese with a cryopowder	Molten cheese	
		«Rossiyskiy»	with cryopowder
1	Cheese «Rossiyskiy»	360.0	360.0
2	Cheese «Golandskiy»	354.0	354.0
3	Dry cow fat-free milk (mp AV 96 %)	49.2	24.6
4	Mixture of sodium tripolyphosphate (mp AV 20 %)	102.0	102.0
5	Butter «Selianske» (mp AV 75 %, mpf 72.5 %)	52.0	52.0
6	Drinking water	102.8	102.8
7	Cryopowder «Amaranth»	–	24.6
8	Total	1,020	1,020
9	Yield	1,000	1,000

An extremely important role in the complex of overall assessment of dairy products is played by product-related and organoleptic properties of foods, since the physical ap-

pearance of cottage cheese desserts, consistency and flavor activate the receptors of organs of vision, smell of human; they trigger reactions that determine the willingness or unwillingness to eat cottage cheese desserts.

Organoleptic indicators of the molten cheese with a cryoaditive are given in Table 3.

Table 3

Organoleptic indicators of the molten cheese produced traditionally, and with a cryopowder

No.	Name of indicator	Traditional molten cheese «Rossiyskiy»	Molten cheese with a cryopowder
1	Taste and flavor	Strong cheesy, sourish	Nourishing, butter taste, clearly expressed
2	Consistency	Plastic, slightly elastic	Mild density, slightly elastic, external gloss
3	Dough color	From light-yellow to yellow	Light yellow, there are black-red inclusions of different size
4	View on the cut	Absence of drawing, hollows are acceptable	Dense mass without «eyes»
5	Physical appearance	Surface is clear, not dry, not moldy	Surface is clear, not dry, shiny

Organoleptic characteristics of molten cheese with the cryopowder “Amaranth” did not undergo significant changes and mostly complied with regulatory requirements. The examined samples of cheese preserve delicate, elastic consistency, have characteristic original taste and flavor (similar to butter). The examined samples had a homogeneous pattern on the cut, the dough color ranged from light-yellow to yellow, with separate inclusions of amaranth (black-red color). The surface of the examined samples was clean, shiny, which matches the standards.

According to regulatory requirements, all kinds of molten cheese manufactured by milk processing industry in Ukraine must conform to certain constants (titrated acidity, the mass fraction of moisture and fat, energy value). Physical-chemical indicators of the examined samples of molten cheese with a cryopowder are given in Table 4.

An analysis of the data in Table 4 indicates that the addition of a cryopowder affects to a certain degree the physical-chemical characteristics as well. Thus, the examined samples of cheese were packed both in a traditional shape (sticks) and in the form of circles. The mass of the examined samples of cheese was within 100 g. Thus, the mass fraction of fat in the dry substance is 43 %, whereas in the base product it is 45 %. All the examined samples of cheese were characterized by approximated magnitudes of mass fraction of moisture to the base product where it was, respectively, 46 against 50 %. The content of salt in the examined samples was 1.4 against 2.0 % in the base product. In addition, pH of the examined samples of molten cheese with a cryopowder was 5.6, which matches regulatory requirements.

For the comprehensive evaluation of dairy products, including molten cheese, an important assessment is the char-

acteristic of its biological value, the amino acid composition of products.

Table 4

Physical-chemical indicators of the molten cheese “Rossiyskiy” and the molten cheese with the cryopowder “Amaranth”

No.	Name of cheese	Content, %			pH of cheese	Shape and mass, g
		fat in dry substance	mois- ture, not less than	salt, not less than		
1	Regulatory require- ments to the molten cheese «Rossiys- kiy»	45	50	2.0	5.6–5.7	a stick with a mass of 100 g
2	Molten cheese with the cryopowder «Ama- ranth»	43	46	1.4	5.6	a stick with a mass of 100 g, circles with a mass of 100 g

Given the high content of protein in amaranth, it was important to investigate nutritional and biological value of the protein component of the molten cheese “Rossiyskiy” with the addition of cryopowder from amaranth. For this purpose, we studied the amino acid composition of the natural and combined sample of a given cheese (Table 5).

Adding the cryopowder from amaranth to the molten cheese “Rossiyskiy” in the ratio of 2.46 g per 1 kg of the product led to an increase in both the total amount (2.26 %) and the sum of essential (2.02 %) and nonessential (2.40 %) amino acids. At the same time, the structure of these amino acids underwent redistribution of the concentrations of a certain number of acids. Specifically, among the essential amino acids, the content of valine (3.34 %), methionine (8.94 %), lysine (4.16 %) increased more actively, with a slightly less growth of threonine (2.01 %), isoleucine(1.86 %) and tryptophan (1.66 %).

More noticeable changes were observed among the nonessential amino acids. The concentration of glycine increased most significantly (27.27 %), slightly less for cystine (9.30 %), glutamic acid (4.62 %), arginine (4.70 %), even less for aspartic acid (2.47 %), alanine (2.89 %). At the same time, as compared to the natural sample, there were no any noticeable changes in the content of serine, proline, tyrosine, histidine.

The growth in the content of the specified amino acids contained in the composition of proteins of the human organism affects vital functions of the human body.

Amino acids with a branched chain, specifically valine, isoleucine and leucine, which compose 70 % of amino acids of muscles, support a three-dimensional structure of proteins. In the liver, valine turns into glucose, which is used by muscles as an additional source of energy. Valine is used for the synthesis of vitamin B₃, it regulates the level of sugar in blood, enables the absorption of other amino acids, removing toxic nitrogenous compounds that are formed in the liver from the body.

Table 5

Amino acid content in the examined samples of molten cheese

Amino acids	Samples of molten cheese			
	Rossiyskiy		with cryopowder	
	g/kg of product	g/100 g of protein	g/kg of product	g/100 g of protein
Essential amino acids				
Threonine	8.289	3.96	8.465	3.95
Valine	12.076	5.76	12.173	5.68
Methionine	4.999	2.38	5.446	2.54
Isoleucine	8.298	3.96	8.452	3.94
Leucine	18.196	8.68	18.346	8.56
Phenylalanine	8.298	3.96	8.277	3.86
Lysine	11.098	5.29	11.560	5.39
Tryptophan	4.999	2.38	5.082	2.37
Total	76.262	36.57	77.807	36.29
Nonessential amino acids				
Aspartic acid	14.997	7.15	15.367	7.17
Serine	26.995	12.87	26.757	12.48
Glutamic acid	35.043	16.71	36.664	17.098
Proline	21.196	10.11	20.992	9.79
Glycine	2.999	1.43	3.817	1.78
Alanine	4.499	2.15	4.629	2.16
Cystine	1.699	0.81	2.080	0.97
Tyrosine	9398	4.48	9.504	4.43
Histamine	11.298	5.39	11.268	5.25
Arginine	5.299	2.53	5.548	2.59
Total	133.423	63.63	136.626	63.71
Total	209.685	100.0	214.433	100.0

The sulfur-containing amino acids methionine and cystine are part of the body’s proteins and biologically active peptides, hormones, enzymes. They are the source for the formation of sulfuric acid, which is created by the so-called paired compounds in order to dispose of the toxic products that appear from the products of decomposition of proteins in the intestines. The sulfur-containing amino acids give rise to the compound taurine, which plays an important role in the processes of digestion and absorption of lipids as one of the main components of bile. Taurine is important for a heart muscle, it participates in the removal of toxic chemicals from the body and is used for the synthesis of many amino acids.

It is important to note that the ratio of the amount of essential and nonessential amino acids did not change, which is important for the digestion and utilization of protein in the human body.

Thus, we can conclude that the use of a cryopowder from amaranth in the production of molten cheese “Rossiyskiy” makes it possible to improve its nutritional and biological value of the protein component.

6. Discussion of results of using the cryopowder “Amaranth” in the technology of molten cheese

The disadvantage of using artificial products and products obtained with the application of artificial additives is low digestibility and negative impact on the health of people. It was established that daily consumption of ready-made products produced industrially, obtained with the use of certain kinds of food additives and artificial components, may pose a threat to human health, cause allergies and other diseases.

An important factor in resolving the task on the protection of people from the elevated content of heavy metals, radionuclides, harmful industrial waste is the creation of medical-prophylactic foods by modern food sector [1, 6]. Almost all of these products represent complex systems with the common internal structure and general physical-chemical properties.

One of the ways in the development of technologies for manufacturing such products is the search for innovative technological techniques that make it possible to completely eliminate the need for using food additives and synthetic components during their production and thus obtain products of high quality.

Combined dairy-plant products, including molten cheese, enriched with natural plant supplements, can be related to food with a health-care effect.

One of the effective techniques to provide people with the necessary amount of biologically active substances is the creation of functional products with the addition of plant raw materials, which are a source of vitamins, food fibers, macro- and microelements. Special attention among the means of individual protection from the accumulation of toxic substances in the body is paid to the compounds, which would have the radioprotective properties. Thus, it is very promising to use natural bio supplements, herbal substances, without side effects on the body. Cryopowders are among such nutritional substances [16, 19].

The use of cryopowders with dairy products makes it possible to extend the range of such products with numerous useful properties. It also enables acquiring the new ratios, improving treatment and preventive effect of these locally available products. Several authors indicate the expediency of using cryopowders for medical and prophylactic products for all levels of society [1, 15]. Among them are those that have already won the recognition, specifically the cryopowders “Blueberry”, “Jerusalem artichoke”, “Chokeberry”, “Cabbage Broccoli”, “Celery”, “Laminaria”, “Pumpkin” and many others [19]. Given such a diversity of cryopowders, we are very much interested in the cryopowder “Amaranth”.

It is known that molten cheese is very popular among people of all countries of the world. This is linked to their good taste characteristics, nutritional value and a simple

production technology. They are a valuable source of important functional nutrients for the human body, such as high-grade proteins, essential amino acids, lipids, mineral substances, vitamins of group B, and others. However, they are characterized by the low content of biologically active substances. Molten cheese, produced using the cryopowder “Amaranth”, combines traditional consumer properties with functional and technological ingredients of plant origin. It was established that the examined samples of molten cheese preserve delicate, elastic consistency; they have a distinctive original taste and flavor (similar to butter).

Thus, the application of the cryopowder “Amaranth” in the technology of molten cheese allows enriching it with vitamins, mineral substances, and food fibers. It is known that cryopowders from edible plant raw materials contain a wide range of carbohydrates, pectin substances, as well as vitamins, amino acids, cellulose, polyphenol compounds [7].

Adding pectin substances as fillers prevents the deposition of proteins during heat treatment. Pectin improves stability of milk jelly and protects from whey separation. It positively impacts both the consistency of molten cheese and high stability at low values of pH [1].

Adding the cryopowder “Amaranth” to the cottage cheese desserts, along with treatment and preventive action, leads to the growth in energy value. A complex set of chemical and biochemical compounds, which are part of the cryopowder “Amaranth”, allows us to associate it with products that have a wide range of medical-prophylactic and radioprotection properties [21]. At the same time, it should be noted that the introduction of a food supplement to molten cheese contributes to the improvement of biological value, as evidenced by the positive redistribution of useful amino acids in the examined samples. It is also necessary to emphasize the expediency of using cryopowders, which have a high content of vitamins, mineral substances, food fibers, in the food industry.

7. Conclusions

1. We substantiated the expediency of using the cryopowder “Amaranth” in the technology of molten cheese. The cryopowder “Amaranth” contains necessary vitamins and microelements of natural origin. A given bio additive possesses therapeutic and preventive properties and enriches molten cheese with many nutrients. We studied the possibility of using the cryopowder “Amaranth” as a component of treatment-and-prophylactic molten cheese. The main factors for adding the cryopowder “Amaranth” are the normative organoleptic evaluation of the product and the daily need in its consumption.

2. When examining the organoleptic indicators of molten cheese produced using the cryopowder “Amaranth”, the light yellow color of the examined samples was established. We observed red-and-black-colored inclusions of different size. The samples had a rich flavor, and the taste of butter. The consistency was dense enough, slightly elastic, there was gloss on the surface.

3. Studying the effect of cryopowder “Amaranth” on the physical-chemical and biological quality indicators of molten cheese allowed us to establish the improvement in qualitative indicators of the examined samples as compared

to traditional samples. The molten cheese, produced with the use of cryopowder “Amaranth”, had attractive physical appearance.

4. The identified changes in the amino-acid composition of molten cheese indicate that the use of cryopowder from

amaranth when producing the molten cheese “Rossiyskiy” makes it possible to improve its food and biological value of the protein component. Specifically, we established an increase in the amount of essential (2.02 %) and nonessential (2.40 %) amino acids.

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