Design of a dry specialized dairy product and study of its physiology effect on the body

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Abstract. This article is devoted to the development of a dry specialized dairy product. This specialized dairy product will be made from organic raw materials. There are also some descriptions about effects of the ingredients on the human and animal physiology. The developed product must have the following requirements: it belongs to the group of organic products, i.e., produced from organic raw materials; have increased nutritional value, resistance to long-term storage, good transportability, high organoleptic and physico-chemical indicators, meet other quality and safety indicators. The product is made with the innovative technology based on powdered milk and high–fat cream has such requirements. Those facilitate of increased nutritional value and storage capacity. The product is produced by the gentlest method - the freeze-drying method. This method of production can be used when you need to preserve all the useful and native properties of the finished product. The specialized product of a dry creamy vegetable spread with high nutritional value and long-term storage (up to 24 months) and its technology will be obtained. The results of the research were carried out at the of the Omsk State Agrarian University and the Omsk Region Budgetary Institution "Omsk Regional Veterinary Laboratory".
Keywords. healthy food, spread, dihydroquercetin, polyunsaturated fatty acid, vitamin C.

1. Introduction

Healthy food is a high urgent problem. We need to create a product not only of high biological and nutritional value, but also with a long shelf life. That is relevant for those regions of Russia and other countries where there is a shortage of foods with high nutritional value and healthy, especially in regions with extreme conditions of life. This also

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has an important role for those people who need the special dietary nutrition during their activities with high tension and high reserve capabilities of their organism.

In addition, modern food production should solve the problem of satisfying a person with the necessary nutrients and energy, and maintain the health of the body. In the modern world, technologies are aimed at saving raw materials, increasing the output of finished products, expanding the assortment, which often leads to a decrease in the quality of the product. This trend makes it possible to provide the population with food. An urgent issue remains – the preservation of human health. More than 70% of the world's population takes care of their health, monitors their diet. In this regard, products made from environmentally friendly natural organic raw materials, including specialized dairy products with functional properties, are popular and in demand. In this regard, our research is being conducted at the Omsk State Agrarian University to develop a technology for dry creamy vegetable spread.

The development of spread production technologies is a promising direction for the development of the food industry. This is due to the fact that the fat base of the spread contains vegetable oils and fats along with milk fat, which allows not only to reduce the cost of spreads by saving dairy raw materials, but also to increase their nutritional value and biological efficiency as a result of an increase in the content of mono- and polyunsaturated fatty acids, sterols, fat-soluble vitamins and lowering cholesterol and saturated fatty acids [1, 2]. Among the many fatty acids that make up the basis of lipids, only two are indispensable - linoleic and linolenic which are cannot be synthesized in the body. Lack of these fatty acids can be cause diseases. Therefore, it is necessary to maintain an optimal balance between polyunsaturated fatty acids - omega-3 and omega-6. the content of phospholipids; the content of fat-soluble vitamins, including antioxidant orientation; restriction on the content of trans -isomers of fatty acids and cholesterol [3, 4].

Increasing the shelf life due to the use of antioxidants is also a priority in the development of the food industry. In this regard, it is relevant to increase the resistance to oxidation of fat systems. The use of antioxidants of natural origin based on local medicinal and technical raw materials makes it possible to increase the stability of the fat phase of the spread to oxidation and, as a result, increase the shelf life [5].

The purpose of this research is to develop and study the technology of a creamy vegetable spread with antioxidant properties.

2. Materials and Methods

The development of the technological process for the production of dry creamy vegetable spread in a freeze-dried form of long-term storage and increased nutritional value consists in selecting the optimal dosage and type of natural antioxidants, stabilizing the product during long-term storage [5, 6]. Also, there are made the replacing part of dairy animal fat with its substitutes of vegetable origin, using natural antioxidants of bioflavoid and amino acid forms, enriching raw materials with Bifidobacterium and vitamins. The product is packed in a sealed package based on metallized foil under vacuum in order to exclude hydrolytic and oxidative processes and to increase the durability of the product.

Research of the freshly processed product was carried out in an accredited laboratory of the Omsk Region Budgetary Institution "Omsk Regional Veterinary Laboratory" according to quality and safety indicators. The results were processed by the method of systematic statistics. The research was also carried out at the Federal Research Center for Fundamental and Translational Medicine (FITC FTM) of Novosibirsk. Drying of the product was carried out on a freeze dryer "LP 30 (SXX)" (brand), with a capacity of 16 kg per day, up to a residual moisture content (4 ± 2)% [7].

The regulatory documentation (Technological Instructions and Technical Conditions) will be developed for a new specialized product in freeze-dried form as a result of the present research.

3. Results

The following studies were conducted:

1. to finding the type and dosage of flavonoid and amino acid antioxidants for use in the formulation in order to stabilize the product during long-term storage,

2. Bioflavonoids such as quercetin, dihydroquercetin, as well as amino acids as inhibitors of oxidative processes were studied: cystine, cysteine, methionine, etc. As well as dosages (0.2–0.3) % to fat kilograms of the product were studied. Vitamin "C" was used as a synergist. Antioxidant effects of amino acids are presented in Table 1 [8].

Table 1. Antioxidant effects of amino acids

Experimental number	Amino acid	Antioxidant effect, units.		
		Application dosages, %		
		0.1	0.2	0.3
1	Lysine	2.18 ± 0.12	2.28 ± 0.13	2.32 ± 0.13
2	Tryptophan	2.42 ±0.14	2.50 ± 0.16	2.52 ± 0.16
3	Methionine	4.42 ± 0.18	4.58 ± 0.20	4.61 ± 0.21
4	Cysteine	5.05 ± 0.24	5.20 ± 0.27	5.20 ± 0.28

Source: «Compiled by the authors»

The optimally necessary for inclusion in the recipe of the product, as a percentage of the fat kilograms of the product: Dihydroquercetin 0.2% + vitamin "C" 0.02% and cysteine 0.2% + vitamin "C" 0.02%. These types of antioxidant complexes were used for inclusion in the recipe as additives to increase the durability of the product in storage.

Studies were conducted to replace part of animal milk fat with its substitutes of vegetable origin, rich in essential fatty acids, including ω 3 and ω 6 to increase the nutritional value of the product. Milk fat substitutes of the Soyuz-71, Soyuz-52 brands, manufactured by Soyuz LLC, and also various modifications of fats "Ecolact", produced by LLC and Efko-Ingredient were observed. The fatty acid composition of these vegetable fats is presented in Table 2.

Table 2. Composition of fatty acids of some milk fat substitutes

Experimental number	Mass fat fraction, %				The amount of fatty acids, %		Calculated Ratio ω-6 : ω-3
	«Ecolact»	«Molochny»	«Soyuz 71»	«Soyuz 52»	linoleic	linolenic	
1	50	50	–	–	6.300	0.970	7.0 :1.0
2	30	70	–	–	5.030	1.200	2.5 : 1.0
3	–	50	50	–	13.569	4.640	2.9 : 1.0
4	–	70	30	–	9.630	3.400	2.8 : 1.0
5	–	50	–	50	6.895	5.405	1.3 : 1.0
6	–	70	–	30	5.377	3.882	1.3 : 1.0

Source: «Compiled by the authors»

There was selected the "Ecolact" for further research as a result of studies of the fatty acid composition and the ratio of ω 3: ω 6 of various milk fat substitutes and based on the ratio of essential fatty acids. This type of natural milk fat substitute made from sunflower seeds. Dry milk-containing product of a creamy vegetable spread in a freeze-dried form

was produced. The results of the fatty acid composition of the product are presented in Table 3.

Table 3. Fatty acid composition of the creamy vegetable spread in freeze-dried form

№	Indicator	Amount, %
1	Arachic acid	0.2
2	Begenic acid	less than 0.1
3	Decenic acid	0.3
4	Caprylic acid	1.2 ± 0.4
5	Capric acid	2.9 ± 0.4
6	Kapronic acid	1.9 ± 0.4
7	Lauric acid	3.2 ± 0.4
8	Linoleic acid	3.3 ± 0.4
9	Linolenic acid	0.4
10	Butyric acid	2.6 ± 0.4
11	Myristic acid	10.8 ± 2.2
12	Myristoleic acid	0.9 ± 0.4
13	Oleic acid	25.8 ± 2.2
14	Palmitic acid	29.9 ± 2.2
15	Palmitoleic acid	1.7 ± 0.4
16	Stearic acid	11.0 ± 2.2
17	Other acids	3.9 ± 0.4

Source: «Compiled by the authors»

From the table data it can be seen that the ratio of essential fatty acids ω3: ω6 tends to a ratio of 10:1, which shows the high nutritional value of the product and corresponds to the formula of a healthy diet [9].

The developed product has been tested in the Budgetary institution of the Omsk region "Omsk Regional Veterinary Laboratory" according to the quality and safety indicators (Table 4 and 5) [10-18].

Table 4. The result of testing samples of dry high-fat milk-containing product (spread) in freeze-dried form

№	Indicator	Amount, %
1	The ratio of methyl esters of fatty acids of milk fat stearic to lauric	3.4 ± 0.4
2	The ratio of the mass fractions of the sum of oleic and linoleic to the sum of lauric, myristic, palmitic and stearic	0.5
3	The ratio of methyl esters of fatty acids of milk fat linoleic to myristic	0.3
4	The ratio of methyl esters of fatty acids of milk fat oleic to myristic	2.4 ± 0.4
5	The ratio of methyl esters of fatty acids of milk fat palmitic to lauric	9.3 ± 2.2

Source: «Compiled by the authors»

Table 5. Test results of dry spread safety indicators

№	Indicator	Units of measurement	Test result
Antibiotics (amphenicols)			
1	Levomycetin (Chloramphenicol)	mg/kg	less than 0,000012
Toxic elements			
2	Cadmium	mg/kg	less than 0,0015
3	Arsenic	mg/kg	less than 0,04
4	Mercury	mg/kg	less than 0,004
5	Lead	mg/kg	less than 0,01
Mycotoxins			
6	Aflatoxin M1	mg/kg	less than 0,0005
Pesticides			
7	Hexachlorocyclohexane (α, β, γ- isomers)	mg/kg	less than 0,005
8	Dichlorodiphenyltrichloroethane and its metabolites	mg/kg	less than 0,005
Microbiological indicators			
9	S. aureus	g	not found in 0,1
10	E. coli group bacteria (coliforms)	g	not found in 0,01
11	Yeast and mold (total number)	CFU /sm^3	less than $1,0x10^{-1}$
12	Number of mesophilic aerobic and facultative anaerobic microorganisms	CFU /g	$3,6x10^{-1}$
13	Pathogenic microorganisms, including Salmonella	g	not found in 25

Source: «Compiled by the authors»

4. Discussion

The development of a food product with polyunsaturated fatty acids, antioxidants (dihydroquercitin and vitamin C), is a successful compound for improving the qualities and storage capacity. In addition, the great advantage of this product is that it has significant benefits for the human body [20]. That is important for people who are in extreme conditions of life, where the involvement of their reserve and adaptive capabilities is required to the highest degree. After all, the fact that polyunsaturated fatty acids have immunoregulatory, hypocholesterolemic, hypotriglyceridemic, antiatherogenic, antithrombogenic, vasodilating (hypotensive), anti-inflammatory, antiarrhythmic, cardioprotective effects is crucial in choosing the most suitable components for the development of functional products. In addition, dihydroquercitin, which has an antioxidant and anti-inflammatory effect, promotes the destruction of cancer cells, controls blood sugar levels and helps prevent heart disease. Its importance is high in that it provides the necessary protection of critical brain and nerve cells, which is especially important at high mental loads [19, 20]. Dihydroquercetin has been found to help vitamin C circulate throughout the body. In addition, it limits the inactivation or oxidation of vitamin C, which allows vitamin C to last longer in the body. Dihydroquercitin creates a new way of delivering vitamin C to cells in need of its protection. Long-term use of dihydroquercitin (more than 72 days) against the background of stress of the body helps to maintain blood parameters at a physiological level [20]. The omega-6 and omega-3 help the body maintain homeostasis under stressful influences and increase its adaptive capabilities with its prolonged use.

The scheme of the technological process for obtaining a freeze-dried product resistant to long-term storage, with increased nutritional value for specialized purposes, based on the results of our research, analysis and information on the components of the product was developed.

5. Conclusion

1. An innovative technology has been developed for obtaining a high-fat product (creamy vegetable spread) in a freeze-dried form, increased nutritional value and storage capacity for specialized purposes.

2. The types and dosages of natural antioxidants have been established to stabilize the product in long-term storage: bioflavonoid dihydroquercitin and the amino acid cysteine; the dose of 0.2% to the fat-acidograms of the product.

3. Antioxidant complexes have been developed to extend the shelf life: dihydroquercetin 0.2% + vitamin "C" 0.02% cysteine 0.2% + vitamin "C" 0.02% to the fat-acidograms of the product.

4. It is necessary to replace part of the unstable animal milk fat with substitutes of vegetable origin rich in unsaturated fatty acids in order to increase the nutritional value and prolong the shelf life. For example, to use the "Ecolact" made from natural vegetable raw materials, produced by "Efko – Ingredient" LLC.

5. It is recommended to introduce a consortium of bifidobacteria and vitamin "C" in a concentration of 0.02% to fat to increase the nutritional value of the product.

6. The drying of the product is carried out by sublimation to preserve the vitamin composition and nutritional value.

7. The developed product is recommended for regions with limited resources of natural dairy raw materials, solving nutrition problems, the Arctic zone of the Russian Federation, people in autonomous conditions of existence.

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