

The use of biologically active components of plant and animal origin

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Abstract. Preserving health, as well as increasing country population life expectancy, are priority directions of Russian Federation state policy. Human health mainly depends on the usefulness and balance of the nutrition. Ecological factors are the same important, which necessitates increase in the volume and assortment of food products with bifidogenic properties, introduced by phytocomponents of functional purpose systems. The use of natural origin biologically active substances, the source of which are plants, is a promising direction for expanding the range of functional fermented milk products. The research objective is a development of technology for herodietic food product with the addition of a symbiotic microorganism consortium, as well as the introduction of phytocomponent modules *Amelanchier rotundifolia*. The work was performed at the Department of Engineering and Technology of Food Production FGBOUVPO «Don State Technical University», Rostov-on-Don. The objects of research were irgi phyto-extract (*Amelanchier*), cheese whey, raw cow's milk, developed product. The functional significance of the irgi phyto-extract, as one of the necessary and significant components in the production of specialized products for herodietetic nutrition, is technically justified and experimentally proved.

1 Introduction

Nutrition is one of the most important factors mediating a person's connection with the environment and having a decisive influence on health, working capacity, and the human body's resistance to environmentally harmful factors of production and the environment. Special meaning for maintaining human health, health and active longevity has a full value and regular supply of the body with all the necessary substances. It should act regularly, in full set and quantities [3, 9, 10, 15].

In most of countries, including Russia, soft drink of a functional direction defined for any consumer population and used to enrich the human body with biologically active substances [11, 14].

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Currently, dairy products are increasingly used in nutrition as a preventive measure. Expanding the functional products range allows controlling the process of the intake of biologically active substances in the human body, thereby influencing the nutritional status, and provides the market with the necessary products [1, 6, 8].

The most promising basis for creating functional foods are whey-based drinks, since the use of secondary dairy raw materials, which are formed in large quantities during the production of cottage cheese, cheese and casein, helps to increase its nutritional value and reduce the cost of finished products [2, 7, 13].

Of great interest is the possibility of expanding the range and adjusting the biological drinks value using whey by adding plant extracts, which contain certain concentrations of biologically active substances that prevent the occurrence of various pathological conditions of the body, to the formulations [4, 5, 12].

In this case, the aim of the research was to develop a technology for the herodietic food product with the addition of a symbiotic microorganism consortium, as well as the irgi phyto-components modules introduction (*Amelanchier rotundifolia*). The irgi phyto-extract (*Amelanchier*) was chosen for its biological value, balanced composition of macro- and micronutrients, low calorie content and high content of functional modules. The developed technology of the herodietic product is relevant, as it will allow to get specialized food product that is not presented on the domestic market, to adjust the nutritional status and prevent pathological conditions for the elderly people by adding vitamins of groups B, A, C, P, as well as micro and macro elements, amino acids, tannins and pectins, to the digestive system.

2 Materials and Methods

The studies were carried out in food products biochemical and spectral analysis laboratory of Food Production Technologies Department, FGBOUVPO «DSTU».

The main objects of research in this work were irgi phyto-extract (*Amelanchier*), cheese whey (lyophilic concentrate of strains), raw cow milk (LLC «Aksay milk Plus»), complex of dry probiotic microorganisms «EVITALIA» (LLC «PPF «Probiotic»), end-product.

The research methodology included the irgi phyto-extract production. Ripe berries were used to make irgi phyto-extract: round navy blue berries, by diameter up to 10 mm, with no damage or dents. The berry raw materials were thoroughly inspected and sorted. Then it was blanched with distilled water brought to a boiling point, for the purpose of short-term contact berries' surface sterilization of to comply with the septic tank requirements. Next, the berry raw was chopped. To speed up the process and improve the homogeneous mass yield, distilled water was added from the ratio of two parts of berries to one part of water. The next stage was filtering the resulting homogeneous mixture to separate large insoluble parts of the berries from the liquid phyto-concentrate. Obtaining this concentrate without insoluble impurities is necessary for many laboratory studies quality. The resulting phyto-concentrate liquor was subjected to thermal pasteurization ($t=72-74^{\circ}\text{C}$). After this operation, the phyto-concentrate can be considered suitable for further use in the production of herodietic nutrition specialized foods.

3 Results

The calculation of irgi extract energy value was conducted. According to the results of studies, it was found that the irgi extract energy value is 17,64 kcal/100g or 73,81 kJ/100g accordingly. Biologically active phyto-extract has a low energy value and can be recommended as a functional ingredient in the specialized foods production, including

overweight people, etc. The physicochemical parameters of the irgi extract were studied by capillary electrophoresis on a device «KAPEL 105M» (Table 1).

Table 1. Physico-chemical characteristics of the irgi extract.

Name of research	Research methodology	The actual value of indicators according to research
Moisture content, %	GOST 28561-90	97.5±0.71
Mass fraction of raw ash, %	GOST 15113.8-77	0.089±0.007
Mass fraction of protein, %	GOST 26889-86	0.7
Mass fraction of fat, %	GOST 26183-84	1.6±0.8

As a result of phytoextract irgi nutritional value studies, there was established its high functional significance. The data of physical and chemical parameters confirm previous studies of energy value and indicate a low calorie content of the ingredient.

The next stage of work was the development of herodietic food product based technology on whey with irgi phyto-component addition. In the production of the end product, it is necessary to comply with the requirements of the septic tank, namely, all the components that make up the product must be subjected to heat treatment in order to avoid contamination by pathogenic microflora.

It is known that whey proteins are thermolabile, therefore, to eliminate the precipitation possibility, it is necessary to choose a rational pasteurization temperature, studying the temperature regime influence on the coagulative abilities of whey proteins. Due the studies, pasteurization exposed seven samples of produced cheese whey of one batch of equal volume (pasteurization temperature ranged from 72°C to 84°C). Due heating the first, second and third samples (pasteurization temperature estimated 72°C, 74°C and 76°C accordingly) apparent external changes were not detected. The whey was clear; visible protein coagulation was not observed. Due heating the fourth sample to the temperature of 78°C there was observed the beginning of protein molecules coagulation – the formation of small protein particles on the walls of a beaker. Due heating the fifth sample (pasteurization temperature was 80°C) the flaky residue was observed. Due the heating the sixth and seventh samples (pasteurization temperature 82°C and 84°C accordingly) the intensity of protein flaky residue formation was increasing, the precipitated protein formed a well visible residue at the bottom of the glass. Residue particles were small and dry (78°C – 0.1 ml of residue, 80°C – 0.3 ml of residue, 84°C – 0.5 ml of residue accordingly).

As a result of the studies, it was found that at a pasteurization temperature of 78°C to 84°C the drink structure changes, due to latent and explicit whey proteins coagulation, which negatively affects the functional and technological properties of the end product. Therefore, the rational temperature of cheese whey pasteurization was chosen 74±2°C - in this range whey proteins remain easily digestible and are in a stable state.

The whey mixture rheological properties were determined by the indirect method of isolating whey during centrifugation. There were studied seven prototypes fermented with starter microflora, with a different percentage of milk to whey (20/80, 30/70, 40/60, 50/50, 60/40, 70/30, 80/20 accordingly). This study is necessary to determine the technological properties of the end product and to develop a hardware-technological production scheme, as it allows to determine the possibility of product development in a thermostatic or tank way (Table 2).

Table 2. Determination of the milk to whey ratio.

№	Ratio M:C (ml)	Sourdough amount (ml)	Flaky residue amount (ml)	Amount of formed whey (ml)
1	20:80	5	1,6	8,4
2	30:70	5	1,7	8,3

3	40:60	5	1,8	8,2
4	50:50	5	2,1	7,9
5	60:40	5	2,6	7,4
6	70:30	5	3,4	6,6
7	80:20	5	4,1	5,9

It is known that the structural and mechanical properties of clot depend on the presence of casein fraction in the milk-whey system, since milk protein casein, as a result of coagulation, forms strong clot framework, strengthened by calcium, the so-called casein calcium-phosphate complex (CCPC). The amount of separated whey in the sample with the ratio of milk to whey concentration 20/80 composed 8,4 ml. In the sample with the ratio of milk to whey concentration 50/50 – 7,9 ml, so the amount of excreted whey, with an increase in milk concentration, decreased 1.1 times. In the sample with the ratio of milk to whey concentration 80/20 it composed 5,9 ml, so the amount of excreted whey, with an increase in the concentration of milk, decreased by 1.4 times.

As a result of the studies, the optimal concentration of milk to whey in the whey mixture was selected – 40/60. The current concentration is due to the need for a sufficiently high concentration of whey in the mixture, since whey contains easily digestible protein, which, unlike casein, forms in the system of the gastrointestinal tract a soft easy folding flocculent clot. The cost of production can be significantly reduced using secondary products of milk processing. Thus, the production of this product is possible in the form of a milk-whey fermented drink with a flowing, low-viscosity consistency.

The selected concentration allows producing a product with stable semi-viscous consistency, sweetish taste (without adding sugar to the system), as well as pleasant sour-milk odor with very weak odor of whey, which is easily corrected by adding an aromatic phyto-additive to the system. Physico-chemical indicators provide the necessary amount of whey protein – 0,12%, enough amount of protein – 2,1%, casein – 1,98%, nitrogenous substances – 2,17%, lactose – 5,2%, skimmed milk powder – 7,2%.

Studies have been carried out to determine the amount of phyto-additive added to the mass of the milk-whey base using an indirect method for determining the rheological properties. For the study, ten samples were taken with a different percentage of phyto-extract (from 1% to 10%) in whey (milk to whey ratio 40:60), which underwent an indirect method of determining rheological properties by centrifuging samples. The research results are shown in the Table. 3.

Table 3. Studies of samples with different percentages of phytoextract.

№	The percentage of phytoextract	Ratio M:W (%)	Number of discharge residue (ml)	Whey separation Results (ml)
1	1	40:60	1.9	8.1
2	2	40:60	2.1	7.9
3	3	40:60	2.2	7.8
4	4	40:60	2.3	7.7
5	5	40:60	2.6	7.4
6	6	40:60	2.8	7.2
7	7	40:60	3	7
8	8	40:60	3.1	6.9
9	9	40:60	3.2	6.8
10	10	40:60	3.3	6.7

It was found that with an increase in introduced phyto-component concentration, the amount of isolated serum decreases. Structural and mechanical properties of the clot depend on pectin and tannin concentration in the studied product system, which are part of the

phyto-extract, as well as on carbohydrates, which play the role of nutrition additional sources for probiotics in the system that affects the protein clot formation.

As a result of the studies, the optimal concentration of the introduced phyto-component in the milk-whey mixture was selected – 8%. This concentration is due to the need for sufficient viscosity and density of the product, necessary to create a strength structure in which molecules of whey proteins and easily digestible small casein clot will be evenly distributed throughout the volume.

The study of the organoleptic properties of fermented milk-whey base with various concentrations of phyto-additives is presented in Table 4.

Table 4. The study of fermented milk-whey base organoleptic properties with various phyto-additives concentrations.

Phyto-extract content in the samples	Appearance and consistency, color	Flavor	Odor
1%	Lightly doped white liquid, the color of whey and phyto-extract is practically invisible. Protein particles are evenly distributed throughout the sample.	Intense flavor of whey, slightly expressed sour milk smack.	Mild odor of plant phytoextract, strong odor of whey.
2%	Lightly doped white liquid with slight pinkish tint (phyto-extract), whey color is almost invisible. Protein particles are evenly distributed throughout the sample.	Taste of whey is practically absent, mild sour milk flavor, slight berry flavor appears.	Mild odor of plant phytoextract, whey odor less pronounced.
3%	Quite sufficiently dense for the drink liquid, in white color with faint shade of purple, the color of whey is not visible. Protein particles are distributed evenly throughout the sample.	The taste of whey is practically absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour milk odor, the phytocomponent odor is also well expressed, whey odor is practically absent.
4%	Quite sufficiently dense for the drink gellike consistency liquid pale pink - pale violet colored with evenly distribution of protein particles throughout the volume.	The taste of whey is practically absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour milk odor, the phytocomponent odor is also well expressed, whey odor is practically absent.
5%	Quite sufficiently dense for the drink gellike consistency liquid pale pink - pale violet colored with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour-milk odor, the phytocomponent odor is intense, whey odor is absent.
6%	Quite sufficiently dense for the drink gellike consistency liquid pale pink - pale violet colored with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour-milk odor, the phytocomponent odor is intense, whey odor is absent.

7%	Quite sufficiently dense for the drink gellike consistency liquid pale pink - pale violet colored with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour-milk odor, the phytocomponent odor is intense, whey odor is absent.
8%	Quite sufficiently dense for the drink gellike consistency liquid in pale pink - pale violet color, the intensity of which increased significantly compared to samples 6 and 7, with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with intense taste of the phytocomponent.	Pleasant sour-milk odor, the phytocomponent odor is intense, whey odor is absent.
9%	Quite sufficiently dense for the drink gellike consistency liquid in pink - violet color, the intensity of which increased significantly compared to samples 6 and 7, with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with very intense taste of the phytocomponent.	Pleasant mild sour-milk odor, the phytocomponent odor is intense, whey odor is absent.
10%	Quite sufficiently dense for the drink gellike consistency liquid intense pink - intense violet colored with evenly distribution of protein particles throughout the volume.	The taste of whey is absent, intense lactic-acid taste with very intense taste of the phytocomponent.	The phyto-component odor is very intense, the sour-milk odor is more distant, no whey odor.

As a result of the organoleptic evaluation of samples with different percentages of phyto-component, the following conclusions can be made:

1. The intensity of the pink-violet color intensely increases with the addition of the irgi phyto-extract into samples in increments of 1%. If we compare the color formation intensity of an identical drink, but with the content of another fruit and berry filler, then it is significantly less in relation to the color formation intensity of the same irgi phyto-extract concentrations samples.
2. The phyto-concentrate odor is intense enough to neutralize the whey odor even at the concentration at 4%, as well as at concentrations from 9% the phyto-component odor begins to interrupt the sour-milk odor.
3. Due to the presence of pectin and tannins, the drink consistency becomes quite dense with evenly distributed protein particles throughout the volume of the samples, which indicates the irgi phyto-concentrate high functional importance.

The study of the whey mixture physicochemical properties with different irgi phyto-extract contents was carried out by determining the mass fractions of protein, lactose and skimmed milk powder in milk using IRF-464 refractometer. The method is based on measuring the refractive indices of the test mixture and its protein-free whey obtained from the same sample of the mixture, the difference between which is directly proportional to the protein mass fraction in the sample. The protein mass fraction was determined by the differences in the refractive indices of light in the mixture and its protein-free whey on scale «PROTEIN», mass fraction of skimmed milk powder – by differences in refractive

indices in the mixture and distilled water, mass fraction of lactose – by the difference in refractive indices of protein-free whey of the mixture and distilled water.

The results of the study of physico-chemical parameters are shown in the Table 5.

Table 5. The study of the whey mixture physicochemical properties with different contents of irgi phyto-extract.

Phyto-extract content	Mass fraction. (%)					
	Protein	Casein	Whey protein	Nitrogen substances	Lactose	Skimmed milk powder
1%	0.8	0.66	0.12	0.87	5.2	6.0
2%	0.9	0.88	0.02	0.98	5.3	6.2
3%	1.0	0.99	0.01	1.09	5.4	6.4
4%	1.0	0.88	0.12	1.09	5.4	6.4
5%	1.0	0.66	0.34	1.09	5.4	6.4
6%	1.1	0.77	0.33	1.19	5.4	6.5
7%	1.1	0.66	0.44	1.19	5.5	6.6
8%	1.2	0.88	0.32	1.30	5.6	6.8
9%	1.25	0.71	0.54	1.36	5.7	6.95
10%	1.25	0.70	0.64	1.36	5.7	6.95

As a result of the studies, directly proportional dependence of the protein mass fraction, casein, nitrogenous substances, lactose, skimmed milk powder was established. The most rational concentration of the introduced phytoextract was selected – 8%, since it contains the necessary amount of whey proteins – 0,32%, enough amount of protein present – 1,2%, casein – 0,88%, nitrogenous substances – 1,3%, lactose – 5,6%, skimmed milk powder – 6,8%. The current concentration allows to make product with stable semi-viscous consistency, sweetish taste (without adding sugar to the system), as well as pleasant sour-milk odor with intense odor of the introduced irgi phyto-component.

The study of lactobacillus activity is important in the development of herodietic nutrition specialized foods, since in elderly people lactose assimilation is sharply reduced due to the almost complete absence of β -galactosidase enzyme, therefore it is important to ensure the production of lactose-free or low-lactose food products.

Studies of probiotic microorganisms' lactobacillus activity are presented in the Table 6.

Table 6. Studies of probiotic microorganisms lactobacillus activity.

Amount of additive. %	Lactobacillus activity index	Amount of fermented lactose.%
0 (controle)	0.96	65.8
1	0.96	65.8
2	0.97	66.1
3	0.97	66.1
4	0.97	66.2
5	0.97	66.2
6	0.97	66.2
7	0.98	66.7
8	1	68.4
9	0.98	66.8
10	0.98	66.8

It was found that with an increase in the introduced phytocomponent, the probiotic enzyme systems are activated. The rational amount of the additive is 8%, lactobacillus

activity index – 1, which corresponds to 68,4% of fermented lactose in the sample and allows to recommend the developed product as low lactose.

Studies of biological value were conducted using the device «KAPEL 105M», according to GOST M-04-38-2009. The results are presented in the Table 7.

Table 7. The study of product aminoacid composition.

Name of the study	Prototype (end product with the irgi extract addition)	Control sample (whey)
Arginine mass fraction,%	48	33
Lysine mass fraction,%	94	100
Tyrosine mass fraction,%	41	30
Phenylalanine mass fraction,%	50	39
Histidine mass fraction,%	46	23
Leucine and isoleucine mass fraction,%	78	58
Methionine mass fraction,%	54	43
Valine mass fraction,%	62	58
Proline mass fraction,%	84	70
Threonine mass fraction,%	68	59
Serine mass fraction,%	63	54
Alanine mass fraction,%	66	51
Glycine mass fraction,%	42	21

As it is shown at the presented data, there is an insignificant difference in the end product aminoacid composition in relation to the control (whey). The total number of essential aminoacids in the end product composition of herodietic prescription composed 50%, in whey mixture – 55% accordingly. It should be noted that the total irgi extract aminoacids content exceeds the similar results of the control sample by 1.23 times (786mg/100g against 639mg/100g accordingly).

Thus, as a result of aminoacid composition study, it was found that the content of both individual aminoacids and the total amount of essential aminoacids significantly exceeds the results of the control sample.

4 Discussion

As a result of the work, the following scientific and practical conclusions are formulated:

1. To determine the necessary and sufficient amount of phyto-additive, research of the symbiotic properties of probiotic and phyto-supplements by studying the acid-forming activity of probiotic microorganisms consortium included in the «EVITALIA» sourdough in the milk-whey – phyto-additive system, was conducted.

The functional significance of the irgi phyto-extract, as one of the necessary and significant components in the specialized foods production for herodietic nutrition, has been technically justified and experimentally proved. It has been determined and proved that biologically active phyto-extract has a low energy value and can be recommended as a functional ingredient in the production of specialized foods, including for people who are overweight, etc.

2. It was found that to obtain a dairy product with the required viscosity, the introduced phyto-component mass fraction should be 8%, and the ratio of milk to whey concentrations in the whey mixture should be 40/60.

3. It was found that the introduced functional ingredient is a catalyst for proteolytic processes occurring in the fermentation system and exhibits symbiotic activity with respect

to the starter microflora. With an increase in the introduced phyto-additive amount, the rate of acid formation increased, which indicates the symbiosis of probiotic microorganisms and phyto-concentrate.

4. The milk components pasteurization regime ($t=74-76^{\circ}\text{C}$), which ensures the preservation of the milk and whey necessary components in an easily digestible state, is justified.

5. The need for the production and sale of a new herodietic product with irgi phyto-concentrate has been established and justified.

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