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PROCESSING OF DAIRY RAW MATERIALS IN HEALTHY FOOD PRODUCTS

Доведено перспективність використання сироватки з-під кисломолочного сиру і рослинної сировини у виробництві напоїв профілактичного призначення. Обґрунтовано раціональні співвідношення інгредієнтів у напоях на основі сироватки. Отримано експериментальні дані щодо впливу рослинних інгредієнтів на біологічну активність напоїв. Розроблені рецептури нових напоїв. Розроблена технологія виробництва напоїв на основі сироватки для профілактики ожиріння. Встановлені режими та строки зберігання напоїв.

Ключові слова: *сироватка з-під кисломолочного сиру, рослинна сировина, рецептури нових напоїв, показники якості, режими зберігання.*

1. Introduction

In many economically developed countries over the past decade, the prevalence of obesity has doubled. According to the forecasts of experts of the World Health Organization, while maintaining the current rate of increase in the incidence rate to 2025 the world will have more than 300 million people that will be obese [1].

According to the European segment of the World Health Organization, overweight leads to a million deaths per year in the European Region alone. The European Union and the World Health Organization in Europe called the prevention and treatment of obesity the greatest challenge for the health system in the 21st century [2].

Among the able-bodied population of Ukraine obesity is found in almost 30 % of cases, and every fourth inhabitant has an overweight body. Sedentary lifestyle, irrational food with an increase in the number of refined products, constant psychological stress characteristic for a modern society lead to an increase in the frequency of obesity among people of any age, especially young people [3].

If several decades ago there were doubts about the importance of nutrition in the etiology of obesity, today, in modern society, it is proved that the diet is of paramount importance. Food monitoring shows that over the last 30–40 years, energy consumption from food has increased and this problem will continue in the future [4].

Today, the market has a lot of tools designed to reduce weight. A significant part of drugs for weight loss refers to biologically active additives (BAA), most of which cause side effects and has a high cost [5, 6].

A promising direction in the technology of production of products with targeted functional properties is the use of whey enriched with various types of plant raw materials and juices [7–10].

The biological value of whey is determined by the content of protein and nitrogen compounds (primarily essential amino acids), proteins, carbohydrates, lipids, mineral salts, vitamins, organic acids, enzymes, immune bodies and microelements in it [8, 9].

One of the most valuable components of whey is whey proteins, the content of which reaches 1 % in whey. Whey proteins have valuable useful biological properties, they contain the optimal set of vital amino acids and, from the point of view of the physiology of nutrition, approach the amino acid scale of the «ideal» protein, that is, the protein in which the amino acid ratio corresponds to the needs of the organism. Slowed in comparison with other carbohydrates, the hydrolysis of lactose in the intestine limits the processes of fermentation, promotes the normalization of the vital activity of the beneficial microflora and prevents autointoxication. In the whey, a small amount of fat (0.1–0.2 %) is present, but its value lies in the fact that it is dispersed to the size of the balls with a diameter of less than 2 μm. Whey has a high content of mineral salts, macro- and microelements. The composition of whey includes vitamins of group B, vitamin C, nicotinic acid, choline, vitamin A, vitamin E and biotin [9].

From dairy products, the products obtained on the basis of whey have the most pronounced dietary and curative properties. They can be primarily attributed to products that do not have atherogenic properties. The wide use of these highly bioactive food products makes it possible to provide a health and preventive effect in preventing obesity and cardiovascular pathology [9].

Juices exhibit antisclerotic, antistress, tonic, immunostimulating, antioxidant action. Antisclerotic action of juices is associated with the antioxidant properties of vitamins C, E, β-carotene, as well as phytonutrients contained in fruits, vegetables and berries. They reduce the oxidation degree of the most dangerous fraction of lipoproteins, thereby slowing the growth process of atherosclerotic plaques in the vessels. Antistress, tonic, immunostimulating and antioxidant effects of juices are caused by the content of polysaccharides, sulfur-containing proteins, minerals, vitamins A, E, C, group B, bioflavonoids, etc. [10].

Studies of recent years show that vegetable raw materials have their medicinal properties and ability to prevent obesity due to the optimal ratio of biologically active substances contained in them. These substances have an

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evolutionary and genetically greater affinity with the human body than synthetic agents [11]. They provide therapeutic and regulatory actions, affect the metabolic processes in the body, increase its protective properties.

Known substances that stimulate the breakdown of fats are L-carnitine, α-lipoic acid, stevia, gingerol and bromelain. Cinnamon has the ability to several times enhance the metabolism in the body, so that fat deposits are broken down faster [11].

Therefore, the relevance of the work is conditioned by the need to increase the output and expand the assortment of new combined milk and vegetable beverages using whey and natural plant raw materials that can accelerate metabolic processes in the body and thereby contribute to the obesity prevention. Secondly, the scientific work is devoted to the urgent problem – the whey processing that indirectly solves the issues of environmental protection.

2. The object of research and its technological audit

The object of research is whey-based beverages.

As raw materials for the production of beverages use: whey, several types of vegetable raw materials (ginger, stevia, cinnamon, dry extract of pineapple fruit), fresh juices of lemons, cranberries, orange, pumpkin, yostaberry, alpha-lipoic acid, L-carnitine and pectin , which are used as an additive to the mixtures.

The main characteristics of the components of the research object are presented in Tables 1–3.

Table 1

Organoleptic and physicochemical parameters of whey

Indicator name	Indicator
Taste and smell	Pure, inherent in the whey from cottage cheese, without foreign flavors and odors, sourish taste
Color	Yellowish green
Consistency	Homogeneous liquid, with a small part of the protein precipitate
Mass fraction of dry substances, %, incl.:	5.67
– mass fraction of fat, %	0.31
– mass fraction of protein, %	0.81
– mass fraction of lactose, %	4.41
Density, kg/m^3	1023
Titrated acidity, °T	54
Active acidity, pH	4.7

Physical and chemical parameters of freshly squeezed juices are given in Table 2.

The characteristics of the plant components of the formulation are given in Table 3.

The most problematic areas are the limited shelf life of beverages and the risk of product stratification during storage. It is required a homogenization operation.

Table 2

Physical and chemical parameters of freshly squeezed juices

Product	Mass fraction of dry substances, %	pH	Mass fraction of vitamin C, mg/100 g	Mass fraction of vitamin E, mg/100 g	Mass fraction of β-carotene, mg/100 g
Lemon juice	7.80	2.36	48.70	0.12	0.001
Orange juice	11.70	3.54	52.10	0.02	0.03
Cranberry juice	12.90	2.84	19.30	1.22	0.06
Pumpkin juice	8.40	4.72	8.20	0.41	1.51
Yostaberry juice	13.10	3.11	86.40	0.51	0.35

Table 3

The characteristics of the plant components of the formulation

Raw materials	Kind and composition of raw materials	TM	Standard
Ginger	Powder	«Prypravka»	TU U 15.8-310621 61-010:2008
Cinnamon	Powder	«ЕКО»	GOST 29049-91
L-Carnitine	Tablets, L-carnitine-0.1 ascorbic acid-0.03 g	PLC «Elit-Pharm»	TU U 15.8-32547646-001-2003
Alpha-lipoic acid	Tablets, lipoic acid – 0.025 g	JSC «Marbiolpharm»	–
Stevia	Tablets, stevioside 0.05 g	«Korysna Kondyterska», Kyiv region	DSTU 4929:2008
Pineapple fruit extract	Tablets	PLC Nutrimed	TU U 15.8-30112347-014:2006
Citrus pectin	Powder	«Apteka prirody»	DSTU 6088:2009

3. The aim and objectives of research

The aim of research is development of a scientifically-based technology for the production of whey-based beverages for the obesity prevention and the optimal shelf life.

To achieve the aim it is necessary to solve the following objectives:

1. To choose and justify the concentrations of components those make up the composition of beverages by organoleptic indicators and biological activity.

2. To determine the organoleptic composition of the beverages under investigation and investigate the activity of pancreatic lipase.

3. To determine the antimicrobial activity of the beverages.

4. To determine the main physicochemical parameters of the beverages.

4. Research of existing solutions of the problem

The development of the technology of whey-based beverages is examined in [12–23].

Thus, in work [12] studies on the development of technology of a prebiotic whey-based beverage using fructooligosaccharides are given. Additionally, citric acid, carboxymethylcellulose (CMC), sweetener (aspartame), preservative (sodium benzoate), dyes (orange red) and flavor (orange) are added to the beverage. The developed functional beverages are determined by physicochemical parameters (pH, acidity, total amount of solids, fat, crude protein, mineral composition, amino acid composition).

The influence of supercritical carbon dioxide technology (SCCD, 14, 16 and 18 MPa at 35±2 °C for 10 min) on the characteristics of a whey-grape beverage is studied in [13]. Physical and chemical parameters (pH, acidity titrations, total soluble solids) are determined. Biologically active compounds (phenolic compounds, anthocyanins, DPPH and ACE activity) and volatile compounds are determined.

The authors [14] develop the technology of a papaya-based beverage with the whey addition (25 %). The resulting beverage has an acidity of 0.20±0.11 %, a weight fraction of the reducing sugars is 5.37±0.01 g/100 g, a total sugar content of 14.06±0.46 g/100 g and a mass fraction of ascorbic acid – 5.60±0.02 mg/100 g.

In [15], the classification and general information on whey beverages are presented, the main problems encountered in the production of whey-based beverages with fruit juices are discussed. Also, a literature analysis of the developed and existing whey beverages (with fruit and vegetable juices, fermented and non-fermented, low-alcohol beverages, lactose-hydrolyzed beverages, diet beverages with cereals, sweeteners, etc.) and beverages for athletes are also conducted.

In [16], the authors propose a technology for a whey-based beverage with encapsulated lycopene (2 %) and tomato juice (12 %). The beverage composition included acids, sugar, stabilizer, preservative.

The authors [17] develop a symbiotic milk beverage consisting of 50 % milk whey, 10 % sucrose, 25 % milk powder, 15 % cellulose from the yakon and cultures Lactobacillus acidophilus – La 5E and Bifidobacterium bifidum – Bb12. The physicochemical and sensory characteristics of the beverage are evaluated.

Whey beverage with sugar and mango pulp (4–6 %) is suggested by the authors [18].

In [19], a whey-based carbonated beverage with orange juice (a ratio of whey to juice 30:70) is proposed. The analysis of the beverage shows a general increase in the amount of nutrients with the addition of whey compared to the standard orange juice.

The authors of the study [20] propose a method for producing a whey-based beverage, known as «Nutrilife» by incorporating functional ingredients:

– premix (A, C, E vitamins, calcium, iron) (0.09 %);
– water extract of barley (30 %);
– flax powder (5 %);
– extract of green tea (5 %);
– stabilizer (0.1 %);
– digestive enzymes (0.5 %) (in the form of «Digene» tablets). Sugar in beverages is replaced by sucralose (1.4 %).

In work [21], development of compositions of preventive beverages on the basis of curd whey, an extract of colors Tagetes patula and a berry filler «Strawberry» are resulted. The recommended ratio of the mass share of the berry filler «Strawberry» and the extract of the flowers Tagetes patula in preventive beverages, respectively, 7 and 20 % of the finished product. The developed beverages have antioxidant, probiotic and hepatoprotective properties.

Studies on the use of herbal components (extracts of lemon balm, peppermint, echinacea purpurea) in the preparation of whey-based beverages of functional purpose are given in [22]. On the basis of whey, a technology for producing whey and juice beverages for functional purposes has been developed. The results of the research shows that beverages are characterized by a wide range of biologically active substances, including organic acids, polyphenolic compounds, vitamins, amino acids and carbohydrates. The energy value of obtained beverages is in the range of 46–48 kcal/100 g of product, which allows them to be classified as low-calorie products.

The authors [23] develop the technology of whey-based functional beverages from cottage cheese and compositions of plant extracts from the Far Eastern region and mangosteen (*Garcinia mangostana L.*). The method of mathematical modeling optimizes the extraction of biologically active substances from plants of the Far East (cinnamon hips, cranberry four-petalled berries, blackberry berries, Amur grapes, actinidia colomicta berries). The proposed technology makes it possible to obtain gel-like beverages on whey, which are natural food products. These beverages have higher organoleptic indices and shelf life compared to the analogue, as well as significant concentrations of functional antioxidant ingredients (flavonoids, xanthones, vitamin C).

The main results given in [20–23] are not confirmed by laboratory studies of the specific action of the samples on certain systems of the human body: immune, endocrine, digestive and the like. In addition, components of formulations are used, the receipt of which is associated with consumable and multistage technologies (extraction, purification, etc.). Further introduction of the technology of the developed products [20–23] will invariably cause the need for production facilities for the production of additional components. The need for additional equipment for extraction and purification of plant material will significantly increase the cost of the product.

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An important stage for food products is their microbiological stability during storage, associated with the deterioration of the product and its safety for humans. In the analyzed sources [12, 13, 16–19], the data are completely missing or insufficient. The same data are not available on the changes in the parameters of nutritional and biological values during storage. In addition, in the sources [12, 13, 26], the tasting evaluation of organoleptic indices is not presented, but it is the most important for food products.

Thus, to date, there is almost no information on the development of whey-based beverages for the obesity prevention, so there is a need for new developments in this segment, which has become the aim and objective of this research.

5. Methods of research

Methods for researching the properties of research objects are based on standards and original techniques:

– titratable acidity according to GOST 3624-67;
– sensory indicators – according to DSTU 3662-97;
– mass fraction of dry substances – according to GOST 3626-73;
– mass fraction of protein – refractometric method and by titration according to [24];
– mass fraction of fat – without centrifuge method (according to G. Inikhov) according to [24];
– mass fraction of lactose – iodometric method according to [24];
– mass fraction of vitamin E – according to [25], mass fraction of β-carotene – according to [25], mass fraction of vitamin C – according to [25];
– density – by areometric method in accordance with GOST 3625-84;
– active acidity – potentiometric method according to [24, 25], activity of digestive enzymes in vitro – according to [26];
– antimicrobial activity of ready-made beverages – by a method based on the suppression of the development of microorganisms according to [27];
– biological activity – according to [28];
– efficiency of pasteurization regimes – by microbiological method and chemical method – according to GOST 3623-73;
– the amount of mesophilic aerobic and facultative-anaerobic microorganisms – according to GOST 10444.15-94;
– the number of bacteria of E. coli group – according to GOST 9225-84.

6. Research results

After determining the physical and chemical parameters of whey, plant raw materials and juices, rational ratios are determined in the mixtures through biological activity and organoleptic indices. All other components in the mixture are added with stirring, based on the recommendation to medical standards and technological considerations.

The biological activity of whey mixtures with various fillers is determined from the rate of oxidation of NAD^*H_2 to NAD in the control and test samples. The results of the experiments are shown in Fig. 1–3.

For mixtures with pineapple extract and cinnamon, the results are better at concentrations of 0.5 %, and with ginger – 0.15 %. When determining the relative biological activity of various herbal supplements to whey, ginger has an advantage (Fig. 4). The biological activity of ginger is 900 conventional units of activity compared to 150 units for whey without additives. This proves a significant increase in the bioactivity of mixtures of plant raw materials.

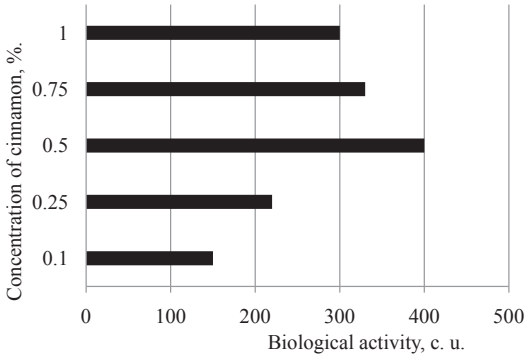

Fig. 1. Biological activity of whey with cinnamon depending on the mass fraction of cinnamon

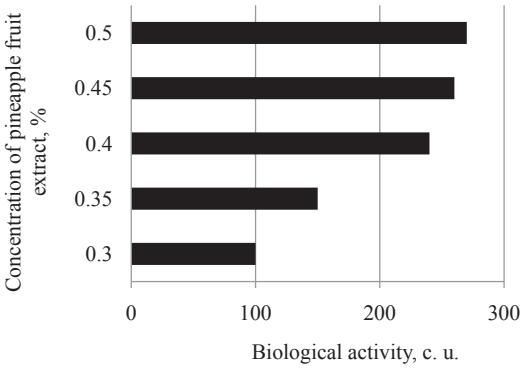

Fig. 2. Biological activity of whey with a pineapple fruit extract depending on the concentration of the dry pineapple fruit extract

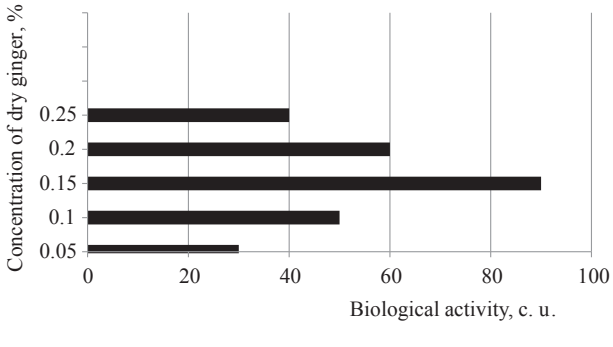

Fig. 3. Biological activity of whey with ginger depending on the dry ginger concentration

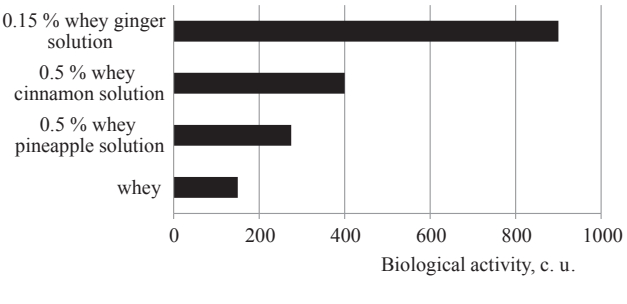

Fig. 4. Biological activity of whey solutions with plant raw materials

Fig. 5 shows the results of the biological activity of whey and juices.

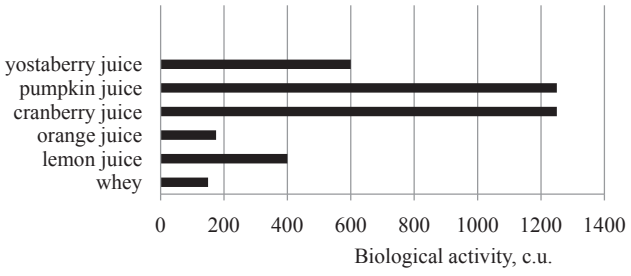

Fig. 5. Biological activity of investigated whey and juices

All samples were previously tested for biological activity at various concentrations of juices in whey (Fig. 6–10).

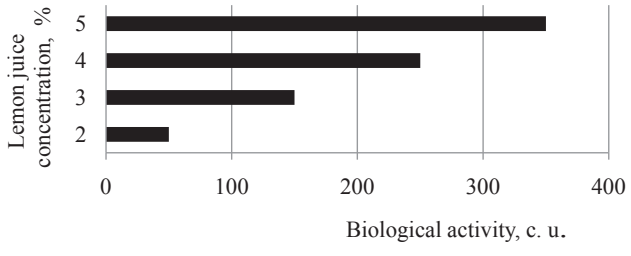

Fig. 6. Biological activity of whey with lemon juice depending on the lemon juice concentration

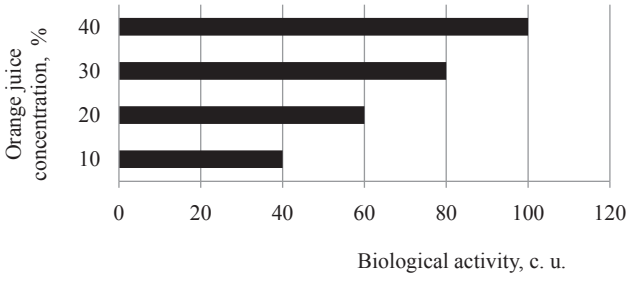

Fig. 7. Biological activity of whey with orange juice depending on the orange juice concentration

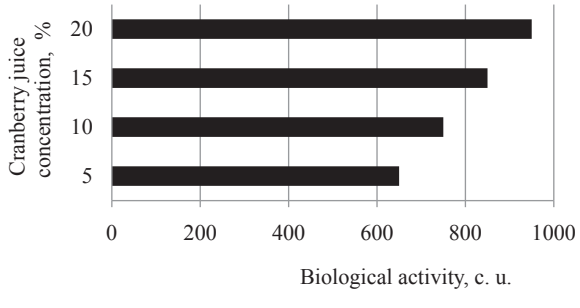

Fig. 8. Biological activity of whey with cranberry juice depending on the cranberry juice concentration

For the biological activity of mixtures of whey and juices, the obtained results are shown in Fig. 11.

The best results are given by adding 40, 20, 50, 50, 5 %, respectively, of orange, cranberry, pumpkin, yostaberry and lemon.

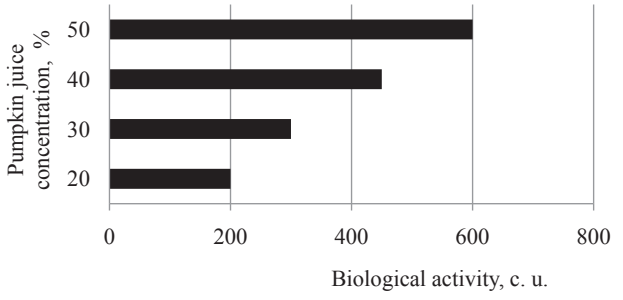

Fig. 9. Biological activity of whey with pumpkin juice, depending on the pumpkin juice concentration

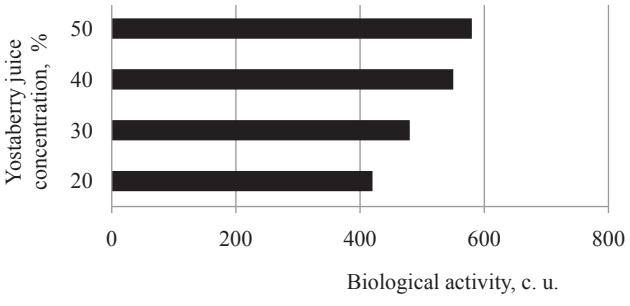

Fig. 10. Biological activity of whey with yostaberry juice depending on the yostaberry juice concentration

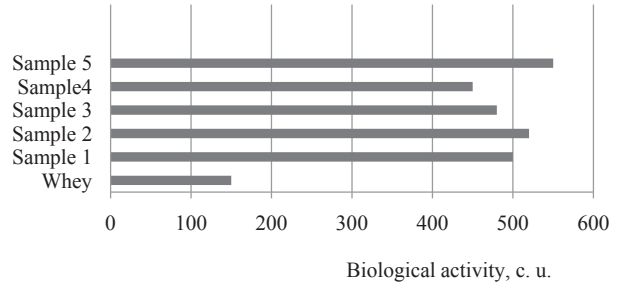

Fig. 11. Biological activity of whey and various juice compositions (variant 1)

However, taking into account the organoleptics of the mixtures, the ratio of juices and whey is corrected to the values given in Tables 4, 5.

Table 4

Ratio of juices in %

Sample	Cranberry juice	Lemon juice	Orange juice	Whey
1	10 %	10 %	40 %	40 %
2	5 %	5 %	30 %	60 %
3	10 %	5 %	25 %	60 %
4	5 %	5 %	20 %	70 %
5	10 %	5 %	29.5 %	50 %

Table 5

Ratio of juices in %

Sample	Pumpkin juice	Yostaberry juice	Whey
6	40 %	10 %	50 %
7	30 %	20 %	60 %
8	20 %	20 %	60 %
9	10 %	40 %	50 %
10	20 %	30 %	50 %

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The biological activity of the samples are different according to Fig. 11, 12.

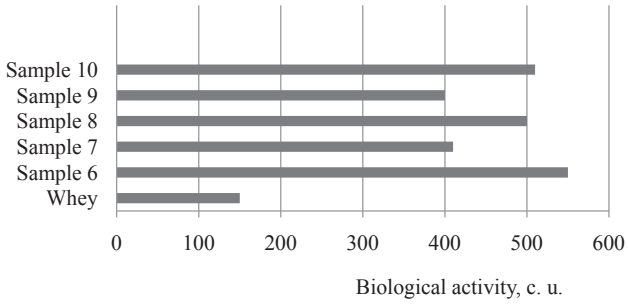

Fig. 12. Biological activity of whey and various juice compositions (variant 2)

Concentrations of stevia sugar substitutes (0.09 %) and fructose (2.5 %) are determined organoleptically.

In all samples, 0.15...0.3 % pectin is added, which prevents the delamination of multicomponent mixtures. As a result of the research, two beverage formulations are proposed, with better indicators of organoleptic and biological activity (Table 6).

Table 6

Formulations for whey beverages, kg/100 kg

Ingredients	Sample 5	Sample 8
Whey cottage cheese	50	60
Ginger	0.15	–
Lemon juice	5	–
Orange juice	33.21	–
Cranberry juice	10	–
Pumpkin juice	–	18.23
Yostaberry juice	–	18.23
Stevia	0.09	–
Cinnamon	0.5	0.5
L-Carnitine	0.15	0.15
α-lipoic acid	0.1	0.1
Pineapple fruit extract	0.5	–
Fructose	–	2.5
Pectin	0.3	0.3
Total	100.00	100.00

The biological activity for sample 5 is 550 conventional units of activity, and for sample 8 – 500 conventional units of activity.

For these samples, it is found that the activity of pancreatic lipase in vitro has different values, which are determined by titration of free fatty acids. They are formed by the hydrolysis of fat. For both samples, this indicator is greater than for whey without additives (Fig. 13).

Antimicrobial activity for the obtained beverages is proved by inhibiting the test cultures of putrefactive microorganisms and bacteria of the Escherichia coli group (CGB). For sample 8, a slow action corresponding to the diameter of the test-culture retention zone of 8–9 mm is detected. Sample 5 gives a higher result of 12–13 mm of the diameter of the delay zone, characterizing its high antimicrobial activity.

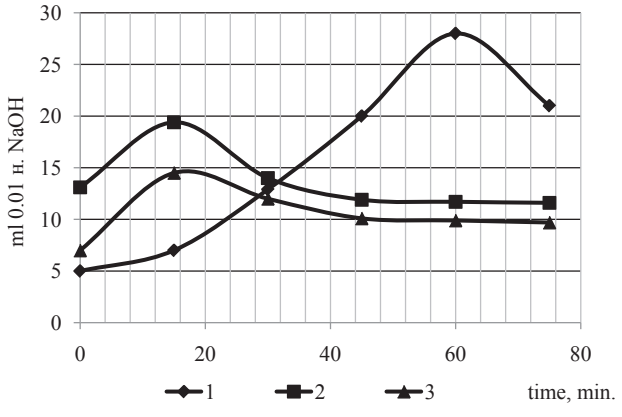

Fig. 13. Activity of pancreatic lipase: 1 – whey; 2 – sample 5; 3 – sample 8

As a result of studies of the physicochemical properties of the best samples, the obtained results are presented in Table 7.

Characteristics of food and energy value of beverages have the composition presented in Table 8.

Table 7

Physical and chemical parameters of beverages

Product	Mass fraction of dry substances, %	pH	Mass fraction of vitamin C, mg/100 g	Mass fraction of vitamin E, mg/100 g	Mass fraction of β-carotene, mg/100 g
Sample 5	13.3	3.84	53.48	0.83	0.07
Sample 8	12.8	3.96	34.83	0.51	1.10

Table 8

Food and energy value of beverages

Samples	Protein, g	Fat, g	Carbohydrates, g	Energy value, kcal
Sample 5	0.93	0.41	10.1	47.81
Sample 8	0.76	0.28	8.23	38.48

It is important that both samples have a very low energy component, high values of biological value with high organoleptic characteristics. To develop the technology of such beverages, it is necessary to know some technological indicators that affect the flow of basic technological processes. In particular, the solubility of the dry components of the beverages is determined by the volume of the precipitate that accumulated after dissolution. The regime is adopted: temperature 50 °C, time – 30 min.

The efficiency of the beverage pasteurization regime is checked by the calculation method for the number of mesophilic aerobic and facultative anaerobic microorganisms (MAiFAM) before and after pasteurization.

The efficiency of pasteurization, equal to 99.98–99.99 %, is considered sufficient under condition of suppression of vital activity of the most thermolabile pathogenic microorganisms. The results of studies on the efficiency of the pasteurization regime of the obtained beverage samples

are given in Table 9. The presented data show that the optimum regime of pasteurization for the sample is: temperature 84±2 °C, waiting time 15–20 s.

Table 9

The efficiency of the used pasteurization regime

Temperature, °C	Waiting time, s	Pasteurization efficiency, %	
		sample 5	sample 8
76±2	15–20	96.9	97.7
76±2	180	99.6	99.8
84±2	15–20	99.98	99.99

After pasteurization with the selected regimes, the beverages were quickly cooled to 70 °C. The finished product was immediately poured into a sterile glass container, hermetically sealed and cooled to 4–6 °C, and then sent for storage, during which (every 2 days) physicochemical and microbiological indicators were controlled.

During the storage of the product for 18 days, organoleptic indices, active acidity, the amount of mesophilic aerobic and facultative anaerobic microorganisms and the number of bacteria of the group of E. coli were determined.

Sample 5 has better organoleptic properties. Sample 8 corresponds to an excellent quality, since the general quality score (on a point system), which corresponds to an excellent quality, is in the range of 100 to 80 points.

Sample 5 has a homogeneous consistency without the presence of a precipitate, a homogeneous, intense red color, a pleasant sourish-sweetish taste. Sample 8 – homogeneous liquid without sediment, has a homogeneous orange color and a pleasant, slightly sourish-sweet taste.

During storage on the 18th day, there was an insignificant deposit at the bottom of the container in both samples. Bacteria of the group of E. coli in 0.1 cm of the product for 18 days of storage were not detected.

The results of the conducted studies allow to state that the guaranteed shelf life of the test product is no more than 14 days. During this time, minor changes in the physical and chemical parameters of the prophylactic beverages do not affect the organoleptic characteristics of the product. The absence of CGB and the permissible increase in the total number of microorganisms (MAiFAM on day 14 in the sample 5–20.000 CRU/cm^3, in the sample 8 – 4000 CFU/cm^3) is an important proof of the correctness of the choice of all regimes of basic technological processes. This indicates the preservation of the product quality during storage and its full compliance with all requirements of regulatory and technical documentation.

Fig. 14 shows the technological scheme of production of preventive whey-based beverages.

For the production of beverages, obtained whey from the production of cottage cheese, an acidity of not more than 75 °T, and a density of at least 1023 g/cm^3 should be used.

Whey should be cooled to 4–6 °C if necessary. The storage time of the cooled whey should not exceed 6 hours.

Then, the whey is heated to a temperature of 35–40 °C and sent to the separation. The separator is cleaned from fat and casein dust. The next step is heating the whey to 50 °C and introducing the components into the heated whey according to the formulation (except L-carnitine and alpha-lipoic acid). At a temperature of 50 °C, the mixture is stirred and aged for 30 minutes in the intermediate tank. The final mixture is filtered and directed to the heat exchanger. In the heat exchanger, the mixture is heated to a temperature of 60 °C.

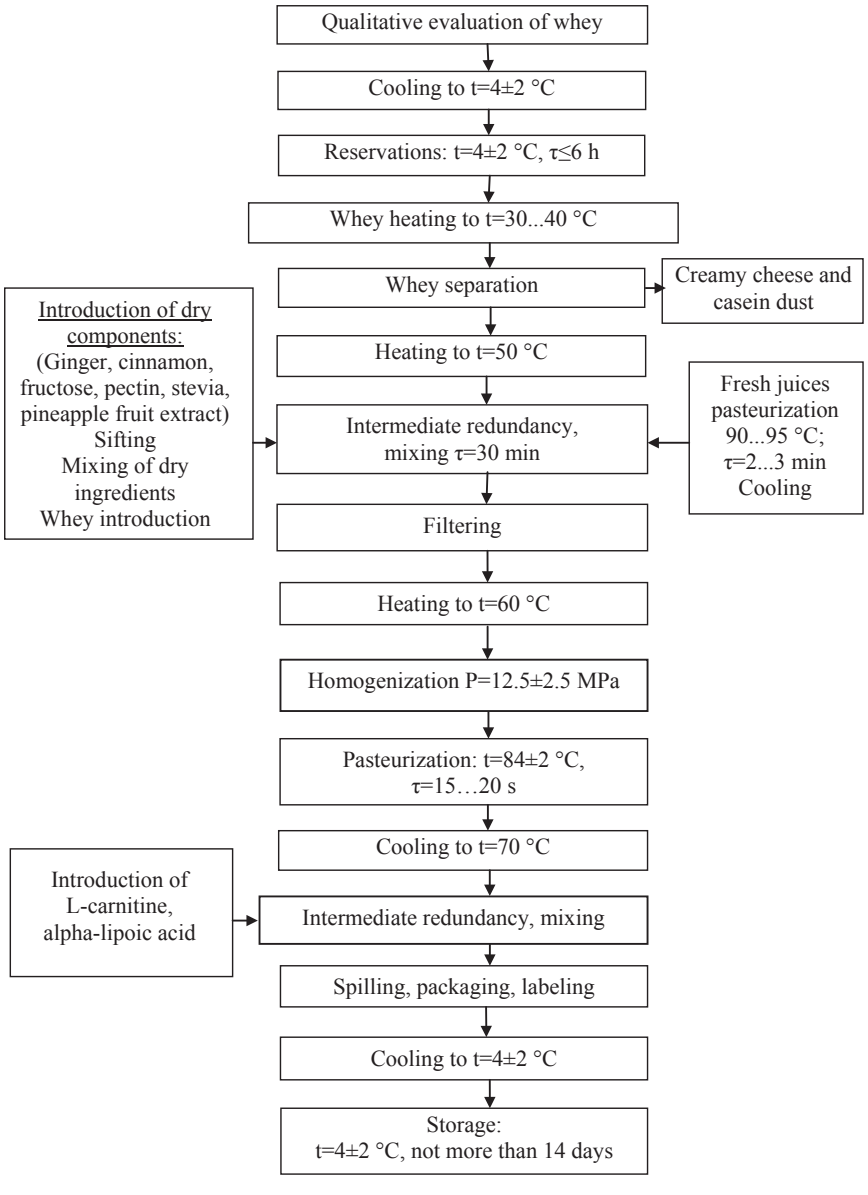

Fig. 14. Technological scheme of production of whey-based beverages of preventive purpose

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The heated mixture is directed to homogenization (temperature 60 °C, pressure 12±2.5 MPa). After homogenization, the mixture is sent to pasteurization, where it is pasteurized at a temperature of 84±2 °C with a waiting time of 15–20 sec. The pasteurized mixture is rapidly cooled to 70 °C and fed to the bottling. L-carnitine and lipoic acid are introduced during the spilling.

Hot spilling of the finished product, tested for compliance with the requirements of regulatory and technical documentation, is carried out in hermetically sealed containers, followed by corking, marking and immediate cooling. The packaged product is cooled to a temperature of 20 °C in the tunnel cooler by blowing the container with the product with cold air, and then packing it in boxes or blocks of 12 packages.

The ready products are sent to the refrigerating chamber for post-cooling (up to $t=4\pm2$ °C) and storage at this temperature for a period not exceeding 14 days from the production date, including at the enterprise – no more than 2 days.

7. SWOT analysis of research results

Strengths. The strengths include: the consumer's interest in a new beverage, high nutritional and biological value, natural ingredients and improved organoleptic indicators. The problem of utilizing the main waste of milk – whey is indirectly solved, is 90 % [16] and environmental protection, since among all the liquid wastes of the food industry, it is the whey that has the highest biological oxygen consumption (BOC) and chemical oxygen consumption (COC). This does not allow the discharge of these wastes directly into the sewerage network.

Among the strengths of this research are: technological ease of use of raw materials, good storage of raw materials, ease of transportation and processing of raw materials, availability in the market of raw materials throughout the year.

Weaknesses. The weaknesses include: a higher price compared to analog products and a weak awareness of consumers about the new product, its advantages. In the conducted experiments, a limited range of components of the formulations is used, while similar properties have: green tea, green coffee, chitosan, bran, garcinia, brown seaweed fucus, vitamin-mineral complexes, diuretic complexes (bearberry, spores, horsetail leaves, etc.), weakening complexes (senna, rhubarb, etc.), etc. The use of these types of raw materials may affect the mechanism of therapeutic action through the formation of intermediate products of interaction with the components of the basic formulation.

More research is needed related to the mechanism of obesity in the human body, which can be caused not only by the excess of fatty foods, but also by other components, such as carbohydrates. And also does not take into account the specificity of biochemical transformation and the corresponding systems of the human body that «manage» these processes.

Opportunities. As for the opportunities of the new product, it is: the presence of unsaturated segments of markets, there is almost no assortment of food products for the prevention of obesity.

Threats. When a new product enters the consumer market, there may be such threats:

– possibility of new products and substitute products;
– growing competitive pressure, as a result of the emergence of new competitors;
– unstable economic and political situation in the country;
– decline in the purchasing power of the population.

Based on the SWOT analysis, the following solutions are proposed:

– access to new markets or market segments. This is an active role of marketing and flexible pricing policy;
– expanding the range of products through the inclusion of a wide range of natural supplements;
– a high price in comparison with analogous products on the market, by reducing the price of our own product by increasing production volumes;
– it is proposed to solve the informative nature of consumers about the new product by informing consumers about the properties of the new product;
– to reduce the impact of such factors as «the emergence of new competitors» and «growing competitive pressure» it is proposed: an active role of marketing, flexible pricing policy, expansion of the range. As for the «purchasing power reduction» factor, it is envisaged to take measures to position a new product among potential consumers;
– promotion of the product through merchandising.

8. Conclusions

1. The possibility of increasing the nutritional value of products by enriching beverages with vitamins and other substances, the source of which is whey and vegetable raw materials, is proved. Rationally rational ratios of ingredients in whey-based beverages; experimental data on the effect of plant ingredients on the biological activity of the whey-based beverages are obtained. The results of the studies confirm the possibility of using whey for the production of beverages. The biological value of the obtained beverages is 3.3...3.7 times greater than the biological value of whey.

2. Formulations of new dietary beverages of preventive purpose on the basis of whey are developed. The obtained beverages contribute to weight loss, this effect is possible due to the right combination of components, together they stimulate the metabolism. This is confirmed by the activation of pancreatic lipase. The increase in activity of pancreatic lipase in 3.8...4.0 times in comparison with the control (whey) is explained by the content of the introduced ingredients (ginger, cinnamon, L-carnitine, alpha lipoic acid, pineapple fruit extract, fruit and berry juices).

3. Beverages have different antimicrobial activity. Moderate antimicrobial activity is possessed by sample 8, and high – sample 5, which contains cinnamon, ginger, fruit and berry juices in its composition.

4. The results, characterizing the high physicochemical and organoleptic characteristics of beverages, are obtained. The technological parameters for the introduction of dry plant components are developed, namely: temperature – 50 °C, stirring time 30 min. Pasteurization regimes are developed: pasteurization temperature 84±2 °C, waiting time 15–20 s, shelf life of beverages 14 days at 4±2 °C.

References

1. Obesity and overweight [Electronic resource] // Fact sheet of the World Health Organization. – 2014. – Available at: \www/ URL: http://www.who.int/mediacentre/factsheets/fs311/en/

2. Perederii, V. G. Izbytochnyi ves i ozhirenie. Posledstviia dlia zdorov'ia i zhizni, sovremennye rekomendatsii po dostizheniiu i podderzhaniiu normal'noi massy tela [Text]: Monograph / V. G. Perederii, S. M. Tkach, V. M. Kutovoi, M. N. Rotter. – Kyiv: Start-98, 2013. – 240 p.
3. Rodionova, T. I. Ozhirenie – global'naia problema sovremennogo obshchestva [Text] / T. I. Rodionova, A. I. Tepaeva // Fundamental'nye issledovaniia. – 2012. – No. 12–1. – P. 132–136.
4. Bessesen, D. Evaluation & Management of Obesity [Text] / D. Bessesen, R. F. Kushner. – Hanley & Belfus, 2002. – 190 p.
5. Minina, S. A. Himiia i tehnologiia fitopreparatov [Text] / S. A. Minina, I. E. Kauhova. – GEOTAR-MED, 2004. – 560 p.
6. Pokrovskii, A. A. Spravochnik po dietologii [Text] / ed. by A. A. Pokrovskii, M. A. Samsonov. – Moscow: Meditsina, 1981. – 611 p.
7. Chabanova, O. B. Obgruntuvannia retseptur diietychnykh napoiv na osnovi syrovatky [Text] / O. B. Chabanova, S. I. Vikul, S. M. Bondar, O. F. Niedova // Naukovi pratsi ONAKhT. – 2014. – No. 44. – P. 185–192.
8. Hramtsov, A. G. Napitki iz syvorotki s rastitel'nymi komponentami [Text] / A. G. Hramtsov, A. V. Brykalov, N. Yu. Pilipenko // Molochnaia promyshlennost'. – 2012. – No. 7. – P. 64–66.
9. Hramtsov, A. G. Tehnologiia produktov iz molochnoi syvorotki [Text] / A. G. Hramtsov, P. G. Nesterenko. – Moscow: DeLi print, 2004. – 768 p.
10. Telezhenko, L. N. Human diet enrichment with physiologically active ingredients due to the consumption of juices and beverages [Text] / L. N. Telezhenko, E. A. Mikhailova // Journal of Food Science and Technology. – 2015. – Vol. 9, No. 3. – P. 9–13. doi:10.15673/2073-8684.3/2015.50267
11. Mogilnyi, M. P. Pishchevye i biologicheski aktivnye veshchestva v pitanii [Text] / M. P. Mogilnyi. – Moscow: DeLi print, 2007. – 240 p.
12. Yasmin, A. Compositional analysis of developed whey based fructooligosaccharides supplemented low-calorie drink [Text] / A. Yasmin, M. S. Butt, M. Yasin, T. B. Qaisrani // Journal of Food Science and Technology. – 2014. – Vol. 52, No. 3. – P. 1849–1856. doi:10.1007/s13197-014-1535-z
13. Amaral, G. V. Whey-grape juice drink processed by supercritical carbon dioxide technology: Physicochemical characteristics, bioactive compounds and volatile profile [Text] / G. V. Amaral, E. K. Silva, R. N. Cavalcanti, C. P. C. Martins, L. G. Z. S. Andrade, J. Moraes et al. // Food Chemistry. – 2018. – Vol. 239. – P. 697–703. doi:10.1016/j.foodchem.2017.07.003
14. Panghal, A. Utilization of Dairy Industry Waste-Whey in Formulation of Papaya RTS Beverage [Text] / A. Panghal, V. Kumar, S. Dhull, Y. Gat, N. Chhikara // Current Research in Nutrition and Food Science Journal. – 2017. – Vol. 5, No. 2. – P. 168–174. doi:10.12944/crnfsj.5.2.14
15. Chavan, R. S. Whey Based Beverage: Its Functionality, Formulations, Health Benefits and Applications [Text] / R. S. Chavan, R. C. Shraddha, A. Kumar, T. Nalawade // Journal of Food Processing & Technology. – 2015. – Vol. 6, No. 10. – P. 495. doi:10.4172/2157-7110.1000495
16. Gajbhare, S. N. Utilization of Encapsulated Lycopene for the Preparation of Tomato Whey Beverage as Health Drink [Text] / S. N. Gajbhare, V. N. Pawar, A. R. Sawate // The Indian Journal of Nutrition and Dietetics. – 2015. – Vol. 52, No. 1. – P. 70–79.
17. Dias, M. de L. L. A. Phisicochemical, sensory, and microbiological evaluation and development of symbiotic fermented drink [Text] / M. de L. L. A. Dias, S. M. Salgado, N. B. Guerra, A. V. S. Livera, S. A. C. Andrade, G. N. da C. Ximenes // Food Science and Technology (Campinas). – 2013. – Vol. 33, No. 4. – P. 805–811. doi:10.1590/s0101-20612013000400030
18. Pandiyan, C. Development of Mango Flavoured Sweetened Whey Drink [Text] / C. Pandiyan, R. A. Villi, V. Chandirasekaran // Journal of Indian Veterinary Association Kerala (JIVA). – 2011. – Vol. 9, No. 3. – P. 35–37.
19. Pareek, N. Preparation of healthy fruit based carbonated whey beverages using whey and orange juice [Text] / N. Pareek, A. Gupta, R. Sengar // Asian Journal of Dairying & Foods Research. – 2014. – Vol. 33, No. 1. – P. 5–8. doi:10.5958/j.0976-0563.33.1.002
20. Jain, S. Development of Low Cost Nutritional Beverage from Whey [Text] / S. Jain // IOSR Journal Of Environmental Science, Toxicology And Food Technology. – 2013. – Vol. 5, No. 1. – P. 73–88. doi:10.9790/2402-0517388
21. Tkachenko, N. Modelling formulae of strawberry whey drinks of prophylactic application [Text] / N. Tkachenko, P. Nekrasov, S. Vikul, Y. Honcharuk // Journal of Food Science and Technology. – 2017. – Vol. 11, No. 1. – P. 1–9. doi:10.15673/fst.v11i1.303
22. Brykalov, A. V. Razrabotka tehnologii napitkov na osnove molochnoi syvorotki, obogashchennyh fitokomponentami [Text] / A. V. Brykalov, N. Yu. Pilipenko // KubGAU. – 2014. – No. 98. – P. 1–12.
23. Cherevach, E. I. Razrabotka tehnologii funktsional'nyh napitkov na molochnoi syvorotke s rastitel'nymi ekstraktami [Text] / E. I. Cherevach, L. A. Tenkovskaia // Food Processing: Techniques & Technology. – 2015. – Vol. 39, No. 4. – P. 99–105.
24. Inihov, G. S. Metody analiza moloka i molochnyh produktov [Text] / G. S. Inihov, N. P. Brio. – Moscow: Pishchevaia promyshlennost, 1971. – 424 p.
25. Marh, A. T. Tehnohimicheskii kontrol' konservnogo proizvodstva [Text]: Handbook / A. T. Marh, T. F. Zykina, V. N. Golubev. – Moscow: Agropromizdat, 1989. – 304 p.
26. Honskyi, Ya. I. Biolohichna khimiia: laboratornyi praktykum [Text] / Ya. I. Honskyi. – Ternopil: Ukrmedknyha, 2001. – 288 p.
27. Lekarstvennoe rastitel'noe syr'e. Opredelenie antimikrobnoi aktivnosti antibiotikov metodom diffuzii v agar [Text] // Gosudarstvennaia farmakopeia SSSR: Vol. 2. Obshchie metody analiza. – Ed. 11. – Moscow: Meditsina, 1989. – P. 210–225.
28. Sposib vyznachennia biolohichnoi aktyvnosti obiektiv pryrodnoho pokhodzhennia [Electronic resource]: Patent UA 107506 S2 MPK G01N 33/00 (2015.01) / Khomych H. P., Vikul S. I., Kapreliants L. V., Osypova L. A., Lozovska T. S.; assignee: Odessa National Academy of Food Technologies. – Appl. No. a201302626; Filed 04.03.2013; Publ. 12.01.2015, Bull. No. 1. – Available at: \www/URL: http://uapatents.com/7-107506-sposib-viznachennya-biologichno-aktivnosti-obehktiv-prirodnogo-pokhodzhennya.html

ПЕРЕРАБОТКА МОЛОЧНОГО СЫРЬЯ В ПРОДУКТЫ ЗДОРОВОГО ПИТАНИЯ

Доказана перспективность использования творожной сыворотки и растительного сырья в производстве напитков профилактического назначения. Обоснованы рациональные соотношения ингредиентов в напитках на основе сыворотки. Получены экспериментальные данные о влиянии растительных ингредиентов на биологическую активность напитков. Разработаны рецептуры новых напитков. Разработана технология производства напитков на основе сыворотки для профилактики ожирения. Установлены режимы и сроки хранения напитков.

Ключевые слова: творожная сыворотка, растительное сырье, рецептуры новых напитков, показатели качества, режимы хранения.

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