

Using of whey in dairy desserts technology

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Abstract

Keywords:

Whey
Desserts
Fruit
Berry
Filler

Article history:

Received 25.10.2019
Received in revised
form 28.03.2020
Accepted 30.06.2020

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DOI:

10.24263/2310-
1008-2020-8-1-9

Introduction. Research is underway intensively in the world in the direction of modifying the structure and properties of whey. The purpose is to regulate the characteristics for use in various industries, including the creation of qualitatively new special purpose foods.

Materials and methods. The object of research – whey as a raw material in the production of dairy desserts.

Results and discussion. Work on the implementation of methods of the full cycle processing of whey by isolating, concentrating, modifying its properties and developing innovative technologies for its use in food products, including the intended purpose has a certain resource-saving orientation. This will allow effectively use of the technological properties of fillers, their synergistic interactions with each other and with whey. The ability to improve the functional and technological characteristics of whey. Expanding the possibilities of use in whey-based food production technologies.

Scientists are conducting research on the creation of technologies for the further use of whey in the dairy industry for the production of intermediate goods, process mixtures and functional products, to obtain complete food products for the intended purpose and thus to provide the population with proteins and nutrients in bioavailable form.

The introduction of resource-saving technologies and the production of high-quality and safe products with high consumer properties, contributes to solving the problem of protein deficiency, as well as providing the population of various social groups and living conditions with complete, balanced and bioavailable micronutrient composition, combined and multi-component target food products is of current importance area of research.

Conclusions. The combination of dairy components and fruit and berry fillers will provide the desired technological effect and original organoleptic characteristics of new types of dairy desserts.

Introduction

The development of non-waste technologies with the maximum use of helpful components that are part of the secondary raw materials is relevant for the food industry.

Whey is milk plasma, which is obtained by thermomechanical processing of milk clot during the manufacture of cheese, cottage cheese or casein.

The composition and physico-chemical properties of whey, depending on the type of main product and the features of the technology of its manufacture, are presented in the table 1 [1, 2].

Table 1
Composition and physico-chemical properties of whey

Index	Whey		
	Cheese	Curd	Casein
Dry matter content, %	4.5–7.2	4.2–7.4	4.2–7.4
Including:			
lactose	3.9–4.9	3.2–5.1	3.5–5.2
nitrogen compounds	0.5–1.1	0.5–1.4	0.5–1.5
mineral substances	0.3–0.8	0.5–0.8	0.3–0.9
milkfat	0.05–0.5	0.05–0.4	0.02–0.1
Acidity (pH), °T	15–25	50–85	50–120
Density, kg/m ³	1018–1027	1019–1026	1020–1025

Lactose is the main component of whey and accounts for about 70% of whey dry matter. A significant amount of biologically valuable whey proteins, free amino acids and minerals passes into the whey. Whey proteins are more finely dispersed than casein, are better absorbed by the human body and contain more essential amino acids [3, 4].

Whey proteins consist primarily of globulins and albumins. The main amongst the whey proteins is β -lactoglobulin, its share is about 10% of the total amount of milk proteins (table 2) [1].

Table 2
Total amino acids in whey

Whey	Amino Acids, mg/dm ³			
	Free		In proteins	
	Total	Including Essential	Total	Including Essential
Cheese	132.7	51.0	6490	3326
Curd	450.0	356.0	5590	2849

Milk fat contained in whey is finely dispersed, which has a positive influence on its digestibility. The composition of whey includes almost all the minerals of milk, as well as organic acids [5].

Lactic, citric, nucleic and volatile fatty acids (acetic, formic, propionic, butyric) were found among organic acids in whey. The content of volatile fatty acids in curd whey is higher

than in cheese whey, which is explained by partial hydrolysis of fat in the process of cheese clot formation [6, 7].

The food energy of whey is slightly lower than that of whole milk, and the biological value is even higher, which contributes to its use in dietary nutrition. Water-soluble vitamins almost completely pass into whey, besides there are a few more of them in cheese whey (table 3) [6].

Table 3

Whey Vitamin Content

Whey	Vitamins, mcg/kg								
	β -carotene	A	E	B ₁	B ₂	B ₆	choline	PP	C
Cheese	13	22	227	315	1389	524	160000	140	500
Curd	75	110	315	263	1107	478	140000	140	500

Due to the insufficient number of innovative developments, a significant part of the nutrients and regulatory substances necessary for the human body is being lost. Research is underway intensively in the world in the direction of modifying the structure and properties of whey. The purpose of which is to regulate the characteristics for use in various industries, including the creation of qualitatively new special purpose foods.

Whey is used for the manufacture of beverages, dairy products, concentrates, milk sugar, dessert products, namely, kysil, jelly, puddings and mousses. World and domestic experience shows the viability of research to improve the nutritional properties of whey-based dessert products. Desserts are made from natural pasteurized whey, concentrated or condensed, with or without the addition of fat-free cheese, sugar, semolina, fruit syrups, stabilizers. This group of products is intended for direct use [8, 9].

The aim of the research is to study the chemical composition, nutritional value and technological properties of whey as a promising raw material for the manufacture of milk desserts.

To achieve this aim, the following tasks were set:

- to justify the choice of raw materials for the manufacture of dairy desserts;
- to study the technological properties of whey as a potentially promising raw material for the production of dairy desserts;
- to substantiate the feasibility of using natural ingredients in the manufacture of milk desserts.

Materials and methods

The object of research – whey as a raw material in the production of dairy desserts.

The scientific-research papers, articles, conference reports, conference abstracts, monographs, various methods, technologies of whey processing were analyzed.

Results and discussion

Analysis of the current state of whey processing

Various fermented whey-based beverages have been developed to reduce waste. However, approaches to increase the preference of whey-based beverages are required because of the low sensory acceptability of whey. Here, we identified the better starting material (whey type), between raw whey (RW) and demineralised whey (DMW), and determined the optimal initial concentration using multiple sensory evaluations to develop acceptable fermented beverages made from sole whey with pure cultured *Kluyveromyces marxianus* (i.e. without additional ingredients and processing methods). Acceptance tests showed that fermented beverages made from DMW were superior to RW as the starting material. The amounts of ethanol produced were 5.0%, 7.6% and 9.5% v/v from the different initial DMW concentrations of 10%, 15% and 20% w/v, respectively. We observed a significant positive correlation ($r(s) = 0.32$, $P < 0.05$) between the assessment attributes, strength of taste as alcohol beverage and overall acceptability, indicating that higher concentrations of DMW yielded a more desirable product [10].

The replacement of dehydrated products such as whey protein concentrates and isolates (WPC and WPI) by liquid whey protein concentrates (LWPC) obtained by ultrafiltration can be an excellent alternative for the production of innovative dairy products. Thus, the aim of this work is to study the gelation properties of LWPC as raw material for acid-induced dairy gels. Acid-induced gels were produced with non-defatted LWPC, with or without fortification with skimmed milk powder (SMP), by bacterial fermentation and by glucono-delta-lactone (GDL) acidification. The fermented systems (yogurt type acid gels) produced weaker gel structures than the equivalent chemically acidified gels (dessert type acid gels). It was also observed that molecular rearrangement continues during cold storage and that fortification with SMP favored gelation. Whey-based dairy gels obtained by fermentation or by glucono-delta-lactone acidification presented viscoelastic behavior, appealing functional and nutritional properties, and their utilization can effectively contribute to the reduction of waste [11].

At KhDUHT there were developed combined dairy-vegetable functional drinks and dressings based on whey, nanostructured from pumpkin, apples, lemons and oranges with zest. Also as a biocorrector a multiphytocomposition was, which included biologically active substances in ionomolecular form from calendula flowers, leaves of lemon balm, oregano, thyme, marjoram, lemon wormwood, coriander seeds, etc. As a stabilizer of the structure of multicomponent drinks and dressings was nanostructured puree of pumpkin, apples and oranges with zest. They contained water-soluble pectin in active form, and citrus pectin was additionally added to the dressing. The taste and aroma of the drinks were provided by the natural flavoring "Aroma", which is formed during the production of concentrated apple juice and extracts from natural spices. The yellow-orange color was provided by nanostructured pumpkin puree. The drinks were additionally enriched with vitamin C, taking into account the recommendations of the Ministry of Healthcare of Ukraine [12].

Using date syrup, whey permeate, and whey a novel kefir beverage was developed. The levels of the kefir grain inoculum (2–5% w/v), fruit syrup (10–50% w/v), and whey permeate (0–5% w/v) on pH, total phenolic content, antioxidant activity, lactic acid bacteria and yeast counts, and overall acceptability were investigated using central composite design. The use of response surface methodology allowed us to obtain a formulation with acceptable organoleptic properties and high antioxidant activities. The obtained beverages had total phenolic content, % DPPH scavenging activity, and overall acceptability ranging from 24 to

74 mg GAE/mL, from 74.80 to 91.37 mg GAE/mL, and from 3.50 to 6 mg GAE/mL (based on a 1 to 9 preference scale), respectively. Date syrup of 36.76% (w/v), whey permeates of 2.99%, and kefir grains inoculum size of 2.08% were the optimized process conditions achieved [13].

A gel-like emulsion stabilized with whey protein was prepared by microfluidization, and the effects of the oil phase fraction on the physical properties of emulsions were studied. The rheological analysis indicated that these emulsions exhibited thixotropic behavior, and their apparent viscosity and solid-like behavior increased with increasing oil fraction from 0.3 to 0.6 (v/v). The microstructures, droplet size distribution, and thermal stability of these emulsions were also characterized using a light microscope, dynamic light scattering (DLS), and differential scanning calorimetry (DSC), respectively. The viscosity of these emulsions increased in an exponential way versus increasing oil fraction and showed good correlation coefficient ($R^2 > 0.99$). The size of droplets in the emulsion increased from 301 ± 3.6 to 597 ± 7.3 nm. The DSC results showed that the crystalline peak of these emulsions gradually decreased from -15 to -21 degrees C and started thawing at similar to 3 degrees C. Visually, the textures of these emulsions could be transformed from flexible to rigid by changing the oil fraction, which suggests they could have multiple potential applications. Finally, the semi-solid emulsions were fabricated into delicate shapes using extrusion-based 3D food printing. Based on the results obtained, these emulsions may have the potential to be used as a solid-like fat substitute, which could be used in various applications such as cake decoration or customized functional foods [14].

Systematical consumption of functional products has a significant positive effect on health and can reduce the risk of diseases. The aim of this study was to investigate the possibility of using whey protein hydrolysate (WPH) and pumpkin pectin as ingredients in a functional mousse, to evaluate the mousse's antioxidant and hypotensive activities *in vitro*, and to evaluate the effect of the long-term intake of mousse samples on the progression of hypertension in spontaneously hypertensive rats (SHRs) and on the microbiome status in Wistar rats with antibiotic-induced dysbiosis. The experimental mousse's *in vitro* antioxidant activity (oxygen radical absorbance capacity) increased by 1.2 times. The hypotensive (angiotensin-1-converting enzyme inhibitory) activity increased by 6 times in comparison with a commercial mousse. Moreover, the addition of pectin allowed the elimination of the bitter aftertaste of WPH. *In vivo* testing confirmed the hypotensive properties of the experimental mousse. The systolic blood pressure in SHRs decreased by 18 mmHg and diastolic blood pressure by 12 mmHg. The experimental mousse also showed a pronounced bifidogenic effect. The *Bifidobacterium* spp. population increased by 3.7 times in rats orally administered with the experimental mousse. The results of these studies confirm that WPH and pumpkin pectin are prospective ingredients for the development of functional mousses [15].

With a long-term nutrition goal for healthy aging, the aim of this study was to compare the bioavailability of amino acids, in particular the leucine, after the ingestion of two solid and isocaloric dairy products (cheese) based either on whey or on caseins, by using pig as an *in vivo* digestion model. The whey-based cheese contained 25% more leucine than Mozzarella, however its digestion by pigs resulted in a concentration of postprandial plasma leucine between 2 h and 5 h30 twice higher than that produced during the digestion of Mozzarella. Noting that the dry matter of the duodenal effluents were similar after each of the two cheese meals, differences in gastric emptying would not explain the difference in leucine bioavailability. These results suggest the possibility of stimulating more efficiently the muscle synthesis in elderly people with cheese based on whey proteins rather than those based on caseins [16].

Production is relevant of liquid whey protein concentrates by ultrafiltration followed by thermal denaturation and homogenization of the ultrafiltered concentrate, as well as on the production of ultrafiltered permeates concentrated by reverse osmosis. Kefir grains (fresh and thawed) and/or commercial probiotic bacteria were inoculated in both liquid whey protein concentrates and concentrated ultrafiltered permeates and grown at 25 degrees C for 24 h for the manufacture of fermented drinks. The physicochemical characterization (pH, titratable acidity, viscosity, and content of total solids, ash, fat and proteins) of the obtained drinks was then assessed and compared. Enumeration of viable microorganisms was carried out immediately after inoculation (at 0 h), during the fermentation period (at 12 and 24 h) and during refrigerated storage (at 48, 168 and 336 h). The fermented drinks showed acceptable physicochemical and sensorial properties, and contained above 7 log CFU/mL of lactococci and lactobacilli and 6 log CFU/mL of yeasts after 14 days of refrigerated storage, which is in agreement with the standards required by international organizations like European Food Safety Authority (EFSA) and Food and Drug Administration (FDA) for products containing probiotics. In summary, the strategy developed in this work contributes to the expansion of the applications of products derived from whey fractionation for the design of novel functional foods [17].

Natural plant ingredients in dairy technology

In contemporary dairy industry, especially in the cheese or casein production, only 10–20% of processed milk is directly available for produced cheese and casein, while 80–90% of raw milk is transferred into the main by-product, whey. Due to insufficient utilization, whey was becoming the major pollutant, what is entirely inconsistent to its potentials as a raw material. Whey is an excellent source of high quality proteins, minerals, vitamins and lactose that can be used in daily nutrition, or transformed throughout the different technological processes into the numerous valuable food products. The main goal of paper is to test the possibility of carrot juice use in the production of functional fermented drinks based on whey, as well as to estimate the possibility of inclusion of its production within the process of cheese production. Materials and methods – based on previous laboratory tests, conducted at the Faculty of Technology and Metallurgy-Belgrade University, that were focused on increase of utilization of available raw materials in dairy industry, dairy drink based on cow whey and carrot juice has been established. Later, according to realistic data (input values), using the SuperPro Designer program (software), the simulation and economical evaluation of the establishment of created fermented drink production process was done. Integrated production process of cow cheese that includes production of fermented drink based on whey and carrot juice has shown greater economic sustainability compared to basic process of cheese production. Establishment of mentioned production process could enable extra short payback period (PP), (0.15 years), as well as high level of net present value (NPV), (10,464.04 x 10⁶ US\$) and internal rate of return (IRR), (384.61%). Besides, inclusion of line for beverage production within the process of cheese production enables achieving of improved quality product that can be in line to most requirements of highly sophisticated consumers, increasing the totally achieved profit (economic efficiency) of dairy industry. The production of functional fermented whey-based beverages represents one of the efficient alternatives related to better whey utilization. Created type of functional beverage production covered by unique production process leads to the utilization of all whey potentials that has as a raw material, material which also represents biologically strong pollutant. So, besides removal of certain quantity of whey from environment, it could be got a cheap, nutritionally valuable, healthy and fully natural product [18].

Research, gum Arabic (GA) and whey protein nanofibrils (WPN) were employed for the encapsulation of curcumin as a bioactive compound with low water solubility through the complex coacervation method. The optimum conditions for the formation of complex coacervates were found at WPN/GA weight ratio of 1:1 and pH value of 3.0. The resulting complexes showed a high ability for loading of curcumin as a bioactive cargo. Fluorescence spectroscopy showed that the curcumin was loaded in the hydrophobic core of WPN/GA coacervates. The characteristics of curcumin-loaded coacervates were also evaluated by XRD and FT-IR analysis. The curcumin-loaded complex coacervates dispersions showed a shear thinning behavior. They also showed a good surface activity which makes them excellent candidates to fabricate new functional food emulsions and beverages. The results indicated that the antioxidant activity and photo-stability of curcumin were significantly improved by encapsulation into WPN/GA complexes. A sustained-release profile also was investigated for curcumin from WPN/GA complexes in the simulated gastrointestinal conditions. This study suggested that the WPN/GA electrostatic-driven complexes can be used as efficient carriers for curcumin delivery [19]. The results of researches to substantiate the rational parameters of the extraction of biologically active substances from flowers *Tagetes patula* are presented. The recipe composition of the health-improving beverage based on curd whey, an infusion of *Tagetes patula* flowers, and berry filling «Forest Berry» (Lisova Yahoda) has been optimized. Recommendations on the development of technologies for non-fermented and fermented whey and vegetable drinks for health purposes are given. Substantiated rational parameters of the process of extracting biologically active substances from *Tagetes patula* flowers by drinking water: temperature (95 ± 5) °C, duration 60 min., duty of water 10. The obtained infusion of marigold flowers contains 2.0% of dry matters, including flavonoids – 42.1–42.3 mg / 100 g, which causes high biological activity – 230–232 enzyme units. Therefore, the infusion of *Tagetes patula* flowers is recommended to use as a physiologically functional food ingredient in the production of health beverages based on curd whey [20].

In recent years, the sphere of manufacture of dairy functional products and the use of dietary supplements in their production has been developing rapidly. Use of phytonutrients will significantly expand the range of traditional products, which will have the properties of the base product and the filler that is used, and the result of their joint action. Currently, preference will be given to those products that have the ability to cleanse body of radionuclides, heavy metals, toxins, ensure optimal functioning of the consumer's body and increase its resistance to adverse environmental factors. In recent years, cryopowders have been actively involved in the list of natural dietary supplements. Traditional cryopowders are powders, concentrates of fruit pulp and juice, which are immediately absorbed by the body. Moreover, they are able to remove radionuclides, cholesterol, toxins and contain 6–10 times more nutrients than canned fruits or vegetables. Considering the biocompatibility, almost (practical) non-toxicity, there is a possibility of prolonged use of cryopowders for treatment and preventive care purposes in the form of impurities in food. These dietary supplements can be used as a natural enhancer to enrich food with vitamins, microelements, organic acids, carbohydrates, dietary fiber in the manufacture of dairy products, sweet foods (jellies, mousses, sambuca, kysil), cooking, jams, various beverages. Cryopowders from edible plant raw materials contain a wide range of carbohydrates, pectin, as well as vitamins, amino acids, fiber, polyphenolic compounds. The complex structure of chemical and biochemical compounds, that are part of cryopowders, allows them to be classified as products with a wide range of treatment and preventive, radioprotective properties, including types of domestic curd mass, desserts, processed cheeses and fermented milk beverages [21].

The use of barley malt extract as a recipe part of the product contributes to the solution one of the problems of the dairy industry – creation of technology for new fermented dairy products with a combined composition of raw materials. Such products are characterized with increased nutritional and biological value without the addition of sugar. The concentration of barley malt extract influences the physico-chemical parameters of milk base: acidity, water content, water holding capacity [22].

The possibility of using pear and cinnamon in the technology of kefir made by thermostatic method is substantiated. Natural sources of plant raw materials were selected – pear, which contains sugar, organic acids, enzymes, fiber, tannins, nitrogen and pectin, vitamins C, B1, PP, carotene, flavonoids, volatile and cinnamon, which contains essential oils, tannins, resins, minerals and dietary fiber. The technology of cooking of pear fillers, namely, pear puree and pear jam, has been developed [23].

The dairy industry produces a wide range of dairy products, a significant share of which is occupied by products with various flavoring components. Not all of them are natural and have certain restrictions on consumption. Consequently, the task today is to create products of a balanced composition for nutrition of school-age children, corresponding to physiological needs in nutrients and energy, and contain only natural ingredients. To give products a pleasant taste and aroma, the use of fruit and berry processing products is promising. Particularly noteworthy are fruits of wild plants, which often contain useful biologically active substances, even more than in garden species, and have a lower cost [24].

The most accessible raw materials in Ukraine are fruits such as apples, which are characterized by a high content of low molecular weight phenolic compounds, such as ursolic acid, quercetin, rutin, caffeic, ferulic, quinic acids, etc. They have healing properties on the human body. They are also natural antioxidants and immunomodulators, strengthen the capillaries of the heart and brain, remove heavy metal ions from the gastrointestinal tract, etc. In addition, apples contain a significant amount of such Biologically Active Compounds (BAC) as vitamin C, pectin, tannins, and others. Besides, on Ukrainian market due to export, there are inexpensive vitamin tropical fruits, such as oranges, lemons, bananas, etc. They are consumed mainly fresh. Food additives in the form of pastes or frozen purees, cooked of them, are absent. Hence, it is important to create additives from these fruits in the form of frozen puree with maximum preservation of BAC and to use them in health foods, including ice cream. So far, we have not found any data on the production of frozen additives in the form of puree. The influence of "shock" freezing and low-temperature grinding on changes in the main BAC during the processing of plant raw materials has not been studied either [25].

Characteristics of Biologically Active Compounds in frozen finely dispersed fruit supplements compared to fresh raw materials are given in table 4 [25].

Due to the peculiarities of the chemical composition, fruit and berry raw materials not only enrich taste and color of milkshakes, but, having certain surface-active properties, participates in the formation of foam structures, due to the content of pectin substances [26, 27]. Pectin, which is a part of fruit and berry raw materials, is a surfactant. Its molecules have a diphilic structure, i.e., they contain lyophilic and lyophobic (usually hydrophilic and hydrophobic) atomic groups. Hydrophilic groups provide its solubility in water, hydrophobic at a sufficiently high molecular weight help to dissolve surfactant in a nonpolar environment. At the phase boundary, hydrophilic groups are oriented toward the polar phase, hydrophobic – toward the nonpolar (gas) phase. Thus, an interfacial boundary layer is formed, due to which the surface tension is reduced and the foams formation becomes possible or facilitated. In this way, the surface-active properties of pectin influence foaming ability of fruit and berry raw materials, which is an important factor in the development of milkshake technology [28].

Table 4

Comparative characteristics of content of biologically active compounds of raw materials

Product	Mass fraction, mg in 100 g				Pectin, %
	L-ascorbic acid	Phenolic compounds (chlorogenic acid)	Flavonol glycosides (rutin)	Tannins	
Fresh apples of «Snow Calvil» variety	11.3±0.6	1720.2±1.3	540.0±3.5	843.8±6.3	1.1±0.01
Nanostructured puree of apples of the «Snow Calvil» variety	45.7±3.2	2541.0±13.8	980.3±6.4	1170.5±10.3	2.8±0.02
Fresh apples of «Semerenko» variety	50.0±5.1	1830.8±11.4	620.5±3.6	923.5±5.2	1.2±0.01
Fresh bananas	13.2±0.7	1100.5±9.8	610.0±3.6	530.0±3.1	1.0±0.01
Nanostructured puree of bananas	48.6±3.4	1901.3±11.8	1003.3±6.4	965.0±7.6	2.5±0.02

It is known that vegetable and fruit raw material has a high content of nutrients that reveal functional properties.

In terms of accumulation of sugars (mainly glucose), grapes have no equal among other fruit and berry plants (up to 30% in some varieties). Grapes contain 10–20% sugars and 0.6–2.0% acids, mainly tartaric and malic. Except sugars and acids, berries contain pectin substances (on average 0.2%), vitamins, potassium salts, calcium, magnesium, iron, manganese, copper, cobalt, etc. Rind contains tannins and dyes from the group of anthocyanins, as well as essential oil; in seeds – 4–19% and 1.8–8.0% of tannins [29].

Vitamins of group B, K, C, carotene, surfactants were found in grapes, but there are quite few of them in berries. For example, vitamin B is 0.06 mg / 100 g, carotene is not higher than 0.5 mg/100 g, and the average amount of vitamin C does not exceed 4 mg/100 g. Among the entire group of biologically active substances contained in fruits, only three deserve attention: vitamins B₉ (folate) – up to 0.5 mg/100 g, surfactants (up to 450 mg/100 g) and vitamin K (phyloquinone) – up to 2 mg/100 g. In trace elements contained in the pulp of berries a large quantities of iron (up to 600 µg/100 g), manganese (up to 90 µg/ 00 g), copper (up to 80 µg/100 g) were found [29].

Molecular identification and genetic analysis of cherry are necessary for solving the problem of synonyms and homonyms that occur in cherry production. In this study, capillary electrophoresis with fluorescent-labeled simple sequence repeat (SSR) primers was used to identify 63 cherry cultivars (varieties and rootstocks) planted in Shaanxi province, China. A total of 146 alleles were amplified by 10 SSR primer pairs, ranging from 10 to 20 per locus (mean: 14); among the SSR primer pairs, genotype number ranged from 12 to 26 (mean: 18). The mean values of gene diversity, heterozygosity, and polymorphism information content were 0.7549 (range 0.4011–0.8782), 0.5952 (range 0.3810–0.9683), and 0.7355 (range

0.3937–0.8697), respectively. An unweighted pair-group method with arithmetic average cluster analysis was used to separate the cherry cultivars. A model-based structure analysis separated the cultivars into three populations, which was consistent with the results of a phylogenetic and principal component analysis. Based on Bayes' rule, the cultivars were further subdivided into seven populations. Some of the 63 cherry cultivars that are often confused in production were distinguished, and DNA fingerprinting of cherry cultivars was established. This research will significantly assist in the identification of cherry cultivars at the molecular level [30].

Sweet cherries contain 10.0–13.5% sugars and very little acids (0.3–0.6%, predominant malic). That is why their fruits are sweeter than the fruits of cherries and southern varieties of cherries, their amount of organic acids reaches 1.3–1.6%. Their fruits have the same or slightly less vitamins than cherries. An increased levels of surfactants were observed only in varieties with dark-colored pulp. Their seeds, like cherries, contain bitter glycoside amygdalin [31].

Persimmon fruits have greater nutritional value mainly due to their content of glucose and sucrose (up to 25%). Food energy of 100 g of edible part of the fruit is 56–78 kcal. Persimmon also contains vitamin C, provitamin A, malic and citric acid, a lot of iron, calcium, copper, manganese and potassium. It has 16.3–21.8% of dry matter; 0.6–0.8% protein; 0.2–2.4% fat; 1.2–1.9% fiber; 0.4–0.9% ash. The mineral composition of the fruit is represented by calcium (6–10 mg / 100 g), phosphorus (10–26), iron (0.3–3.0), sodium (2–6), iodine (up to 50 mg/100 g), potassium (174–176 mg/100 g). The vitamin complex consists of vitamin C – 10–20 mg/100 g, β -carotene – 600–1 626 mg/kg, vitamins B₁ – 0.03–0.05 mg/100 g, B₂ – 0.02–0.05 and B₅ – 0.05–0.3 mg/100 g [31].

Persimmons contain much more antioxidants than apples. And although there is more copper and zinc in apples, persimmon is the first in terms of sodium, potassium, magnesium, calcium, and iron. As well persimmon has more β -carotene, which protects against cancer, and 2 times more dietary fibers and minerals than apples [31].

Quince in raw form is not very edible due to the viscous taste caused by high content of tannins. Among the organic acids, citric dominates. It has little sugars from 0.8 to 2.0%. By the content of tannins, it is close to wild apples, the amount of pectin takes one of the first places among other fruits and berries. Ripe fruits of only certain Transcaucasian and Central Asian varieties are used for food, which have few tannins and sugars content reaches 15%. After 5–6 months of storage, they become soft and suitable for fresh consumption and are well preserved until January-March [31].

Apricot fruits are delicious and nutritious. They contain 4.7–20% sugars, 0.3–2.6% organic acids, 0.5–1.6% pectin, vitamins B₁, B₂, C, carotene, biologically active phenolic compounds. The carotene content is 1.6 mg/100 g. Among sugars, sucrose prevails, the main acids are malic and citric. The seed kernel in some varieties is sweet, in others it is bitter, it contains up to 25% protein and 45–58% sweet-tasting high-value vegetable oil. The sweet kernel of apricot seeds is used as a substitute for almonds [31].

Apricots are high in potassium (up to 305 mg/100 g) and copper. Potassium has a positive effect on the heart muscle, prevents fluid retention in body tissues. Apricot fruit is used to make varenya, jam, powidl, jelly, compot, marmalade, succades, juices, dried fruits – dried apricots (kuraga – seedless fruits) and uryuk (seed fruits), in which level of sugars increases to 52–93% [31].

Peaches in chemical composition are close to apricots. Peach fruits contain many mineral salts that are quite useful for the body. They are also high in vitamins and enzymes. Peach fruits are high in carotene, potassium and iron (iron in these fruits is in an easily digestible form for the human body). They also have a lot of amino acids, vitamins B₁, B₂,

C, E, P, PP, folic acid. Peaches have sugars (up to 15%), malic, tartaric, citric, quinic, chlorogenic acids, vitamins A (0.62%) and C (12–20 mg/100 g), dyes (carotenoids: lycopene, cryptoxanthin, zeaxanthin), and essential oils, which influence smell of peaches. Chemical composition of its seeds includes fatty oil – up to 57% (consisting of oleic, palmitic and stearic acids; and sitosterols), glycoside amygdalin, and bitter almond essential oil (0.4–0.7%) [31].

Banana's pulp food energy is quite high from 80 to 240 kcal for 100 g. Banana pulp in raw form contains 30% of dry matter, 27% – carbohydrates, including 15–25% sugars, 7–20% – starch, 0.5% – fiber and pectin, 0.3–0.6% essential oil. The pulp has up to 1.3% of proteins, which contain the essential amino acid tryptophan. Isovaleric, isoamyl and isoamyl ethers give a peculiar aroma to the fruit. Vitamin complex consists of vitamin C – 37–53 mg/100 g, β -carotene – up to 30 mg/kg, vitamins B₁ – 0.04–0.07 mg/100 g, B₂ – 0.02 and B₃ – 0, 2–0.3 mg/100 g, as well as vitamins B₆, PP, E. The mineral composition of bananas is big and varied. It is represented by calcium (8–33 mg/100 g), phosphorus (21–38), iron (0.4–1.4), sodium (1–5), magnesium (42), copper (0.16), zinc (0.2), and potassium (370–401 mg/100 g). Moreover, bananas have biologically active compounds: catecholamines, serotonin, norepinephrine, dopamine, as well as ephedrine. An enzyme, helping to absorb carbohydrates, has been found in bananas. There are a lot of tannins and carotene in the fruit rind [31].

The pulp of fresh pineapple contains 13.0–14.7% dry matter, 0.4–0.7% proteins, 11.6–13.7% carbohydrates, 0.4–0.5% fiber, from 8 to 18% sugars, mainly sucrose, 0.4–1.4% – free organic acids, mainly citric, 0.3–0.4% – ash. Pineapples are quite high in potassium (125–321 mg/100 g), calcium (17–18 mg / 100 g), magnesium, phosphorus (8–12 mg/100g). Also they have iron (0.5 mg/100 g) and copper [31].

Dates have high food energy 142–274 kcal for 100 g of edible part of fruits, if it's dried dates than – 340 kcal. Dates contain from 40.0 to 77.5% of dry matter; 26–55% of sugars, mainly glucose and fructose; 0.9–2.9% protein; 0.3–1.0% of fats; 1.7–6.5% of fiber. Dates contain 1.0–1.9 of ash constituents, they are represented by phosphorus (30–350 mg/100 g), calcium (34–60 mg/100 g), iron (0.7–6.0 mg/100 g), potassium (up to 700 mg/100 g), sodium (up to 1 mg/100 g). Vitamin complex of dates consists of β -carotene (30–145 mg/kg), vitamins B₁ (0.07–0.09 mg/100 g), B₂ (0.05–0.1 mg/100 g), B₅ (0.1–2.2 mg/100 g), vitamin C (up to 30 mg/100 g), E. The seeds contain an average of 23.2% fat and 5.8% protein [32].

Figs have similar chemical composition to dates. Due to its high fiber content (12.5%) it is a good stimulant of bowel and liver functions. Fresh figs fruits consists of pulp (84%) and rind (16%). They have from 12.3 to 22.5% dry matter, up to 20.3% carbohydrates, including 11.2–18.0% sugars (glucose and fructose), 0.5% organic acids (mainly malic and lemon, as well as pyruvic, tartaric, etc.), 0.7–1.6% protein, 1.2–1.9% fiber, 0.2–0.4% fat, up to 2.5% pectin. The protein contains an essential amino acid tryptophan. The vitamin complex is represented by β -carotene – 60–200 mg/kg, vitamins B₁ and B₃ – 0.02–0.5 mg/100 g, rutin – 60–80 mg/100 g, vitamin C – 2–25 mg/100 g, vitamin P – 0.5 mg/100 g. In figs were others biologically active compounds – carotenoids, bioflavonoids, tocopherols, various enzymes. In terms of minerals, figs take one of the first places among fruits and berries. 14 mineral elements were found in the fruits: 177–286 mg/100 g of potassium; 1.6–1.8 – sodium; 34–52 – calcium; 20.0 – magnesium; 32.2 – phosphorus; 0.4–3.2 – iron; 0.06 – copper; 12.9 – sulfur and others. Food energy of fresh figs is low – 40–80 kcal/100 g [31].

Strawberries contain from 5.5 to 9.2% sugar, 0.56–1.57% organic acids, vitamin C – up to 80 mg/100 g (but there are also varieties in which the content of ascorbic acid in the fruit does not exceed 15–30 mg/100 g), carotene (0.03 mg/100 g). Reactive compounds (catechins, anthocyanins, flavones, etc.) – from 250 to 750 mg/100 g, 0.064–0.128% of tannins and dyes.

In strawberries were also found such organic acids as malic (dominates), citric, quinic, oxalic, succinic, and salicylic. Pectin makes up 0,75 % of strawberries' chemical composition. The berries contain a fairly significant amount of vitamin E (0.54 mg/100 g), surpassing oranges, tangerines, red currants, bananas, cherries, sweet cherries and a number of other fruits and berries [31].

Sugars are mainly represented with glucose and fructose, sucrose is much less. It was established that amount of sugar in berries depends on the time of collection. Thus, more sugars are found in the berries of the first harvest and much less in the fruits of the second harvest. The third harvest takes a medium position. Compounds of potassium, calcium, magnesium, sodium, sulfur, phosphorus, and chlorine were found in the berries. In terms of amount of potassium strawberries, however, are inferior to many fruit and berry crops – gooseberries, raspberries, black currants, plums, apples, apricots, peaches, grapes. Among trace elements in strawberries there is iron, boron, vanadium, iodine, cobalt, manganese, copper, molybdenum, zinc, etc. Strawberry leaves contain ascorbic acid (up to 300 mg/100 g), tannin, alkaloids (traces), glycoside fragmentarin, carotene, polysaccharide, ash (8.12%), macronutrients (mg / 100 g); potassium – 21.90, calcium – 14.70, magnesium – 4.50, iron – 0.60. A lot of iron was found in the seeds, tannins and iron were found in the rhizomes [31].

Raspberries contain 5–9% of sugars (approximately equal amounts of glucose and fructose), 1–3% of organic acids (mainly malic and little bit of citric, salicylic, oxalic, formic, etc.), 0.9–1.2 % of pectin, 0.03–0.13% of tannins and dyes, also up to 5% fiber, that stimulates the intestinal motor function and helps to remove cholesterol from the body. Among vitamins, ascorbic (25–30 mg/100 g), folic acids (6 µg/100 g) and P-active compounds (50–100 mg/100 g in yellow fruit and 200–300 mg/100 g in red fruit) are the main. The pulp of the berry is high in iron [31].

Depending on growing conditions, cornelian cherry contains 6.4–10.2% of sugars (mainly glucose and fructose), 1.4–3.0% of organic acids (with the predominance of malic), 0.2–0.4% tannins and dyes, on average about 60 mg/100 g of vitamin C. Pulp yield – 68–81%. Fresh leaves have vitamins E and C. Due to the presence of phytoncides, fruits, leaves and bark have bactericidal properties [31].

Viburnum berries contain 6.5–7.8% of sugars (mainly glucose and fructose), 1.7–1.9% of organic acids (malic, valeric), 0.4–0.6% of pectin. The peculiar aroma of fresh berries of viburnum is caused by valeric acid, essential and other compounds. Viburnum berries are quite high in carotene (1.4–2.5 mg/100 g), ascorbic acid (up to 50–75 mg/100 g in the best selected forms) and P-active compounds (300–500 mg/100 g) [31].

Sorbus (rowan) contains 5.9–8.0% sugars (fructose predominates), 1.8–3.6% organic acids (malic, in small quantities parasorbic, tartaric, succinic and oxalic), 0.3–0.6% pectin. In addition to fructose, glucose and sucrose in fruits were found up to 3% of sorbitol, which is a substitute for sugar. Rowan is a multivitamin plant. Ripe fruits contain significant amounts of carotene (more than some varieties of carrots and sea buckthorn) ascorbic acid, P-active compounds and vitamin E (up to 5.1 mg/100 g) [31].

Blackcurrant contains 5–12% of sugars (mainly fructose), 3–4% organic acids (citric prevails), 0.8–1.4% of nitrous, 1.1–1.7% – pectin, nearly 0.4 % tannins, as well as up to 3% of fiber. The berries, leaves and buds of blackcurrant, in their chemical composition, are a natural and complex concentrate of vitamins. Amount of vitamin C (up to 300–340 mg/100 g) in blackcurrant fruits (second only to rose hips and actinidia) is 4–5 times higher than in strawberries and citrus fruits, 8–10 times than in gooseberries and raspberries, 15–20 times higher than in apples, cherries and plums and the most rich in vitamin C green berries. As they ripen, C-vitamin activity decreases and reaches the lowest level in overripe fruits. The high content of P-active compounds (1000–1.200 mg/100 g and higher) in combination with

vitamin C has a beneficial effect on the activity of the human cardiovascular system, helping to maintain the elasticity of capillary blood vessels. In berries quite a lot of vitamins E and K (0.7–0.9 mg/100 g). In terms of vitamin E, blackcurrant surpasses almost all fruit and berry crops, second only to sea buckthorn, rosehip and chokeberry. Black currant berries have many useful salts of potassium, calcium, iron, phosphorus, magnesium and numerous trace elements, which are part of organic compounds and are easily absorbed by the body. Among other fruits black currant has a high level of potassium (more than 370 mg/100 g). Iron in berries is much more than in citrus fruits, grapes, gooseberries, plums, apples, apricots and others [31].

Chokeberries have, on average, about 1.2% of acids, 7.5% of sugars (mainly glucose and fructose), 17% – dry matter, 0.5% pectin and up to 0.4% tannins (hence the tart-viscous taste). There are 3.5% of sorbitol – a sugar substitute for patients with diabetes. Amount of vitamin C in chokeberry is low (10–25 mg/100 g), but the amount of P-active compounds reaches, on average, 1.500–2.500 mg/100 g. According to this indicator, chokeberry cannot be surpassed by any fruit and berry crop. Also such biologically active compounds in the fruit were found: carotene, vitamin K, nicotinic acid, vitamin E, B vitamins. Chokeberries also have high level of trace elements: boron, cobalt, copper, molybdenum, fluorine and others. The pulp contains, on average, 1.2 mg/100 g of iron, 0.5 mg/100 g of manganese. In terms of iodine content, chokeberry is 2–3 times superior to other fruits and berries [31].

A review of recent researches has shown that with help of complex processing of fruit and berry raw materials, it is possible to expand and improve the production of dairy products.

Conclusion

1. The high biological value of whey, its functional properties and the possibility of using it as a basis for various food products, determine the relevance of creating new dairy desserts.
2. The analysis of literature shows that development of innovative whey technologies, and its complex use with food from animal and vegetable raw materials is a promising direction in the development of resource-saving food technologies.
3. The mechanism of joint work milk components with fruit and berry fillers requires a theoretical explanation, which provides desired technological effect and original organoleptic characteristics of the products.

Acknowledgments. The research was carried out on the example of the conditions of Central and Eastern Europe, as part of scientific study (R&D) «Implementation of resource-saving methods of modification of functional and technological characteristics of whey in food technology of products with special purpose» (State registration number 0120U100868).

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