Influence of processing parameters on the techno-functional properties of berry coagulants

Liudmyla Deinychenko[1], Grygorii Deinychenko[2], Victoriya Gnitsevych[2], Tamara Kravchenko[3]

1 – National University of Food Technologies, Kyiv, Ukraine
2 – Kharkiv State University of Food Technology and Trade, Kharkiv, Ukraine
3 – Pavlo Tychyna Uman State Pedagogical University, Uman, Ukraine

Keywords:

Milk Protein Concentrate
Berry
Purees
Pectin

Article history:

Received 01.06.2019
Received in revised form 21.12.2019
Accepted 30.03.2020

Corresponding author:

Liudmyla Deinychenko
E-mail: deliugri@gmail.com

DOI: 10.24263/2304-974X-2020-9-1-7

Abstract

Introduction. The aim of the research is to determine the influence of the parameters of hydrothermal treatment and rubbing of berry raw materials on the content of soluble pectins in berry purees. Attention is paid to the compliance of the purees with the requirements for berry coagulants, which can be used to obtain milk-protein co-precipitates from the buttermilk.

Materials and methods. Fresh cranberries and viburnum berries were chosen as the subjects of study. The treatment of the berries with acute vapor was made with the help of the electric steam-convection oven of the injector type at a temperature of 105–107 °C during 5–60 seconds. The berries rubbing was made with the help of a crushing-rubbing machine using sieves with hole diameters of 0.4–1.2 mm.

Results and discussion. The content of pectin substances in both berry purees increases in direct proportion to the extension of hydrothermal treatment from 5 s to 60 s. The viburnum puree is characterized by the slower increase in the amount of pectin substances comparing to the cranberry puree, which can be explaned by the difference in the structure of protopectin molecules.

The losses of vitamin C for both berry purees are relatively low in the first 15 s of treatment, while then they are increasing rapidly due to the acceleration of hydroxyl bonds breaking in the ascorbic acid structure.

Processing berry raw materials with an acute vapor is considered rational at a temperature of 105–107 °C for 15–30 seconds for cranberries and 5–15 seconds for viburnum berries, which corresponds to an increase in the amount of pectin substances on 19–22% and 11–19% in cranberry and viburnum purees respectively.

The largest outcome of cranberry puree was achieved using a sieve with a holes diameter of 0,8–1,2 mm, whereas for the production of viburnum puree it is rational to use a sieve with a holes diameter of 0.6–0.8 mm. The need to use sieves with larger holes to increase the yield of cranberry puree can be explaned by the more pronounced susceptibility of the coarse viburnum fibre towards mechanical stress compared to the finer cranberry fibre with regard to particle size reduction.

The chemical composition of obtained purees comparing to the berry raw materials is characterized by an increase in the content of pectin substances by 20 and 21%, and a decrease in the content of vitamin C by 30 and 29 for cranberry and viburnum purees, respectively. The obtained coagulants are characterized by an organic acid content of 2.0 and 1.7% for cranberry and viburnum purees, respectively.

Conclusions. The significant increase in the content of soluble pectins and the presence of organic acids allow to use the obtained berry purees as coagulants in the technology of milk-protein co-precipitates from the buttermilk.

Introduction

In the global market current conditions the demand for protein and protein-rich foods, in particular those obtained using dairy protein concentrates, is spreading steadily. This tendency is explained by a wide range of properties of milk proteins, in particular, the proximity of their amino acid composition to the proteins of human body tissues, which indicates their ability to meet the needs of human body more quickly and fully [1].

Despite the variety of methods used for protein precipitation, a large part of the obtained concentrates contains only casein fraction of milk proteins or is produced using various chemical substances of artificial origin during precipitation [2]. As a result, they are characterized by a number of organoleptic deficiencies, not to mention the content of substances for the utilization of which the enzyme system is not genetically foreseed. The exceptions are presented only by microparticulates obtained using membrane technologies, but the equipment needed for their obtaining is very complex and can not be applied in the establishments of restaurant industry [1–3].

The disadvantages given above indicate the need to improve the existing technologies of proteins coagulation for the purpose of reaching the appropriate harmonization of the obtained concentrates quality with international benefits to the foods that can be used in the enterprises of restaursnt industry. Therefore, an urgent and promising task today is the research of ways of using natural domestic raw materials which will enable obtaining of protein substances by precipitation methods and will lead to the production of milk-protein concentrates with new techno-functional and consumer properties.

Literature analysis

Nowdays, the development of a new method of protein substanses precipitation will be considered expedient when it increases its effectiveness compared to traditional methods of protein concentration. It is possible to achieve the efficiency of the new technology by reducing the amount of raw materials, energy or technical resources required for the production process. This causes the need for modification of existing technologies by introducing additional factors that can reveal the potential of techno-functional properties of dairy proteins.

In recent years, a number of improved methods for milk-protein concentrates obtaining was proposed, and each of this methods included the modernization of separate stages of thermoacid and thermocalcium coagulation or membrane methods [4–8]. In our opinion, the most expedient component capable to accelerate and simplify the concentration of milk proteins is the use of natural plant products or components that are characterized by rich chemical composition, sorption and radioprotective properties [9–11].

However, it should be noted that the current world and national experience of the use of dietary supplements in nutritional diets indicates a lack of efficiency in the use of the potential of food plant raw material components, not to mention a limited number of studies on the use of plant components to stabilize the processes of protein precipitation [12–14].

An additional factor in improving the efficiency of innovation technology is the use of available domestic raw materials. From this perspective, it is expedient to use buttermilk as the main raw material, as it contains almost the entire protein, carbohydrate and mineral complex of whole milk and is characterized by significant volumes of production within the country. As a plant material it is expedient to use cranberries and viburnum berries, which, unlike food additives, synthesized in an industrial way, are characterized by low cost and high content of different Biologically Active Substances, necessary for maintenance of normal homeostasis, satisfaction of energetic and plastic needs of the human organism, as well as reduce the risk of diseases caused by oxidative stress, such as cancer and cardiovascular diseases [9, 15].

In the proposed technology of protein coagulation [16] it is expedient to use cranberries and viburnum berries as coagulants, additional coagulation centers and source of structure stabilizing and enrichment components. In the first case, the plant material is considered as a source of organic acids that can regulate pH and, accordingly, provoke the coagulation and denaturation of protein substances. This determines the need to ensure the use of the maximum content of organic acids of berry raw materials and to investigate the optimal amount of berry component required by the system to achieve pH, neighbor to the isoelectric point of dairy proteins.

Regarding the influence of the berry pectinates on the structural characteristics of received products, it should be noted that for today mixtures of biopolymers, in particular proteins and polysaccharides, are widely used to stabilize foam and emulsions, which in most cases are unstable polydisperse systems due to the large surface of the disperse phases [17]. In this context, the mechanism for increasing the stability of named disperse systems is based on the creation of protective layers around the emulsion drops or foam bubbles by biopolymers.

It has been experimentally established [18] that the long-term stability of the emulsions and the foam is increased if additional polysaccharides, capable of creating a spatial structure of the dispersion medium, are added to the proteins. That strengthens the disperse phase and prevents its destruction. Hence the need for transfering of the pectin substances of berry raw materials into a soluble state. This will cause the activation of their techno-functional properties and the provision of the necessary conditions for the creation of complexes, which becomes possible with additional technological processing of berries.

The dispersed state of plant materials, as a component of the dispersion medium of foam-emulsion systems, plays a significant role in the formation of organoleptic parameters of the final product [19]. To facilitate the whipping process, to prevent the coalescence of air bubbles and, as a consequence, the formation of a subjective perception of the whipped products «velvety», it is advisable to ensure the homogeneity of the system components structure, which requires the most diligent grinding of plant materials. In this case, it is necessary to preserve the maximum amount of Biologically Active Substances of fresh raw materials, in particular organic acids and pectin substances. Similar studies were done in the work [13], where the technological parameters of protein substances precipitation of skim milk were substantiated and determined due to the effect on them of the acids contained in purees of cornel and blackthorn berries treated in a special way and addition of 0.9% of the phosphates mixture «Biofos 90».

Analyzing the presented data, it can be concluded that in order to effectively use pectin substances in the process of proteins precipitation in order to improve the structural-mechanical and techno-functional properties of received products, it is expedient to finely shred plant materials till the state of berry puree. In addition, considerable attention needs to be paid to the study of ways to increase the content of soluble pectins in purees.

Taking into account the aforementioned, the **aim** of research is to determine the influence of parameters of acute vapor processing and rubbing of the berry raw materials on the content of soluble pectins in berry purees. Attention is paid to the compliance of the obtained puree with the requirements for berry coagulants, which can be used to obtain milk-protein co-precipitates from the buttermilk.

Indicated aim can be achieved through a number of **tasks**, namely:

– Study of the chemical composition of the berry raw materials (cranberries and viburnum), in particular the content of organic acids and pectin substances

– Determination of influence of the technological parameters of processing on the properties of berry purees;

– Justification of the rational method and modes of plant raw materials processing.

Materials and methods

Materials

Raw materials. Fresh cranberries and viburnum berries harvested in the Obukhiv and Vasylkivsky districts of the Kyiv region in 2015–2016 were chosen as the subjects of study.

Methods

Study of chemical composition of berry raw materials and purees

Mass fraction of water. The mass fraction of water was determined by drying the samples to constant weight at a temperature of 105–110 ºC (AOAC 7.003) [20].

Protein content. Nitrogen content was determined by the Kjeldahl method, followed by conversion to crude protein, conversion factor 6.25 (AOAC 2.057) [20].

Fat content. Study of fat content in berry raw materials and purees was determined by Soxhlet method [21].

Crude fiber. The samples for carbohydrates investigation were prepared by rapid grinding of berries, adding weighed samples to hot alcohol and H_20 and successive heating on H_20 bath during 30 min, stirring frequently (AOAC 3.002 b) [20]. The content of crude fiber was determined by the weight method after successive boiling of the analyzed weight in the medium of sulfuric acid and sodium hydroxide with following drying [22].

Soluble sugars. The content of soluble sugars was determined by the titrimetry method by Bertrand [23].

Pectin substances. The content of pectin substances in berry purees was determined by the titrimetry method based on the titration of the alkaline pre-selected and prepared pectin substances before and after hydrolysis [24].

Mineral constituents. The samples for mineral constituents investigation were prepared by oven drying and grinding (AOAC 3.002 a) [20]. The mineral constituents were determined by X-ray fluorescence method using a spectrophotometer SF-2000 (AOAC 3.015, 3.019, 3.065) [20].

Orgamic acids. The content of orgamic acids was determined by Bitartrate method (AOAC 22.062) [19] in recalculation on the malic acid.

Polyphenols. The content of polyphenols was determined by a method based on the extraction of colored substances with concentrated hydrochloric acid and the optical determination of their concentration in the samples in comparison with a standard solution of cobalt sulfate [24].

Study of vitamin C content in berry raw materials and purees

The content of vitamin C was determined by the Indophenol Titration Method. 50 cm^3 of berry puree was pipette into 100 cm^3 volumetric flask. 25 cm^3 of 20% acetic acid was added as stabilizing agent and was diluted to 100 cm^3. 10cm^3 was pipette into a conical flask, and 2,5 cm^3 acetone was added. It was titrated with 2, 6-Dichloroindophenol (DCIP) Standard solution. A faint pink colour that was persisted for about 15 seconds was observed. The amount of dye used in the titration was determined volumetrically and used in the calculation of the vitamin C content mg/ 100 ml in the berry puree samples [25].

Technology of berry raw material processing into purees

The proposed method of berry raw materials processing should include the following technological operations:
1. Inspection;
2. Washing;
3. Hydrothermal treatment – processing with acute vapor at the temperature of 105–107 °C during 5–60 seconds;
4. Rubbing with the help of a crushing-rubbing machine.

Study of the influence of parameters of acute vapor processing on the raw materials chemical composition

The treatment of the berries with acute vapor was made with the help of the electric steam-convection oven of the injector type «Convotherm 4 EasyTouch 6.10 ES». The analysis were made in the «wet air» mode at a temperature of 105–107 °C during 5–60 seconds.

The berry treatment involved two stages: the first stage – in which a layer of berries was heated to suffcient temperature and the second stage – held to allow the temperature at the centre of each piece to increase to that needed for conversion of pectin substances into a soluble state.

Determination of berry rubbing parameters

The berries rubbing was made with the help of a crushing-rubbing machine with a speed of 1500 rpm at the step and the height of teeth in a crusher of 2.5 mm.

Experimental researches for berry purees were made using sieves with hole diameters of 0.4; 0.6; 0.8; 1.0 and 1.2 mm.

Statistical analysis

Data were expressed as means ± standard deviations. All laboratory studies and experiments were conducted with a fivefold repetition. The obtained data are given in the unit of the international SI system.

Statistical analysis was performed using Microsoft Excel 2010.

Results and discussion

Chemical composition of berry raw materials

At the first stage, the chemical composition of berry raw materials was investigated. The study was conducted because the chemical composition of the berry raw materials depends on many factors [23, 25–27], in particular climatic conditions and the place of growth (Table 1).

Based on the data obtained, it can be stated that cranberries and viburnum berries are the valuable source of macro- and micronutrients necessary for human beings, such as mono- and polysaccharides, dietary fibers, proteins, organic acids and pectin substances.

Generally, the highest share in total solids of berries is contributed by carbohydrates, i.e. sugars. Organic acids, together with sugars, play an important role in the sensory characteristics of berries. The results show that higher sugar-to-acid ratio among studied berries had cranberry, when viburnum is characterized by lower content of this substances.

Table 1

Chemical composition of berry raw materials, g/100 g of berries (n = 5, P ≤ 0,05)

Name of the indicator	Content in berries	
	Cranberry	Viburnum
Water	85.2	86.1
Proteins	0.4	0.3
Fats	0.1	0.2
Including pufas	-	0.1
Carbohydrates	10.2	8.8
Including sugars	4.1	2.7
dietary fibers	3.8	3.2
pectin substances	1.0	1.4
Ash	0.1	0.1
Organic acids (in recalculation on the malic acid)	2.1	1.8
Polyphenols	0.5	0.8
Vitamin c, mg	13.3	12.7
Calcium, mg	8.2	7.4
Potassium, mg	85.0	34.2
Ferum, mg	0.3	0.3
Phosphorus, mg	13.0	0.3

The content of soluble pectin substances in cranberries is 1.0, which is 0.4 g lower then in viburnum berries. This result can be explaned by the firmness of cranberries comparing to the viburnum berries.

The organically bound mineral elements in the studied berries are presented by Ferum, Calcium, Potassium and Phosphorus, and the vitamin content is high in Vitamin C. Between the other substances such polyphenolic compounds as anthocyanins, leucoanthocyanins, catechins, flavonols and phenoxy acids can be noted, which indicates the high antioxidant properties of the studied berries.

Influence of the time of processing with an acute vapor on the chemical composition of raw materials

Hydrothermal treatment of berry raw materials with acute vapor was made with the purpose of giving the determined techno-functional properties to the final product and ensuring its protection against microbiological contamination.

The key part in the obtaining of the desired techno-functional properties of berry purees plays the convertion of pectin substances into a soluble state. This transformation can be explaned by the fact that pectin substances of studied berries involve high amount of protopectin – an insoluble high-molecular-weight pectin complex which gives soluble pectin when treated with high temperature [28].

In addition, this method of treatment was aimed on the other technological tasks as well: reducing microbiological contamination, inactivating enzymes and facilitating subsequent rubbing.

The literature analysis [29–30] defined that the most rational was the hydrothermal method of berry raw materials processing. It allows not only to satisfy the conditions for the technological tasks implementation, but also to preserve the maximum amount of valuable nutrients of berries. At the same time it is expedient to do the hydrothermal treatment of berries at a temperature of at least 80–85 °C for the convertion of pectin substances into a soluble state, and to maintain microbiological purity using a temperature of 95–100 °C.

Regarding the duration of hydrothermal treatment, it is well known that its increase contributes to significant losses of thermally unstable nutrients of berry raw materials. Therefore, the next step was to study the effect of the duration of raw materials processing on the content of target components in berry purees. The evaluation of the quality of the obtained purees was made by determining the content of pectin substances and ascorbic acid, as the most thermoplastic vitamin, in them (Figure 1, 2).

According to the data of the Figure 1, the content of pectin substances in both berry purees increases in direct proportion to the extension of hydrothermal treatment from 5 s to 60 s.

With the further processing the increase in the amount of pectin substances is rather slow, but the content of vitamin C has a marked tendency to decrease because of its sensibility to high temperatures (Figure 2). This occurs due to the high temperature effect on vitamin C which is thermally labile. Therefore, it was decided to limit the time interval to 60 s during the studies.

The hydrothermal treatment of viburnum puree is characterized by the slower increase in the amount of pectin substances comparing to the cranberry puree (Figure 2), which can be explaned by the difference in the chemical composition, i.e. difference in the structure of protopectin molecules.

The losses of vitamin C (Figure 2) for both berry purees are relatively low only in the first 15 s of treatment, while then they are increasing rapidly. Such dynamics is explained by the fact that temperature increase accelerates the break of hydroxyl bond in the ascorbic acid structure, thus enlarging rate of its destruction [24].

As prolonging the berries processing time will reduce the vitamin C content in the berry purees, in our opinion, it is rational to treat berry raw materials with an acute vapor at a temperature of 105–107 °C for 15–30 seconds for cranberries and 5–15 seconds for viburnum berries, which corresponds to an increase in the amount of pectin substances on 19–22% and 11–19% in cranberry and viburnum purees respectively, and can prevent significant loss of vitamin C.

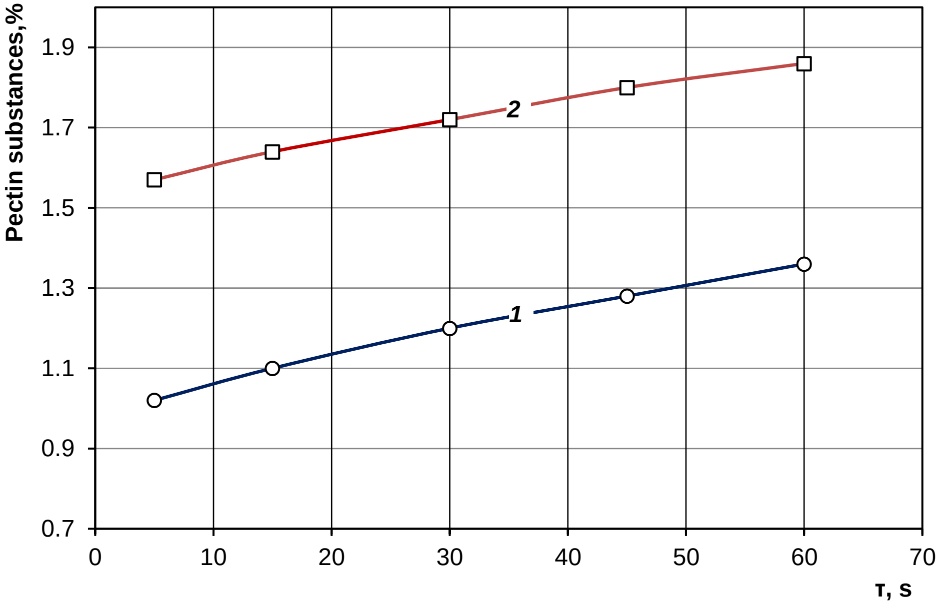

Figure 1. Impact of hydrothermal treatment duration on the content of pectin substances in berry purees:
1 – cranberry puree; 2 – viburnum puree.

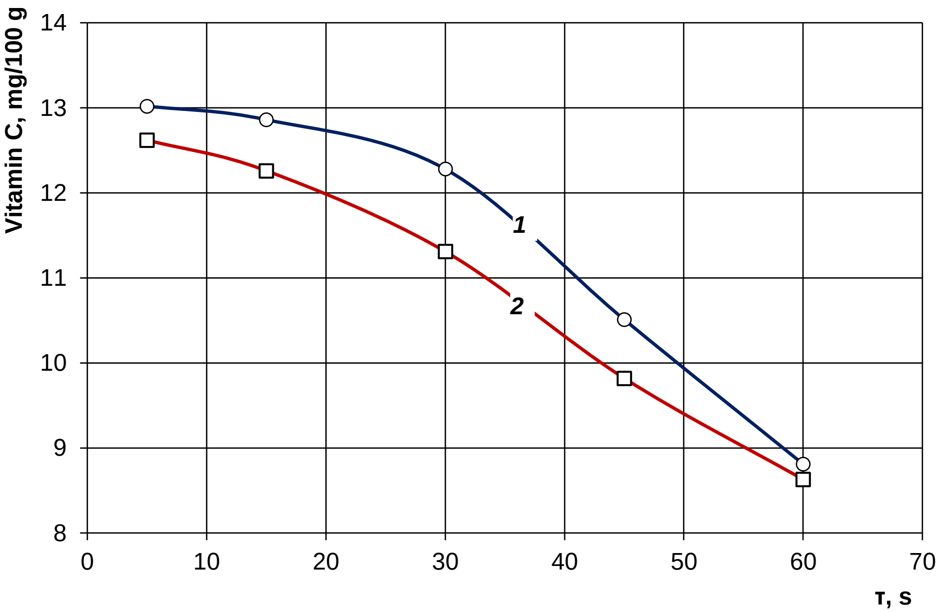

Figure 2. The impact of hydrothermal treatment duration on the content of vitamin C in berry purees:
1 – cranberry puree; 2 – viburnum puree.

Rational hole diameters of the crushing-rubbing machine sieves

Berries rubbing with the help of the crushing-rubbing machine was aimed at ensuring the necessary degree of vegetable raw materials grinding, high productivity of the process and quality of the final product. Experimental researches were made to determine the rational hole diameters of the crushing-rubbing machine sieves, subject to the use of which the highest yield of homogeneous puree, which will not flake off during storage, can be achieved (Figure 3).

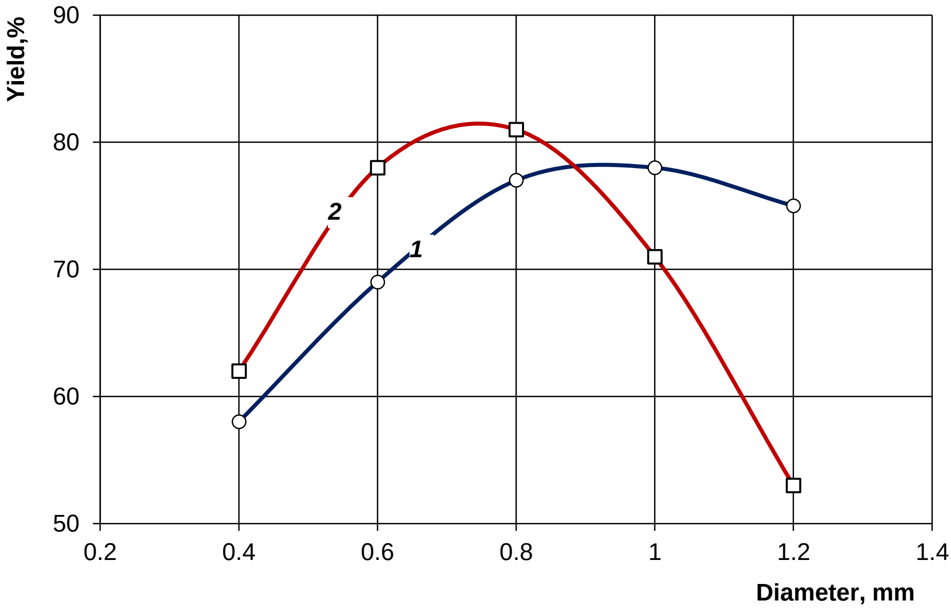

Figure 3. Dependence of the berry puree yield on the hole diameters of the crushing-rubbing machine sieves:
1 – cranberry puree; 2 – viburnum puree.

From the data obtained, it was found that the largest yield of cranberry puree was achieved after using a sieve with the hole diameters of 0.8–1.2 mm, whereas for the viburnum puree production it is rational to use a sieve with the hole diameters of 0.6–0.8 mm.

The need to use sieves with larger holes to increase the yield of cranberry puree can be explaned by the more pronounced susceptibility of the coarse viburnum fibre towards mechanical stress compared to the finer cranberry fibre with regard to particle size reduction. Similar results are presented in the work [31].

The study of the dynamics of changes in the yield of berry purees from changing the diameter of the sieve holes in the rubbing process was not the purpose of our work and needs further researches.

Chemical composition of the berry purees

Taking into account the conducted researches, while berry raw materials processing into purees the following parametrs were used: processing with acute vapor at the temperature of 105–107 °C during 15–30 seconds for cranberries and during 5–15 seconds for viburnum berries; rubbing with the help of a crushing-rubbing machine with the diameter of sieve holes of 0.8–1.2 mm for cranberries and 0.6–0.8 mm for viburnum berries.

The chemical composition of berry purees obtained by the proposed method was investigated (Table 2).

Table 2

Chemical composition of berry purees, g/100 g of puree (n = 5, P ≤ 0,05)

Name of the indicator	Content in purees	
	Cranberry	Viburnum
Water	87.8	89.1
Proteins	0.3	0.2
Fats	0.1	0.2
Carbohydrates including pectin substances	7.4 1.2	6.9 1.7
Ash	0.1	0.1
Organic acids (in recalculation on the malic acid)	2.0	1.7
Vitamin C, mg	9.3	9.0
Calcium, mg	6.3	6.0

According to the table, berry purees contain a small amount of proteins and fats, but they differ by the significant content of carbohydrates – 7.4% for cranberry puree and 6.9% for viburnum puree.

The content of pectin substances increases by 20 and 21% for cranberry and viburnum purees, respectively, compared to the content of this substances in raw materials (Table 1). The obtained results could be related to the berries softening while treatment with an acute vapor which was accompanied with solubilization of pectins due to the temperatue effect.

Vitamin C decreases by 4 mg for cranberry puree and 3.7 mg for viburnum puree comparing to untreated berries, which is permissible in view of the further use of the obtained semi-finished products.

It is particularly important to note a significant amount of organic acids of 2.0% and 1.7%, respectively, for cranberry and viburnum purees, which is sufficient to regulate the pH of the protein-carbohydrate dairy raw materials. That is, the obtaines purees can perform a coagulation function according to a modified method of obtaining of milk-protein concentrates from buttermilk.

Conclusion

The modes of treating of cranberries and viburnum berries with an acute vapor and their fine shredding to the state of purees were investigated.

1. Processing of berry raw materials with an acute vapor at a temperature of 105–107 °C during 15–30 s for cranberries and during 5–15 s for viburnum berries was found rational. This corresponds to an increase in the amount of pectin substances in 19–22% and 11–19% for cranberry and viburnum purees respectively, and allows to prevent significant losses of vitamin C.
2. For the obtaining of finely shredded berry purees by rubbing raw materials in the crushing-rubbing machine, it is expedient to use a sieve with hole diameters of 0.8–1.2 mm for cranberry puree and 0.6–0.8 mm for viburnum puree.
3. The study of the dynamics of changes in the yield of berry purees from changing the diameter of the sieve holes in the rubbing process was not investigated and needs further researches.

   The significant increase in the content of soluble pectins and the presence of organic acids allow to use the obtained berry purees as coagulants in the technology of milk-protein co-precipitates from the buttermilk.

References

1. O'Kennedy B.T. (2009), Dairy-Derived Ingredients: Food and Nutraceutical Uses, Woodhead Publishing Series in Food Science, Technology and Nutrition, p. 712.
2. Gnytsevich V.A., Yudina T.I., Deinychenko L.G. (2016), Technology and biological value of milk-protein co-precipitates, *Goods and markets*, 2. pp. 148–157.
3. Yudina T.I., Nazarenko I. A., Nikiforov R.P. (2015), Investigation of the quality of dairy stuffings based on buttermilk concentrates, *East-European Journal of Advanced Technologies*, 3/10(75), pp. 10–14.
4. Rupp L. S., Molitor M. S., Lucey J. A. (2018), Effect of processing methods and protein content of the concentrate on the properties of milk protein concentrate with 80% protein, *Journal of Dairy Science*, 101 (9), pp. 7702–7713.
5. Banach J. C., Lamsal B. P., Lin Z. (2013), Enzymatic modification of milk protein concentrate and characterization of resulting functional properties, *LWT- Food Science and Technology*, 54(2), pp. 397–403.
6. Shchetinin M.P., Koltyugina A.V., Plutagina E.S. (2011), Protein base for the milk dessert, *Dairy Industry*, 9, pp. 58.
7. Shingareva T.I., Pavlistova N.A. (2016), Development of new types of milk protein products for healthy eating" *Proc. of the International scientific-practical conference " Nutritional Supplements. Nutrition of a healthy and sick person"*, Kryvyi Rih, pp. 122.
8. Smirnova I.A., Pecherina V.N. (2010), Milk-protein concentrate, *Dairy Industry*, 7, pp.57.
9. Ballistreri G., Continella A., Gentile A., Amenta M., Fabroni S., Rapisarda, P. (2013), Fruit quality and bioactive compounds relevant to human health of sweet cherry (Prunus avium L.) cultivars grown in Italy, *Food Chemistry*, 140, pp. 630–638.
10. Maso V.K., Kodentsova V.M., Vrzhessinskaya O.A., Zilova I.S. (2012), Enriched functional and food products: similarities and differences, *Issues of Nutrition*, 1(81), pp. 63–67.
11. DiRienzo D. (2001), Whey products, milk minerals and dairy calcium, *U. S. Dairy Export Council*, p. 8.

12. Vaskina V.A., Ruban N.V., Bogatyreva T.G., Belyavskaya I.E. (2015), Protein-polysaccharide mixtures as an alternative to egg and milk proteins in the technology for producing an emulsion-foam structure cream, *Confectionery Production*, 3, pp. 26–30.
13. Korshunova G.F., Gnitsevych V.A., Nikiforov R.P. (2007), Substantiation of technological regimes of precipitation of protein substances of skimmed milk using berry purees, *Equipment and Technologies of Food Production: a Thematic Collection of Scientific Works*, 17(1), pp. 113–119.
14. Deinychenko G.V., Yudina T.I. (2010), *Novi vydy kopretsypitativ ta yikh vykorystannya v kharchovykh tekhnolohiyakh* [New types of coprecipitates and their use in food technologies], Donechchyna, Donetsk.
15. Stępień A., Aebisher D., Bartusik-Aebisher D. (2018), Anticancer properties of Viburnum, *European Journal of Clinical and Experimental Medicine*, 16(1), pp. 47–52.
16. Gnitsevych V.A., Yudina T.I., Deinychenko L.G. (2016), Technology and biological value of milk-protein co-precipitates, Goods and markets, 2, pp. 148-157.
17. Nakamura A., Yoshida R., Maeda H., Corredig M. (2006), The stabilizing behavior of soybean soluble polysaccharide and pectin in acidified milk beverages, *International Dairy Journal*, 16, pp. 361–369.
18. Obolkina V. (2014), The use of hydrocolloids for the formation of various structures of confectionery products, *Baking and Confectionery Industry of Ukraine*, 6(115), pp.40–41.
19. Khomych G.P. (2012), Investigation of the effect of wiping methods on quality indices of blueberry purees, *Scientific Papers of ONAFT*, 40(2), pp.10–15.
20. Association of Official Analytical Chemists (1980). Official methods of analysis of the Association of Official Analytical Chemists. 13th edition. Washington, DC, pp. 1018.
21. America F.N., Prairie E. (2004), Ch. 2. Soxtec: Its Principles and Applications, AOCS Press.
22. Lebedev P.T., Usovich A.T. (1989), *Metody issledovaniya kormov, organov i tkaney zhivotnykh* [Methods of research of feed, organs and tissues of animals], Moscow.
23. Ermakov I. (1972), *Metody biokhimicheskogo issledovaniya*, Kolos, Leningrad.
24. Khomych G., Matsuk Y., Nakonechnaya J., Oliynyk N., Medved N. (2017), Research of cranberry main indicators of chemical composition and its processing products, *EUREKA: Life Sciences*, 6, pp. 29–36.
25. El-Ishaq A., Obirinakem S. (2015), Effect of temperature and storage on vitamin C content in fruits juice, *International Journal of Chemical and Biomolecular Science*, 1(2), pp. 17–21.
26. Odarchenko D.N. (2012), The development of the scientific foundations of freezing of ordinary viburnum as a promising raw material for the production of semi-finished products, *Food Science and Technology*, 4(21), pp. 63–65.
27. Bashta A.O. (2014), “The use of wild raw materials for the production of confectionery of health-improving purposes”, *Proc. of the International scientific-practical conference “Healthy Foods and Dietary Supplements: Technologies, Quality and Safety”*, National University of Food Technologies, Kyiv, Ukraine, pp. 95–96.
28. Ovodov Yu. S. (2009), Current Views on Pectin Substances, *Russian Journal of Bioorganic Chemistry*, 35(3), pp. 269-284.
29. Ramosa A.M., Ibarzb A. (1998), Density of juice and fruit puree as a function of soluble solids content and temperature, *Journal of Food Engineering*, 35(1), pp. 57–63.
30. Polishchuk G.Ye., Matsko L.M., Sokolenko A.I. (2012), Activation of the functional and technological properties of apple puree in the production of ice cream, *Herald of Moscow State University of Printing Arts*, 1(12), pp. 70–75.
31. Kieserling K., Meyer L., Drusch S., Schalow S. (2019), Influence of mechanical and thermal treatment on particle structure, leaching of alcohol insoluble substances and water binding properties of pectin-rich orange fibre, *European Food Research and Technology*, 245, pp. 1251–1262.