Analysis and features of methods for low-calorie dessert sauce production

A A Varivoda¹, N V Kenijz², T N Zaitseva³, D A Kulikov³ and N A Ginzburg⁴

¹Kuban State Agrarian University, 13 Kalinina str., Krasnodar, Russian Federation
²Nosov Magnitogorsk State Technical University, 38 Lenin Avenue, Magnitogorsk, Russian Federation
³K G Razumovsky Moscow State University of Technologies and Management (the First Cossack University), 73 Zemlyanoy Val str., Moscow, Russian Federation
⁴All-Russian public organization League of Health of the Nation

E-mail: albin2222@mail.ru

Abstract. Fruit and berry sauces are an important and valuable component of nutrition due to sugars, organic acids and biologically active substances. Sauce recipe development should include methods of pre-processing of berries to provide the highest yield of puree while preserving the valuable components of fresh berries. The study focuses on effective methods for processing cornel berries to obtain the maximum yield of puree with high physical and chemical properties. It is shown that the yield of puree can be increased through maximum disruption of the cell cytoplasmic membrane before pulping raw materials that can be attained by blanching (short-term action of steam or hot water for 5–15 minutes), freezing, and microwave treatment. Fresh, ripe, pure, odorless, and mold-free cornel berries of the same pomological variety were taken to conduct the study. The berries pre-sorted and prepared were subjected to freezing, steam and hot water blanching, and microwave treatment at three power modes of the microwave oven. The processed mass of cornel berries was pulped to determine the content of solids, vitamin C, and pH value. It was found that the highest yield of puree (77.5%) from cornel berries is attained through microwave treatment at 350 W. Freezing and steam blanching provide the puree yield of 71.5 and 69.3%, respectively. However, freezing of berry raw materials is accompanied by losses during defrosting. Hot water blanching reduces the amount of soluble solids, which is confirmed by the values of physical and chemical properties of cornel puree.

1. Introduction

Many cuisines of the world include sauces as essential elements of dishes, including those made from fruit and berry raw materials, which are valuable since they contain sugars, organic acids and biologically active substances.

In this regard, the problem of high relevance for the canning industry is the development of new techniques for sweet and sour sauce production, which imply the use of berry raw materials with high functional and technical properties, and methods of pre-processing of berries to make a product of improved nutritive and biological value [1–6].

Authenticity of taste and stability of texture are the main factors that best characterize sauces. Not only development of an original recipe, but also an effective technique of raw material pre-processing is essential to increase the yield of puree and to maximally preserve its valuable components [7–9].
Cellular tissue of some fruits and berries is dense, and for efficient extraction of juice and higher puree yield, cell membranes should be disrupted. Maximum destruction depends on the pomological variety and the type of effort applied. For example, in thick-skinned fruits and berries such as plums, gooseberries and cornel, the outer cell membrane is damaged insignificantly under external impact. Therefore, an effective way to increase the yield of juice and puree is pre-processing of raw materials to maximize destruction of cellular tissue before pulping [4].

Pre-heating provides denaturation of cytoplasmic proteins and membranes, inactivation of enzymes, softening of tissues, removal of air from intercellular passages, which changes the production volume. The data obtained in numerous studies allow us to draw the following conclusions about the effect of heating on cell permeability. The intensity of the process plays a significant role in changing the chemical composition of raw materials during pre-processing. Short-term exposure to rapidly increasing temperature increases cell permeability at 60–80 °C, slow heating increases cell permeability at 40–50 °C. However, unreasonably long pre-processing time results in the destruction of biologically active substances [4–11].

Complete freezing of raw materials promotes disruption of the cell structure due to formation of ice crystals in cells and in the intercellular space of raw materials. To destruct cells, raw materials should be mechanically treated after freezing to prevent defrosting [3–10]. Thus, the study aimed at developing a multicomponent composition of the food product is in line with [12–18] and meets the current trends of nutraceuticals [19–26].

The study aims to select and explore effective methods of processing cornel berries to obtain the highest yield of puree with high physical and chemical properties.

2. Methods
Cornel berries must be of the same pomological variety, fresh, ripe, clean, odorless, mold-free, with a stalk and meet the requirements of the current standard GOST 16524-2017.

Dry solids were determined in accordance with GOST 32742-2014. The pH value was found in accordance with GOST 26188-84. Vitamin C content was evaluated in accordance with GOST 24556-89.

Microwave treatment (MT). Berries were selected, washed, sorted and processed in compliance with regulatory and technical documentation. A layer of berries 4±0.5 cm thick placed in the operating chamber of the microwave oven was treated for 1 min at 2350–2450 MHz. The container with berries was covered with a lid and placed on the bottom. During heating, berries burst and exude their juice which flows down through the holes of the perforated bottom of the container into the juice collecting reservoir.

Freezing and blanching: preliminary washed and cleaned berries were weighed by parts, 100 g each, using a counter balance. When freezing, cornel berries were placed in containers in refrigerators at –18 °C. When blanching with hot water, berries were placed in perforated ladles and immersed in water heated to 60–70 °C for 10 min. For steam blanching, cornel berries were placed in perforated baskets suspended above boiling water for 5 min.

During pulping, the skin and seeds (inedible parts) are separated by passing through sieves with a hole diameter of 0.4 to 1.2 mm to obtain a homogeneous pulped mass.

3. Results
The main results of the study. The effect of freezing, steam and hot water blanching, and MT of cornel berries at three power modes of the microwave oven on the yield of puree after pulping was investigated. The yield of puree was calculated using the equation:

\[ X = \frac{m}{m_0} \times 100 \]

where \( m \) is the mass of puree after pulping; \( m_0 \) is the mass of berries before processing.

The obtained results that show the yield of puree depending on the method of pre-processing of cornel berries are summarized in table 1.
Table 1. The yield of puree depending on the method of pre-processing of cornel berries.

| cornel berries                      | m after processing, g | m puree, g | yield of puree, % |
|-------------------------------------|-----------------------|------------|-------------------|
| Fresh                               | 100                   | 64.97      | 65.0              |
| Frozen                              | 96.8                  | 70.53      | 71.5              |
| Blanched with steam (τ = 5 min)     | 93.2                  | 64.58      | 69.3              |
| Blanched with hot water (τ = 10 min)| 88.32                 | 55.61      | 63.0              |
| MT (ϑ = 2435 MHz, W=800 W)          | 90.37                 | 51.51      | 57.0              |
| MT (ϑ = 2435 MHz, W=500 W)          | 92.2                  | 63.16      | 68.5              |
| MT (ϑ = 2435 MHz, W=350 W)          | 98.5                  | 76.3       | 77.5              |

As can be seen, MT at 350 W provides the highest yield of cornel puree (77.5%). Freezing and steam blanching provide the yield of cornel puree of 71.5 and 69.3%, respectively. Freezing of berries increases the yield of puree by 10% compared to steam or hot water blanching, but it is accompanied by losses during defrosting (cell walls destroyed by ice crystals do not keep their shape and exude juice with soluble substances). In addition, when thawing, especially slow thawing, enzymes in destroyed cells immediately become active. This leads to the oxidation of tannins and other organic substances and darkening of tissues, which negatively affects the quality of the pulped mass. Hot water blanching decreases the amount of nutrients (due to extraction), while the color, taste, and consistency of the puree may change.

After that, the content of dry solids (DS), vitamin C and the pH of the medium of cornel puree were determined depending on the method of pre-processing of cornel berries. The results are presented in diagrams (figures 1–3).

Dry solids are an important indicator in the production of sauces (included in the group of physical and chemical properties), since DS content is normalized in the finished product.
Figure 1. Dependence of DS content in cornel puree on the method of pre-processing of berries.

The analysis of the data (Figure 1) shows that MT of berries at $W=350$ W provides the highest DS content in the puree (17.5%) compared to fresh puree (18%). A high DS content in the puree was achieved by freezing (17%) and steam blanching (16%) of cornel berries.

In the production of sauces using fruit puree, the pH of the medium ranging from 2.8 to 3.5 is quite important to stabilize bioflavonoids, which are subsequently responsible for preserving the natural color of the finished product. The choice of the sterilization mode depends on the pH level.

Figure 2. Dependence of the pH of cornel puree on the method of pre-processing of berries.
Figure 2 shows that MT of berries at 350 W provides the most optimal pH value of 2.98 compared to fresh berries. The rate of chemical reactions changes and their equilibrium shifts under the impact of an electromagnetic field, which causes a change in the pH value. In cornel puree prepared from steam blanched berries, the pH value is 2.92. The remaining pH values obtained for cornel puree are undesirable.

A valuable component of cornel puree is ascorbic acid, which is involved in biochemical reduction processes (without its participation, collagen is not produced). Ascorbic acid is a powerful antioxidant that strengthens the immune system, stimulates the production of antibodies and body resistance to diseases, prevents cholesterol deposition on the walls of blood vessels to resist atherosclerosis, improves detoxification, and helps remove heavy metal ions from the body.

The content of vitamin C in cornel puree depending on the method of pre-processing of berries is shown in figure 3.

The diagram (figure 3) shows the highest content of vitamin C for puree produced from berries subjected to MT at 350 W (117.1 mg/100g) compared to fresh berries (128.8 mg/100g).

![Figure 3. Dependence of the content of vitamin C in cornel puree on the method of pre-processing of berries.](image)

Cornel puree produced from berries subjected to steam blanching and MT at 500 W contains about 103.9 mg/100 g of vitamin C. The lowest content of vitamin C was found in puree produced from berries blanched with hot water (78.3 mg/100 g).

4. Conclusion
It is found that physical and chemical properties, and the amount of vitamin C in cornel puree depend on the method of pre-processing of berries. Microwave treatment of berries at 350 W is found to be the most effective pre-processing method for cornel puree production.

In the absence of microwave ovens at the enterprise, it is advisable to blanch cornel berries with steam for 5 min. The resulting cornel puree is used for production of sweet and sour sauces.

References
[1] Averyanova E 2019 Dessert sauces from berry raw materials of Siberia as an element of a healthy diet Technology and Commodity Science of Innovative Food Products 1 (54) 51–58
[2] Lyutikova M and Botirov E 2015 Chemical composition and practical use of lingonberry and cranberry berries *Chemistry of Plant Materials* 3 267–82

[3] Sultanova I, Petrov S, Maltseva N and Zakharova S 2009 Study of the antioxidant properties of extracts of leaves of viburnum and rosehip *Advances in Chemistry and Chemical Technology* 10 120–22

[4] Huseynova B 2016 Intensification of the extraction of vitamins and phenols from wild fruits *Izvestia of the Samara Scientific Center of the Russian Academy of Sciences* 2 75–79

[5] Kvaratskhelia V and Rodionova L 2014 Comparative analysis of the effect of low temperatures on the change in the analytical characteristics of pectin substances extracted from the albedo of citrus fruits *Scientific Journal KubSAU* 104 (10) 1793–1803

[6] Smolnikova F, Moldabayeva Z, Kenijz N, Burakovskaya N, Shadrin M, Bykov V, Mnatsakania, Ad, Sepiashvili E, Grunina A and Ponomareva L 2019 Effect of food additives on physical and chemical properties of dietary salt free bread *International Journal of Recent Technology and Engineering* 8 (3) 5939–41

[7] Merenkova S and Lukin A 2015 Analysis of the rheological properties of vegetable and mayonnaise sauces produced using functional vegetable additives *Scientific Journal NRU ITMO* 4 96–105

[8] Razumnikova I, Golubtsova Yu and Glebova Since 2008 Main trends in the development of the production of functional nutrition products *Achievements of Science and Technology of the Agro-Industrial Complex* 4 4–47

[9] Smolnikova F, Tokhtarov Z, Kenijz N, Nelyubina E, Grigoryants I, Bobkova E, Orlovtsvea O, Konobeeva A and Nikolaeva N 2019 Technological process of germination of wheat grain under the water tincture of aloe and its physical and chemical properties *International Journal of Innovative Technology and Exploring Engineering* 9 (1) 184–87

[10] Mane C, Loonis M and Juhel C 2011 Food grade lingonberry extracts: polyphenolic composition and in vivo protective effects against oxidative stress *Journal of Agricultural and Food Chemistry* 59 3330–39

[11] Merenkova S and Levchenko A 2015 Analysis of the biological value and technological properties of plant components of the sauce product recipe *Bulletin of the South Ural State University Series: Food and Biotechnology* 1 15–23

[12] Gavrilova N, Chernopolskaya N, Rebezov M, Shchetinina E, Dogareva N, Likhodeevskaya O, Knysh I and Sanova Z 2020 Specialized sports nutrition foods: review *International Journal of Pharmaceutical Research* 12 (2) 998–1003

[13] Kassymov S, Amirzhan T, Moldabayeva Zh, Rebezov M, Sharova T, Nikolaeva N, Gribkova V, Gaidarenko L and Karapetyan I 2020 Nutritional and biological value of bakery products with the addition of vegetable powders and milk whey *International Journal of Psychosocial Rehabilitation* 24 (7) 3985–89 DOI: 10.37200/IJPR/V24I7/PR270394

[14] Kassymov S, Rebezov M, Ikonnikova A, Fedin I, Rodionov I, Rukhadze S and Bokuchava O 2020 Using of pumpkin and carrot powder in production of meat cutlets: effect on chemical and sensory properties *International Journal of Psychosocial Rehabilitation* 24 (4) 1663–70 DOI: 10.37200/IJPR/V24I4/PR201274

[15] Kulushhtayeva B, Okuskanova E, Rebezov M, Burakovskaya N, Kenijz N, Fedoseeva N, Artemeva I, Saranova O and Pershina O 2020 Bread with sesame seeds for gerodietetic nutrition *International Journal of Psychosocial Rehabilitation* 24 (7) 1661–65 DOI: 10.37200/IJPR/V24I7/PR270149

[16] Abilmazhinova B, Rebezov M, Fedoseeva N, Belookov A, Belookova O, Mironova I, Nigmatyanov A and Gizatova N 2020 Study chemical and vitamin composition of horsemeat cutlets with addition of pumpkin *International Journal of Psychosocial Rehabilitation* 24 (8) 7614–21 DOI: 10.37200/IJPR/V24I8/PR280773

[17] Okuskanova E, Assenova B, Rebezov M, Yessimbekov Zh, Kulushhtayeva B, Zinina O and Stuart M 2016 Mineral composition of deer meat pâté *Pakistan Journal of Nutrition* 15 (3) 217–22.
DOI: 10.3923/pjn.2016.217.222

[18] Okuskhanova E, Smolnikova F, Kassymov S, Zinina O, Mustafayeva A, Rebezov M, Rebezov Y, Tazeddinova D, Galieva Z and Maksimiuk N 2017 Development of minced meat ball composition for population from the unfavorable ecological regions Annual Research & Review in Biology 13 (3) 1–9 DOI: 10.9734/ARRB/2017/33337

[19] Kulushhtayeva B, Rebezov M, Igenbayev A, Kichko Yu, Burakovskaya N, Kulakov V and Khayrullin M 2019 Gluten-free diet: positive and negative effect on human health Indian Journal of Public Health Research & Development 10 (7) 906–09

[20] Rozhnov E, Kazarskikh A, Shkolnikova M, Tretyak L, Voytsekhovskiy V, Maksimiuk N, Khayrullin M, Rebezov M and Yessimbekov Zh 2019 Investigation of the conditions for the formation of 5-Hydroxymethylfurfural in the production of honey wines and sea-buckthorn wine drinks Research Journal of Pharmacy and Technology 12 (7) 3501–06 DOI: 10.5958/0974-360X.2019.00595.X

[21] Temerbayeva M et al 2018 Technology of sour milk product for elderly nutrition Research Journal of Pharmaceutical, Biological and Chemical Sciences 9 (1) 291–95

[22] Serikova A, Smolnikova F, Rebezov M, Okuskhanova E, Temerbayeva M, Gorelik O, Kharlap S, Baitukenova Sh, Baitukenova S and Tumbasova Y 2018 Development of technology of fermented milk drink with immune stimulating properties Research Journal of Pharmaceutical, Biological and Chemical Sciences 9 (4) 495–500 WOS:000438848100062

[23] Smolnikova F, Rebezov M, Shaydullin R, Knysh I, Yudina O, Nikolaev N, Sorokin A, Zubtsova Yu and Kozlov V 2020 Vegetable stabilizers used in the production of fermented milk drinks and yogurts International Journal of Psychosocial Rehabilitation 24 (6) 7663–67 DOI: 10.37200/IJPR/V24I6/PR260775

[24] Varivoda A, Kenijz N, Rebezov M and Okuskhanova E 2018 Development of dietary food with the use of soy protein Research Journal of Pharmaceutical, Biological and Chemical Sciences 9 (4) 1005–13 WOS: 000438848100137