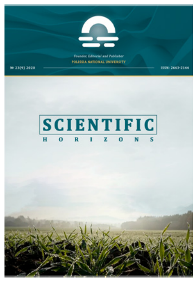
SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua/en

Scientific Horizons, 25(3), 55-67



UDC 330.341.1:[641.521:634.723:663.813]

DOI: 10.48077/scihor.25(3).2022.55-67

Evaluation of Methods of Heat Treatment of Black Currant Fruits to Increase Juice Production

Nina Osokina[1], Olena Herasymchuk[1*], Kateryna Kostetska[1], Nataliia Matviienko[2], Yaroslav Stratutsa[3]

[1]Uman National University of Horticultural
20300, 1 Instytutska Str., Uman, Ukraine

[2]LLC "Kononivskyi elevator" Viktorivska districts
20144, 1 Ukrainian Str., v. Viktorivka, Cherkasy region, Ukraine

[3]LLC JV "Nibulon"
53842, v. Marianske, Dnipropetrovsk region, Ukraine

Article's History:
Received: 10.04.2022
Revised: 12.05.2022
Accepted: 11.06.2022

Suggested Citation:
Osokina, N., Herasymchuk, O., Kostetska, K., Matviienko, N., & Stratutsa, Ya. (2022). Evaluation of methods of heat treatment of black currant fruits to increase juice production. *Scientific Horizons,* 25(3), 55-67.

Abstract. Black currant is a multivitamin crop with high dietary and medicinal properties and is a source of exceptionally valuable raw materials for juice production. The essence of the problem of this paper is the scientific substantiation of ways and methods of efficient juice extraction while preserving the natural chemical composition and biologically active substances. The purpose of this study is to compare the methods of heat treatment of black currant fruits to increase juice production. Evaluation of the efficiency of juice output from black currant fruits should be carried out differentially according to the level of desirability of Harrington: exceptionally good – more than 55%, good – 48-55%, satisfactory – 40-48%, unsatisfactory – 35-40%, very unsatisfactory – less than 35%. The fruits of black currant, as a rule, yield 18-24% of the juice, which is devoid of its inherent colouring. Heat treatment of raw materials increases the juice yield by 1.5-2.5 times compared to grinding, and at the same time, at 50-55°C, the cells die within 5 minutes. Good juice yield indicators upon pressing the pomace of crushed fruits (49-55%), satisfactory – upon heating whole fruits with the addition of 15% water (38-45%), as well as blanching fruits in water with a temperature of 95-100°C (42-45%). Juice extraction by blanching fruits and pomace in their own juice is inefficient (33-36%). In terms of chemical composition, freshly pressed juices, regardless of the method of processing raw materials, are close to fresh fruits. Heat treatment of raw materials does not adversely affect the taste and aroma of juices. The content of ascorbic acid in juices (142-225 mg/100 g) depends on the variety of fruits and weather conditions of the year. Its preservation in freshly pressed juices during heat treatment is 95-97%, including blanching – 83-90%. In juices with sugar, its content is 1.7 times lower, but the preservation is 98-99%. During the storage of juices with sugar, the preservation of ascorbic acid decreases during the first three months – by 1.5-2%, in 6 months – by 5.5-7%, in 9 months – by 10-13%, in 12 months – by 16-19% or 7-10 times. Factors for stabilising ascorbic acid in juices are sugar, hot bottling, and short-term heating at elevated temperatures

Keywords: juice yield, juice quality, ascorbic acid preservation

*Corresponding author

INTRODUCTION

In modern environmental conditions in the field of nutrition, there is an urgent task of organising health-improving nutrition for the population. Scientific developments (Sloan, 2022; Veerapandi *et al.*, 2022; Osokina *et al.*, 2019) aimed at searching for raw materials with a high content of biologically active substances and developing new food technologies using it.

A valuable technical raw material is a multivitamin culture of black currant, the fruits of which have high dietary and medicinal properties with a natural content of functional ingredients, as a complex non-medicinal complex that provides a reliable therapeutic and preventive effect. In terms of the content of essential substances that should regularly enter the human body — ascorbic acid (100-300 mg/100g) and polyphenolic substances (over 1,000 mg/100g), it has no equal among fruit and berry crops (Veerapandi *et al.*, 2022; Osokina *et al.*, 2019; Ongkowijoyo *et al.*, 2018).

The Ukrainian juice market is developing extremely dynamically. And this applies not so much to the capacity of the market, but to its assortment content. The juices presented on the market are close to the world standard in terms of not only taste, but also the appearance of packaging.

Blackcurrant juices belong to one of the main categories of natural food products of high and low calories, which are carriers of biologically active substances. They can considerably diversify your daily diet. However, the range of blackcurrant juices on the market is limited. This is primarily due to the lack of proper technology that would consider the specific features of raw materials. Classical methods of obtaining juices are inefficient in this case. There are numerous factors involved, which are listed below.

Due to the phenomena of adsorption and capillarity, some juice remains in the pomace and reduces the percentage of yield. At the same time, solid particles also enter the extracted liquid. Juice losses in pomace are not only quantitative, but also qualitative ones. The latter are conditioned upon that taste, aroma and colour substances are mainly found in cells that are difficult to destroy during juice extraction (Osokina *et al.*, 2020; Deinychenko *et al.*, 2020).

The chemical composition of fruit juice from different tissues is dissimilar. If for most types of raw materials, it is desirable to extract biologically active substances of juice from the main tissue, trying not to occupy the juice of the integumentary and mechanical tissues, then for black currant fruits, on the contrary, as much as possible from the integumentary tissue, in which colouring substances are mainly localised. The so-called extractives determine the value of the juice (Ongkowijoyo *et al.*, 2018).

The cell wall comprises plasma and cellulose-pectin layers. The latter is mainly permeable to solubles, and the plasma layer is the main barrier to them. It is mainly represented by hydrophilic colloids (proteins, lipids), which constantly interact during vital activity. Therewith, processes of partial coagulation, dissolution, or compaction are often observed. Changes in the internal structure of the plasma layer occur not only during natural die-away, but also during destruction at high temperature (Newman & Cragg, 2020). Therefore, fruit juice production depends on the cellular permeability of the fruit tissue. The juice in fruits is located in cellular vacuoles, protoplasm and partially in intercellular spaces and is firmly retained by a living cell (Osokina *et al.*, 2021). The main factor that inhibits juice production is the protoplasm of cells.

Natural blackcurrant juices are highly acidic. Considering the high extractive ability of natural blackcurrant juice, it is considered as a semi-product for the manufacture of juices with sugar.

In addition, the data presented in the scientific literature on changes in the quality indicators of blackcurrant juices are ambiguous (Osokina *et al.*, 2019; Osokina *et al.*, 2021; Flaumebaum *et al.*, 1986), they are difficult to compare due to the lack of research in the dynamics of production; there is no single approach to evaluating the results.

The purpose of this study is to establish rational methods of preliminary heat treatment of raw materials to increase the yield of juice and their impact on changes in quality indicators. For this, it is necessary to develop criteria for evaluating the efficiency of extracting juice from black currant fruits and investigate the preservation of ascorbic acid, which determines the biological value during cooking.

LITERATURE REVIEW

According to N.M. Osokina *et al.* (2021), the content of cellular juice in blackcurrant fruits is 88-94%. However, upon extracting the juice, it has never been possible to completely separate the liquid and solid phases of the fruit. Furthermore, natural blackcurrant juice has its differences, the objective reasons for which are as follows:

1. According to the biophysical theory of juice production B.L. Flaumenbaum *et al.* (1986), with the loss of semi-permeable properties of the protoplasm, the ability of raw materials to retain juice is lost, which is conventionally achieved by mechanical grinding of fruits. A comparative evaluation of mechanical impact methods (Ongkowijoyo *et al.*, 2018), such as cutting, hitting, crushing, abrasion, showed that for quinces and apples with the appropriate degree of grinding, it is possible to achieve considerable juice yields, for fruits of black currants, plums, gooseberries, apricots, the degree of cell damage is not great: upon cutting — 20-30%, upon crushing — up to 40%. It was found that for black currant fruits, the degree of cell damage upon grinding is 31%, upon crushing — 40%. Other types of mechanical impact are even less efficient. Therefore, after mechanical grinding, it is possible to extract only up to 25% of the juice (Backhall *et al.*, 2018; Deinychenko *et al.*, 2020; Conidi *et al.*, 2020b).

One of the components of the juice output is the degree of grinding. Upon pressing a well-ground mass, the juice is released from its outer parts, compaction (moulding) occurs, which prevents the juice from flowing out of the inner parts, and the juice extraction is noticeably reduced. Upon a uniform loose state, drainage is provided during pressing, which contributes to the flow of juice. The degree of grinding under the same conditions affects the amount of sediment, turbidity, and emergence of the juice (Paniuta, 2019).

There are limits to the grinding of slices, at which the best juice production is observed. The lower limit – under 0.1 mm is limited by the very nature of fruits and berries. Depending on the type of raw material, the particle size is from 1 to 8 mm. When studying the degree of grinding of black currant fruits (from 1.25 to 7 mm), the best juice output in terms of particle size was established – 3.5 mm (Flaumenbaum *et al.*, 1986).

1. According to the anatomical structure in the juicy part of the black currant pericarp, only the mesocarp with bubble-like cells is filled with watery cell juice, and the endocarp, which is factually fruit pulp, due to the sliming of arillus cells represented by pectin gel, has a slimy consistency that complicates the separation of juice (Cherevko *et al.*, 2020).

2. The completeness and speed of juice extraction from black currant fruits is associated with pectin substances. Their splitting can loosen the tissues, reduce the viscosity of the juice, and facilitate its separation. Forms of pectin substances in raw materials are in a mobile state and largely determine the physical and mechanical properties of fruit tissue. As a hydrophilic biopolymer, pectin increases the water retention capacity of plant tissue (Deinychenko *et al.*, 2020; Conidi *et al.*, 2020b).

The destruction of structural polymers that make up the median plates of plant cells leads to the breakdown of connections between cells and causes the breakdown of tissue into individual cells. The intercellular protopectin of the median plates is connected to each other by ionic and covalent bonds. The destruction of ionic bonds is ensured by heating at pH≤4.5 (Castro-Munoz, 2019).

1. The juice in black currant fruits is a biological fluid belonging to a heterogeneous dispersed system. Adsorption processes occur on the surface of the dispersed phase particles, which lead to stabilisation of the colloidal juice solution, which prevents the outflow of juice upon pressing (Blackhall *et al.*, 2018).

2. The shape, nature, and degree of strength of water bonds with fruit pulp affects juice extraction. In black currant fruits, the total amount of bound water in the form of osmotically bound and colloidal bound is 78%. Osmotically bound water in currant fruits occupies only about 46%, while in apple, pear, and cherry fruits – 60-70% (Osokina *et al.*, 2021). It forms flabby fibrous structures of pectin substances between which there is a spatial grid, the cells of which are filled with water molecules, which can be extracted during the production of juice under conditions of preliminary preparation of raw materials – heat treatment and others that destroy the structural grid.

The proportion of colloidal-bound (adsorption) water in currant fruits is 32%, while in apple, pear, and cherry fruits it is 15-25% (Osokina *et al.*, 2021). It occurs because of the concentration of water molecules in the surface layer of colloidal particles of the product, which is part of the micelles of various hydrophilic colloidal solutions – proteins, polysaccharides. Extracting such water is quite difficult.

1. Heat treatment of juices substantially affects the preservation of biologically active substances. Pasteurisation of juices for inactivation of enzymes and destruction of microorganisms is carried out without oxygen access to prevent a decrease in their quality. However, it adversely affects the taste and aroma of juices and causes the "boiled" taste (Vishnikin *et al.*, 2019).

2. Upon the production and storage of juices, various biochemical changes occur associated with hydrolysis, condensation, oxidation, reduction, and other processes (Conidi *et al.*, 2020a; Savas Bahceci, 2022; Denisenko *et al.*, 2018). Some of them are desirable for the formation and improvement of the taste properties of juices, but most of them lead to the formation of undesirable or harmful substances and, thus, to a deterioration in the quality of juice. The intensity of changes depends primarily on the shelf life of the product. The chemical composition of juices undergoes noticeable changes within the first 3 months of storage. The preservation of ascorbic acid in black currant juices is 39-81%. According to other sources, after 6 months of juice storage, the ascorbic acid preservation is 54-73%, after 8 months – 37-43%. After 12 months of storage, the ascorbic acid content in the juice decreased from 186.70 to 62.86 mg/100 g, or the preservation was 35-45% (Savac Bahceci, 2022; Denisenko *et al.*, 2018).

MATERIALS AND METHODS

Research on juice extraction was conducted during 2003-2010 with black currant fruits of the varieties Minai Shmyrev, Belarus Sweet, Novyna Prykarpattia in the laboratory of the Department of technology of storage and processing of crop production, in the Educational and Production Department of the Uman National University of Horticulture. Black currant plantations are located in the central part of the Right-Bank Forest-Steppe of Ukraine.

According to the Uman Weather Station, the region's climate is temperate continental with unstable moisture, uneven precipitation, and unstable temperatures. Features of geographical location and atmospheric processes cause adverse weather events in some years: heavy rains, hail, strong winds, droughts, high temperatures in summer and low in winter, which affects both the crop and its quality.

For this study, black currant fruits without brushes were collected at the end of June in boxes-trays weighing 4-5 kg in dry cool weather and transported to the laboratory. The weight of black currant fruits of each variety is 60 kg.

Juice extraction was carried out by pressing with a screw press (pressure 0.3-0.4 MPa) after inspection and washing of fruits, preparation of raw materials according to the following methods of preliminary heat treatment:

1. Mechanical grinding to the pomace (control).
2. Heating the pomace of ground fruits at 50-55°C, 65-70°C (5 min).
3. Heating the pomace of crushed fruits at 50-55°C (5 min).
4. Heating whole fruits with 15% water at 50-55°C (5 min).
5. Blanching of fruits in water at temperatures of 50-55°C, 95-100°C (5 min).
6. Blanching of fruits in juice at 50-55°C (5 min).
7. Blanching of pomace in the juice of pre-pressed fruits at 50-55°C (6 h).

The mass of the sample for pressing is 1.5-2 kg. Repeatability – three times.

The juice yield was estimated using the generalised Harrington desirability function (Weishtord & Pritykina, 1992).

To harmonise the taste of freshly pressed natural juices by chemical composition, they were used to prepare juices with sugar. According to the content of dry substances and acids that are regulated by DSTU 4150: 2003, they corresponded to the highest grade. According to the technological instructions (Shirokov, 1974), the composition was as follows: 60% juice + 40% sugar (30%) syrup.

The method of preparation of blackcurrant juices with sugar provided for mixing boiling syrup with juice, packaging, pasteurisation at 85°C in a thermal cabinet for 35 min, encapsulation.

In raw materials, freshly pressed natural juices and juices with sugar (after 15 days of storage), the content of dry soluble substances, total sugar content, acid content, and ascorbic acid content were determined. The preservation of ascorbic acid in juices was calculated. The sugar-acid index was calculated. Organoleptic evaluation of juices was performed.

The content of ascorbic acid was determined in blackcurrant juices with sugar for 3 months, 6 months, 9 months, 12 months of storage. Its preservation in juices was calculated using the following formula (1):

$$P_{AA} = \frac{AA_1 \times m_1}{AA_2 \times m_2} \times 100\% \quad (1)$$

where AA_1 is the ascorbic acid content in the finished product, g; AA_2 is the ascorbic acid content in the raw product, g; m_1 is the mass of the finished product, g; m_2 is the mass of raw product, g.

Determination methods:

– for the content of dry soluble substances – refractometric (Shirokov, 1974);

– for acid content – titrimetric (Shirokov, 1974);

– for total sugar content, invert sugar content, glucose – ferricyanide (Shirokov, 1974);

– for the content of ascorbic acid – iodometric (according to B.P. Pleshkov (1976));

– for fruit juiciness – acidimetric (Pleshkov, 1976);

– for preservation of ascorbic acid – according to B.L. Flaumenbaum *et al.* (1986).

The repeatability of chemical analyses is threefold. The mass of the sample for analysis is 2 kg of fruit or 1.5 kg of product.

Statistical processing of research results was performed using variance analysis.

RESULTS AND DISCUSSION

To exclude subjectivity in evaluating the juice yield from black currant fruits, the authors applied the generalised Harrington desirability function (Weishtord & Pritykina, 1992).

When indicating the percentage of juice yield, the authors assumed that according to their data, the juiciness of black currant fruits is, on average, 90.7% (fruits of the Minai Shmyrev variety – 90.5%, fruits of the Belarus Sweet variety – 89.3%, fruits of the Novyna Prykarpattia variety – 92.3%). The yield of blackcurrant juice should be considered efficient starting from 40%. According to the level of desirability, juice extraction efficiency indicators are distributed as follows: under 35% – very unsatisfactory; 35-40% – unsatisfactory; 40-48% – satisfactory; 48-55% – good; over 55 % – exceptionally good. The Harrington desirability function can be a criterion for evaluating methods for pre-treatment of blackcurrant fruits to increase juice yield.

Influence of mechanical grinding on the yield and quality of blackcurrant juices

The first and mandatory operation in preparing raw materials for juice extraction is grinding. However, the need for grinding is quite obvious where the fruit pulp is hard and tough, but there is doubt regarding the need for grinding soft berries. In particular, the degree of damage to the cells of black currant fruits under the influence of mechanical grinding is small.

The studies have shown that when ground, black currant fruits did not produce loose pomace, which would comprise small pieces and juice, which is consistent with the data of other scientists (Deinychenko *et al.*, 2020; Cherevko *et al.*, 2020; Shirokov, 1974). The pomace had a solid, homogeneous mass, from which no juice was released at all. The degree of grinding could only be estimated by the size of the pieces of skin outlined against the background of the pomace. Their size was from 2 to 4 mm. Pressing such a pomace is quite difficult.

According to Table 1, the juice yield during mechanical grinding of fruits to pomace is low (very unsatisfactory) – from 17.8% to 24.3%. On average, over 8 years of study, depending on the variety, it was 20-22%. Fruits of the Novyna Prykarpattia variety yielded 4-10% more juice than fruits of other varieties.

***Table 1.** Juice output from black currant fruits of different varieties,%*

Year	Variety		
	Minai Shmyrev	Belarusian Sweet	Novyna Prykarpattia
2003	21.8	19.0	23.4
2004	19.2	17.8	20.3
2005	20.1	18.6	22.4
2006	20.6	20.3	22.8
2007	22.0	21.3	24.3
2008	23.1	21.8	22.5
2009	22.0	20.7	20.4
2010	20.8	21.2	20.5
Average	21.2	20.1	22.1
HIP_{05}		2.7	

The resulting juice had a light pink colour, high viscosity, pleasant taste and aroma inherent in black currant fruits. However, it was devoid of the most inherent feature – intense colouring. Since the colouring substances in black currant fruits are located in the peel, they did not pass into the juice upon cold pressing and were removed with pomace (Ozola & Duma, 2020).

The chemical composition of freshly pressed juices was different from that of fruits. On average, the dry matter content decreased by 2.4-3.1%, the total sugar content – by 2.1-2.6%, and acids – by 4.8-7.3%. Due to high acid losses, the sugar-acid index of juices increased by an average of 3.7%. The content of ascorbic acid in juices decreased by 15-21%. The low preservation of the C-vitamin value of juices is associated with the high activity of oxidative enzymes during the main technological techniques – grinding and pressing.

According to the indicators regulated by the DSTU 4150:2003 standard, freshly pressed natural fruit juices and juices with sugar met the requirements.

The addition of sugar syrup to natural juices considerably improved their taste qualities due to a 3-4.5-fold increase in the sugar-acid index. Depending on the variety of fruit, it was 11.3-18.7, and in some years it increased to 20.4-22.1 or decreased to 8.5-9.9.

The C-vitamin content of juices with sugar in comparison with natural ones is 1.7 times lower. But considering the recipe for the product, the preservation of ascorbic acid, regardless of the fruit variety, was about 98%.

However, the key difference between blackcurrant juices extracted by pressing mechanically ground pomace is related to their organoleptic assessment. In appearance, they did not correspond to natural juices due to a considerable deviation from the inherent colour. However, the juices had a pronounced smell, and the taste was very pleasant. Over time, during three months of storage, they quickly lost colour. The latter first turned dirty pink, and then dirty light-brown and never once resembled the inherent colour of blackcurrant juice. Therefore, the use of the method of pressing ground black currant pomaces, as an independent one, is not economically and technologically expedient.

Effect of pomace heating on the yield and quality of blackcurrant juices

Literature data on the dependence of black currant fruit juice production on heat treatment are quite contradictory (Osokina *et al.*, 2021; Deinychenko *et al.*, 2020; Vyshnikin *et al.*, 2019), and require clarification of temperatures and processing methods. Results of heat treatment of black currant pomace at 65-70°C (5 min) are presented in Table 2.

***Table 2.** Juice yield depending on the method of pre-treatment of black currant fruits of different varieties,% (three-year data are sufficient to confirm the reliability of the results)*

Pre-processing method	Minai Shmyrev			Belarusian Sweet			Novyna Prykarpattia		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
Mechanical grinding to pomace (control)	21.8	19.2	20.1	19.0	17.8	18.6	23.4	20.3	22.4
Heating of the pomace at 65-70°C, 5 min	40.4	37.1	38.9	38.3	36.4	38.0	42.3	38.5	41.0
HIP_{05}					2.0				

The juice output of raw materials depended on the specific features of the variety and the year of harvest, but the greatest impact was exerted by heat treatment of pomace – 83%.

The yield of juice from fruits, on average, was about 38-41%, which is 1.8-2.0 times more than in the control (19-22%). The advantages of the Novyna Prykarpattia fruit variety are clear: 19% more juice than from the Belarus Sweet variety and 8% more than from the Minai Shmyrev fruit variety in the control and 8% and 5% in the experimental variety, respectively.

Genetic features of the variety related to its anatomical structure and chemical composition directly affected the extraction of juice. This was more evident in the control version. Warming up the pomace, which caused cell die-away, somewhat levelled the difference between the varieties, but remained substantial.

The juice yield varied depending on the year of black currant harvest. The highest rate was recorded in 2003-40.3% (control – 21.4%), which is 12% more in the control and 8% more in the experimental variants.

Qualitative evaluation of juices (Table 3) showed that natural juice is close to fresh fruit in terms of chemical parameters. The main components of the chemical composition were transferred to the juice by 97-99%.

Heat treatment of the pomace before pressing allowed obtaining natural juices, in which the loss of dry soluble substances is almost threefold, sugars and acids are 2.5 times less compared to the juices of the control version.

Table 3. *Indicators of the chemical composition of black currant fruits of various varieties and juices from them (three-year data are sufficient to confirm the reliability of the results)*

Pre-processing method	2003				2004				2005			
	Dry soluble substance content, %	Total sugar content, %	Acid content[1], %	Sugar-acid index	Dry soluble substance content, %	Total sugar content, %	Acid content[1], %	Sugar-acid index	Dry soluble substance content, %	Total sugar content, %	Acid content[1], %	Sugar-acid index
Minai Shmyrev												
Fruits	16.0	7.26	3.32	2.19	15.8	7.01	3.05	2.30	16.4	8.91	2.65	3.36
Fruit grinding to pomace (control)	15.6[2] / 21.4	7.06 / 16.24	3.20 / 1.92	2.21 / 8.46	15.4 / 21.2	6.83 / 16.1	2.92 / 1.75	2.34 / 9.20	16.0 / 21.6	8.68 / 17.2	2.50 / 1.52	3.47 / 11.3
Heating of the pomace at 65–70 °C, 5 min.	15.8 / 21.6	7.18 / 16.28	3.25 / 1.95	2.21 / 8.35	15.6 / 21.4	6.94 / 16.1	3.00 / 1.81	2.31 / 8.93	16.4 / 21.8	8.88 / 17.3	2.68 / 1.60	3.31 / 10.8
Belarusian Sweet												
Fruits	16.0	8.82	2.55	3.46	14.2	6.56	2.31	2.84	16.8	9.21	1.86	4.95
Fruit grinding to pomace (control)	15.6 / 21.4	8.68 / 17.2	2.42 / 1.45	3.59 / 11.8	13.8 / 20.4	6.38 / 15.8	2.12 / 1.27	3.01 / 12.4	16.4 / 21.8	9.12 / 17.4	1.76 / 1.05	5.18 / 16.5
Heating of the pomace at 65-70°C, 5 min	15.8 / 21.6	8.76 / 17.2	2.50 / 1.50	3.50 / 11.4	14.0 / 20.4	6.44 / 15.8	2.25 / 11.3	2.86 / 11.6	16.8 / 22.0	9.25 / 17.5	1.82 / 1.09	5.08 / 16.1
Novyna Prykarpattia												
Fruits	14.6	7.91	2.61	3.03	13.2	6.01	2.18	2.76	13.8	8.40	1.79	4.69
Fruit grinding to pomace (control)	14.0 / 20.4	7.65 / 16.6	2.41 / 1.45	3.17 / 11.5	12.8 / 19.6	5.80 / 15.4	2.10 / 1.25	2.76 / 12.3	13.4 / 20.0	8.26 / 16.9	1.65 / 1.00	5.01 / 16.9
Heating of the pomace at 65-70°C, 5 min	14.4 / 20.6	7.85 / 16.6	2.54 / 1.51	3.08 / 11.1	13.0 / 19.8	5.9 / 15.5	2.18 / 1.30	2.71 / 11.9	13.6 / 20.2	8.34 / 17.0	1.71 / 1.03	4.88 / 16.5
HIP_{05}	0.033 / 0.043	0.48 / 0.47	0.09 / 0.12	0.23 / 0.75	0.033 / 0.043	0.48 / 0.47	0.09 / 0.12	0.23 / 0.75	0.033 / 0.043	0.48 / 0.47	0.09 / 0.12	0.23 / 0.75

Note: *1) in terms of citric acid; 2) above dash – natural juice, under dash – juice with sugar*

Juices with sugar, which were prepared from the fruits of the varieties Belarus Sweet and Novyna Prykarpattia, were distinguished by high taste properties. Their sugar-acid index is from 12 to 17. In years when the acidity of black currant fruits increases above 2.5%, one should use blending juices with those containing a lower acid content, especially less than 1.5%. This technique allows preserving the natural properties of products. As pointed out by C. Conidi *et al.* (2020b), juices with a sugar-acid index below 15 are too acidic, and those with a sugar-acid index above 45 are too sweet. Instead, C. Conidi *et al.* (2020a) and R. Castro-Muñoz (2019) believe that for the average person, juice tastes better if its sugar-acid index is 13. However, the taste is formed not only by the ratio of sugar and acid, but also other organic substances, such as colouring ones, and therefore the assessment of taste may differ in the juices of fruits of different cultivars.

According to organoleptic parameters, the juices obtained by heat treatment of the pomace differed from the juices of the control variants. They had a natural appearance, saturated colouring inherent in black currant, pronounced unique aroma, pleasant taste, the freshness of which is somewhat lost, but boiled tones are not felt. The data in Table 4 indicate a substantial effect of heat treatment of pomace on the preservation of ascorbic acid. The preservation of C-vitamin value, regardless of the variety, was 83-85%. While in similar juices obtained with heat treatment of pomace, the level of preservation is 95-97%.

Table 4. *Ascorbic acid content (mg/100 g) and its preservation (%) in black currant fruits of various varieties and juices from them (three-year data are sufficient to confirm the reliability of the results)*

Pre-processing method	2003			2004			2005		
	Fruits	Juices		Fruits	Juices		Fruits	Juices	
		Natural	With sugar		Natural	With sugar		Natural	With sugar
Minai Shmyrev									
Fruit grinding to pomace (control)	182.1	151.1* / 83.0	88.7 / 97.8	176.0	149.7 / 85.1	88.0 / 98.0	172.0	144.5 / 84.0	85.0 / 98.0
Heating the pomace at 65-70°C, 5 min		176.6 / 97.0	104.1 / 98.3		167.3 / 95.1	91.1 / 98.7		165.9 / 96.5	98.5 / 99.0
Belarusian Sweet									
Fruit grinding to pomace (control)	237.5	227.0 / 83.0	133.2 / 97.8	308.0	261.4 / 84.9	153.9 / 98.1	272.8	229.1 / 84.0	134.8 / 98.1
Heating the pomace at 65-70°C, 5 min		230.4 / 97.0	157.2 / 98.8		292.5 / 95.0	172.9 / 98.5		261.8 / 96.0	155.8 / 99.2
Novyna Prykarpattia									
Fruit grinding to pomace (control)	229.3	191.2 / 83.4	112.4 / 98.0	180.4	153.3 / 85.0	90.3 / 98.2	192.4	162.0 / 84.2	95.1 / 97.8
Heating the pomace at 65-70°C, 5 min		222.3 / 97.0	132.3 / 99.2		171.5 / 95.1	101.9 / 99.0		184.4 / 95.8	109.5 / 99.0
HIP_{05}, mg/100 g		6.9	6.4		6.9	6.4		6.9	6.4

Note*: * — above dash — the content of ascorbic acid in juices, mg/100 g, under dash — the preservation of ascorbic acid in juices, %*

Blackcurrant juices with sugar considerably differed in the content of ascorbic acid. Its amount decreased by 1.7 times compared to natural juices. However, ascorbic acid in juices with sugar had a high stability — its preservation was 98-99%. The value of the juices was determined by the initial content of ascorbic acid in the fruit. If in the fruits of the Belarus Sweet variety its content is 1.2-1.8 times higher than in the fruits of other varieties, then a similar trend was observed in juices. Dispersion analysis confirmed the greatest strength of influence of specific features of the variety (80%) on the ascorbic acid content in natural juices. In juices with sugar, the weight of the method of heat treatment of pomace is 66%, and the variety — 28%.

According to Table 5, it was found that the yield of blackcurrant juice under heat treatment at 50-55°C depended on the method of preparation of raw materials.

Table 5. *Juice yield depending on the method of pre-treatment of black currant fruits of different varieties,%*

Pre-processing method	Minai Shmyrev		Belarusian Sweet		Novyna Prykarpattia	
	2006	2007	2006	2007	2006	2007
Mechanical grinding of fruits to pomace (control)	20.6	22.0	20.3	21.3	22.8	24.3
Heating the ground pomace at 50-55°C (5 min)	36.0	36.8	34.6	35.1	37.2	38.4
Heating the pomace of crushed fruits at 50-55°C (5 min)	53.6	54.0	49.4	51.0	54.2	55.8
Heating the whole fruits with 15% water at 50-55°C (5 min), (excluding water)	41.0	42.8	38.2	40.5	43.0	45.2
HIP_{05}	4.0					

When the ground pomace was heated at 50-55°C, the juice yield increased to 35-38%, which is 1.6-1.7 times more compared to the control. The result is only 7-8% less compared to heating the pomace at 65-70°C (see Table 2). But the temperature regime of 50-55°C probably had a milder effect on the coagulation of colloids, and denaturation of protein substances.

At 50-55°C, the variant with heating whole fruits with the addition of 15% water was satisfactory. Compared to the control, the juice yield increased by 1.9-2 times and amounted to 38-45%, or was at the level of juice yield when the ground pomace was heated at 65-70°C and 10-18% higher at 50-55°C.

The reason for this, evidently, lies in the preservation of the integrity of the fruit before pressing, the skin of the fruit remained intact from the outside, but from the inside the pulp underwent physical and chemical changes, which caused cell plasmolysis (Osokina *et al.*, 2021). It was enough just to press on the fruit as the peel burst, not finding back pressure from the already boiled pulp. The extraction of juice was also facilitated by the water that was added. It liquefied the pomace and promoted the diffusion of soluble organic substances.

The highest juice yield was obtained by pressing the heated pomace of crushed fruits, depending on the variety and year of research, – 49-56%, which is 2.3-2.6 times more compared to the control. The efficiency of fruit crushing is obvious. When comparing the juice output from ground and crushed pomace, under the same heat treatment conditions, the difference was 15-18%. The juice yield increased by 1.4-1.5 times.

The option of pressing the pomace of crushed fruits had advantages over the option of pressing whole fruits with the addition of 15% water. The difference in juice output is 11-13%, which is 23-30% more.

The high efficiency of crushing black currant fruits during heat treatment to increase the juice yield is associated with the degree of cell damage. It was found that for black currant fruits, the degree of cell damage upon grinding is 31%, while upon crushing – 40% (Deinychenko *et al.*, 2020; Conidi *et al.*, 2020b; Cherevko *et al.*, 2020). The use of the combined effect of fruit crushing and heat treatment increased the juice yield by almost 30%.

Juice production of fruits of the Novyna Prykarpattia variety is the best for any juice extraction variant. The increase in juice yield was from 8-9% to 13-14% compared to Belarus Sweet fruits, and from 3-4% to 10% compared to Minai Shmyrev fruits, depending on the variant.

The quality indicators of freshly pressed juices depended on the chemical composition of the fruit. In the juices of the control variants, the content of dry soluble substances and sugars decreased mainly by 1.5-1.7%; the content of acids – by 3-10%. In juices obtained by pressing whole fruits with 15% water – by 9-15%, 8-14%, 9-17%, respectively, which is associated with the dilution of the juices with water.

Freshly pressed juices from the fruits of the varieties Belarus Sweet and Novyna Prykarpattia did not meet the standard (1.5-3.7%) in terms of acid content. This is due to their low content in raw materials (1.3-1.4%), which is rarely found in black currant fruits. The sugar-acid index of juices did not increase significantly (by 2-4%), which did not affect the taste of freshly pressed juices.

Indicators of the chemical composition of juices with sugar depended entirely on the quality of freshly pressed natural juices. The acid content substantially affected the taste of juices with sugar. The sugar-acid index of juices from fruits of the Minay Shmyrev variety is 13-15. The indicator level is satisfactory. However, the sugar-acid index of juices from fruits of the varieties Belarus Sweet and Novyna Prykarpattia is unjustifiably high – 18-22, as it is rare in practice. Although juices with this index are extremely pleasant, soft, silky, and can satisfy the most capricious consumer. They have a pronounced aroma. The appearance and colour of the juices is typical for black currant fruits.

The results of heat treatment of raw materials had a positive effect on the preservation of ascorbic acid. In freshly pressed juices obtained from heated pomace of ground and crushed fruits at 50-55°C, the preservation of ascorbic acid was usually 95-97%, while in the juices of control variants – only 83-87%. At the control level, the preservation of ascorbic acid in juices pressed from heated whole fruits with 15% water, due to dilution, was also found. The high preservation of C-vitamin content of juices is associated with inactivation of oxidative enzymes, acidic environment and deaeration of raw materials upon heating.

In blackcurrant juices with sugar, the content of ascorbic acid decreased by almost 1.7 times. However, the preservation of C-vitamin content remained high – about 99%, regardless of the variety of fruits and the method of pre-processing.

Influence of fruit blanching on the yield and quality of blackcurrant juices

According to Table 6, blanching the fruit before pressing allows increasing the juice yield by 1.5-2 times. But with different processing options, the output was different. Blanching fruits in water is more efficient. The juice yield increased to 39-44% (at 50-55°C) and 42-45% (at 95-100°C), which is 1.8-2 times more than the control. As the water temperature increased, the efficiency of juice extraction increased by 4-7%.

Table 6*. Juice yield depending on the method of pre-treatment of black currant fruits of different varieties (2007), %*

Pre-processing method	Minai Shmyrev	Belarusian Sweet	Novyna Prykarpattia
Mechanical grinding of fruits to pomace (control)	22.0	21.3	24.3
Blanching fruits in water at 50-55°C (5 min)	41.2	39.3	43.6
Blanching fruits in water at 95-100°C (5 min)	44.0	42.0	45.2
Blanching fruits in juice at 50-55°C (5 min), except the juice taken for blanching	35.0	33.4	35.6
Blanching pomace in juice at 50-55°C (6 h)	34.1	33.0	35.0
HIP_{05}	4.2		

Blanching the fruit in juice (5 min) and pomace (6 h) in its own juice at 50-55°C was inefficient – the juice yield increased to 30-35%, which is only 1.5 times more than in the control. The result of juice output is 20-27% worse than blanching fruits in water.

The difference in the yield of juice from the fruits of the varieties under study is from 3-5% to 6-11%.

According to Table 7, quantitative changes in the chemical composition of freshly pressed juices obtained by blanching fruits and pomace in juice, and in the control version, are not substantial. While blanching fruits in water caused a loss of dry soluble substances (5-8%), sugars (3-6%), acids (13-27%) in the juice, which is associated with their diffusion into water. Changes in the content of sugars and acids considerably increased (by 11-32%) the level of the sugar-acid index in juices.

Table 7. *Indicators of the chemical composition of black currant fruits of various varieties and juices from them, 2007*

Preprocessing method	Dry soluble substance content, %	Total sugar content, %	Acid content (in terms of citric acid), %	Sugar-acid index	Ascorbic acid content, mg/100 g	Preservation of ascorbic acid, %
1	2	3	4	5	6	7
Minai Shmyrev						
Fruits	12.8	7.03	2.06	3.41	186.6	–
Mechanical grinding of fruits to pomace (control)	12.6* 19.6	6.93 16.16	1.90 1.14	3.47 13.36	161.9 94.8	86.8 97.6
Blanching fruits in water at 50-55°C (5 min)	12.2 19.2	6.73 16.06	1.62 0.97	4.15 16.56	166.4 98.6	89.2 98.8
Blanching fruits in water at 95-100°C (5 min)	11.8 19.0	6.63 15.98	1.56 0.94	4.25 17.00	156.6 92.6	83.9 98.6
Blanching fruits in juice at 50-55°C (5 min)	13.0 19.8	7.03 16.22	2.10 1.26	3.35 12.87	167.9 99.2	90.0 98.5
Blanching pomace in the juice of pre-pressed fruits at 50-55°C (6 h)	13.0 19.8	7.03 16.22	2.10 1.26	3.35 12.87	160.5 94.7	86.0 98.3
Belarusian Sweet						
Fruits	11.8	6.43	1.54	4.18	234.9	–
Mechanical grinding of fruits to pomace (control)	11.6 19.0	6.36 15.82	1.40 0.84	4.54 17.58	202.3 118.3	86.1 97.5
Blanching fruits in water at 50-55°C (5 min)	11.2 18.6	6.23 15.75	1.34 0.80	4.65 19.69	209.2 123.8	89.1 98.6
Blanching fruits in water at 95-100°C (5 min)	11.0 18.6	6.10 15.65	1.11 0.67	5.50 23.36	194.7 115.2	82.8 98.6

Table 7, Continued

Preprocessing method	Dry soluble substance content, %	Total sugar content, %	Acid content (in terms of citric acid), %	Sugar-acid index	Ascorbic acid content, mg/100 g	Preservation of ascorbic acid, %
1	2	3	4	5	6	7
Belarusian Sweet						
Blanching fruits in juice at 50-55°C (5 min)	12.0 / 19.4	6.48 / 15.90	1.60 / 0.96	4.05 / 16.56	206.6 / 122.0	87.9 / 98.4
Blanching pomace in the juice of pre-pressed fruits at 50-55°C (6 h)	12.2 / 19.4	6.56 / 15.95	1.65 / 1.00	3.98 / 15.95	204.4 / 120.7	87.0 / 98.4
Novyna Prykarpattia						
Fruits	13.4	7.84	1.36	5.76	189.7	–
Mechanical grinding of fruits to pomace (control)	13.0 / 19.8	7.63 / 16.58	1.19 / 0.71	6.10 / 22.10	158.1 / 93.0	83.3 / 98.0
Blanching fruits in water at 50-55°C (5 min)	12.6 / 19.6	7.48 / 16.51	1.20 / 0.72	6.23 / 22.93	170.0 / 101.3	89.6 / 99.1
Blanching fruits in water at 95-100°C (5 min)	12.4 / 19.4	7.42 / 16.45	1.16 / 0.70	6.40 / 23.50	159.3 / 94.8	84.0 / 99.2
Blanching fruits in juice at 50-55°C (5 min)	13.4 / 20.2	7.80 / 16.68	1.39 / 0.83	5.61 / 20.10	170.4 / 101.0	89.8 / 98.8
Blanching pomace in the juice of pre-pressed fruits at 50-55°C (6 h)	13.6 / 20.20	7.90 / 16.72	1.40 / 0.84	5.64 / 19.91	165.0 / 97.80	87.0 / 98.80
HIP_{05}	0.02 / 0.03	0.30 / 0.52	0.12 / 0.06	0.29 / 1.36	4.19 / 5.33	–

***Note**: * – above dash – natural freshly pressed juice, under dash – juice with sugar*

In terms of taste properties, juices with sugar from the experimental versions were pleasant, extractive. Blanching fruits in water practically did not affect their appearance, colouring, aroma, and taste.

The value of freshly pressed juices depended on the blanching method. In juices obtained by blanching fruits in water at 50-55°C, the preservation of ascorbic acid is the best – 88-90%. In juices extracted from pomace blanched in juice, its preservation was lower – 86-87% (close to control), which is associated with the oxidation of raw materials when infused for 6 hours. The preservation of ascorbic acid in juices obtained by blanching fruits in water was the lowest at 95-100°C, amounting to 83-84%.

High losses of ascorbic acid in freshly pressed juices upon blanching in water – 10-17% and upon blanching in juice – 10-14% (control – 13-15%) are associated with dilution of juice with water. The decrease in the biological value of juices is a considerable lack of the variants under study, which is consistent with the results of research by other scientists (Denisenko *et al.*, 2018; Weishtord & Pritykina, 1992). Blackcurrant juices with sugar were described by high preservation of ascorbic acid – 97-99%.

Influence of technological parameters, storage duration on the content of ascorbic acid in blackcurrant juices with sugar

The preservation of ascorbic acid in blackcurrant juices with sugar is influenced by the conditions of the technological process, preparation methods, and storage duration (Table 8).

***Table 8.** Ascorbic acid content (mg/100 g) and its preservation (%) in juices with sugar from black currant fruits of the Minai Shmyrev variety, 2010*

Duration of storage of juice with sugar, months	Method of final heat treatment of juices			
	Hot-bottling		Pasteurisation	
	Content	Preservation	Content	Preservation
Mechanical grinding of fruits to pomace (control)				
Freshly pressed juice	123.0		123.0	
0.5	71.9	97.4	72.3	98.0
3	67.2	91.0	67.6	91.6

Table 8, Continued

Duration of storage of juice with sugar, months	Method of final heat treatment of juices			
	Hot-bottling		Pasteurisation	
	Content	Preservation	Content	Preservation
Mechanical grinding of fruits to pomace (control)				
6	57.2	77.5	56.1	76.0
9	46.1	62.5	43.9	59.5
12	32.8	44.5	29.5	40.0
Heating the pomace at 50-55°C, 5 min				
Freshly pressed juice	143.5		143.5	
0.5	84.7	98.4	85.2	99.0
3	80.9	94.0	81.7	94.9
6	70.7	82.1	69.3	80.5
9	57.7	67.0	55.1	64.0
12	42.4	49.2	38.3	44.5
Heating the pomace at 65-70°C, 5 min				
Freshly pressed juice	141.7		141.7	
0.5	83.3	98.0	83.9	98.7
3	79.4	93.4	80.2	94.3
6	69.2	81.4	67.9	79.9
9	56.5	66.4	53.9	63.4
12	41.1	48.4	37.4	44.0
$HIP_{0.95}$	5.7	–	5.7	–

***Note**: there was no significant difference between varieties and years*

The greatest influence on the content of ascorbic acid in juice is the duration of storage. With its increase, the preservation of C-vitamin content of juices decreased. In the juice of the control version, the process was faster.

Calculations showed that during the first 3 months of storage, the monthly content of ascorbic acid in juices with sugar decreased, depending on the variety and method of final heat treatment: in the control – by 2.5-3%, in experimental versions – by 1.5-2%. For 6 months of storage, the decrease was 7-8% and 6-7%, respectively, for 9 months – 12-14% and 10-13%, for 12 months – 18-20% and 16-19%, respectively. Almost every month, there was a dynamic decrease in the value of the product. For 12 months of storage, the content of ascorbic acid in juices with sugar decreased by 7-10 times. The preservation of ascorbic acid shows the same trend.

During the first 3 months of storage, there was a tendency for a lower ascorbic acid content in hot-bottled juices. But over the last storage period (4-12 months), the picture changed: hot-bottled juices had slightly higher levels of ascorbic acid due to short-term exposure to elevated temperatures. Upon storing juices, their value was higher.

Depending on all these factors, the content of ascorbic acid in juices with sugar largely depended on the initial content in freshly pressed juice, and the latter on the characteristics of the variety.

CONCLUSIONS

The yield of juice from black currant fruits depends on the combined influence of factors – the type of mechanical processing, the temperature of heat treatment of raw materials, the characteristics of the variety, and weather conditions of the growing season.

1. According to Harrington's desirability index, the efficiency indicators for extracting blackcurrant juice are exceptionally good – over 55%, good – 48-55%, satisfactory – 40-48%, unsatisfactory – 35-40%, very unsatisfactory – under 35%.

2. The juice yield upon pressing ground black currant pomace is 18-24%. Juices with a considerable deviation from the inherent colouring. Juice extraction is economically and technologically impractical.

3. The depth of changes and the speed of their passage during heat treatment of fruits is determined by the temperature and methods of influencing raw materials. Already at 50-55°C, the juice yield increases by 1.5-2.5 times compared to the control. The juice yield during 5-minute heat treatment upon pressing is: 49-56% – from the pomace of crushed fruits, 38-43% – from whole fruits with 15% water – at 50-55°C; 37-42% – from the pomace of ground fruits at 65-70°C.

4. Blanching fruits in water with an increase in temperature from 50-55°C to 95-100°C increases the juice yield from 39-44% to 42-45%, and blanching fruits and pomace in their own juice is inefficient – the yield is up to 33-36%.

5. The chemical composition of freshly pressed juices, regardless of the method of processing raw materials, is close to fresh fruits, their taste and aroma do not change.

6. The content of ascorbic acid in freshly pressed juices depends on the variety. Its preservation in juices upon heat treatment is 95-97%, including blanching – 83-90%. In juices with sugar, it is 1.7 times lower compared to natural ones, but the preservation is 98-99%. However, monthly for the first 3 months – by 1.5-2%, for 6 months – by 5.5-7%, for 9 months – by 10-13%, for 12 months – by 16-19% or 7-10 times.

To increase the juice yield, other methods of processing black currant fruits (enzyme, freezing) can also be used, but they require further study and research.

REFERENCES

[1] Blackhall, M.L., Berry, R., Davies, N.W., & Walls, J.T. (2018). Optimized extraction of anthocyanins from reid fruits' Prunus avium 'lapins' cherries. *Food Chemistry,* 256, 280-285. doi: 10.1016/j.foodchem.2018.02.137.

[2] Castro-Munoz, R. (2019). Pervaporation: The emerging technique for extracting aroma compounds from food systems. *Journal of Food Engineering*, 253, 27-39. doi: 10.1016/J.JFOODENG.2019.02.013.

[3] Cherevko, O., Deinychenko, G., Dmytrevskyi, D., Guzenko, V., Heiier, H., & Tsvirkun, L. (2020). Application of membrane technologies in modern conditions of juice production. *Advanced Techniques and Technologies of Food Production, Restaurant Business and Trade,* 2(32), 67-77.

[4] Conidi, C., Castro-Muñoz, R., & Cassano, A. (2020a). Membrane-based operations in the fruit juice processing industry: A review. *Beverages*, 6(1), article number 18. doi 10.3390/beverages6010018.

[5] Conidi, C., Drioli, E., & Cassano, A. (2020b). Perspective of membrane technology in pomegranate juice processing: A review. *Foods,* 9(7), 889-914. doi: 10.3390/foods9070889.

[6] Deinychenko, H.V., Dmytrevskyi, D.V., & Perekrest, V.V. (2020). Investigation of the process of heat treatment of fruits during the manufacture of apple puree. *Proceedings of the Tavriya State Agrotechnological University,* 20(1), 133-142. doi: 10.31388 / 2078-0877-20-1-133-141.

[7] Denisenko, T.O., Miekh, Yu.V., & Vishnikin, A.B. (2018). Spectrophotometric determination of ascorbic acid using 18-molybdodiphosphate in intensely colored juices. *Chemistry,* 23(1), 70-82.

[8] Flaumenbaum, B.L., Tanchev, S.S., & Grishin, M.A. (1986). *Fundamentals of food preservation*. Moscow: Agropromizdat.

[9] Newman, D.J., & Cragg, G.M. (2020). Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. *Journal of Natural Products,* 83, 770-803. doi: 10.1021/acs.jnatprod.9b01285.

[10] Ongkowijoyo, P., A Luna-Vital, D., & Gonzalez de Mejia, E. (2018). Extraction techniques and analysis of anthocyanins from food sources by mass spectrometry: An update. *Food Chemistry,* 250, 113-126. doi: 10.1016/j.foodchem.2018.01.055.

[11] Osokina, N., Kostetska, K., & Gerasymchuk, H. (2020). Formation of frozen blackcurrant fruits quality. *Annual Research & Review in Biology,* 35(10), 97-112. doi: 10.9734/arrb/2020/v35i1030295.

[12] Osokina, N., Kostetska, K., Herasymchuk, O., Tkachenko, H., Podpriatov, H., Pusik, L., Falendysh, N., Bobel, I., & Belinska, K. (2021). Influence of freezing on changes in the structure of black currant fruits. *Science Rise,* 2, 31-39. doi: 10.21303/2313-8416.2021.001811.

[13] Osokina, N.M., Herasymchuk, O.P., & Kostetska, K.V. (2019). Biologically active substances in canned black currant fruits under complex processing. *Bulletin of Agrarian Science of the Black Sea Coast,* 3, 44-51.

[14] Ozola, B., & Duma, M. (2020). Antioxidant content of dark colored berries. *Agronomy Research,* 18(3), 1844-1852. doi: 10.15159/AR.20.123.

[15] Paniuta, O.O. (2019). *Plant anatomy: Manual.* Kyiv: AVEGA.

[16] Pleshkov, B.P. (1976). *Practicumon biochemistry.* Moscow: Kolos.

[17] Savas Bahceci, K. (2022). Effects of pretreatment and various operating parameters on permeate flux and quality during ultrafiltration of apple juice. *International Journal of Food Science and Technology,* 25(10), 45-56.

[18] Shirokov, E.P. (1974). *Practicum on technology of storage and processing of fruits and berries.* Moscow: Kolos.

[19] Sloan, A.E. (2022). The top 10 functional food trends. *Food Technology Magazine,* 76(3), 34-47.

[20] Veerapandi, L., Nivetha, T., Karunyah, A., & Sinthiya, R. (2022). Evaluation and comparative study of antidiabetic activity of anthocyanins derived from various natural sources. *Journal of Natural Remedies*, 22(1), 105-111. doi: 10.18311/jnr/2022/27658

[21] Vishnikin, A., Melnikov, K., Kolisnychenko, T., Lystopad, T., & Pidhorna, D. (2019). Development of berry drinks with a high content of ascorbic acid. *Food Science and Technology,* 13(3), 70-76.

[22] Vyshnikin, A.B., Melnykov, K.O., Kolisnychenko, T.O., Lystopad, T.S., & Pidhorna, D.V. (2019). Development of berry drinks with a high content of ascorbic acid. *Food Science and Technology*, 13(3), 70-76.

[23] Weishtord, I.P., & Pritykina, L.A. (1992). *Collection of technological instructions for the production of canned food. Canned fruits.* Moscow: Light and Food Industry.

Оцінювання способів теплового оброблення плодів чорної смородини для підвищення соковіддачі

Ніна Максимівна Осокіна[1], Олена Петрівна Герасимчук[1], Катерина Василівна Костецька[1], Наталія Петрівна Матвієнко[2], Ярослав Сергійович Стратуца[3]

[1]Уманський національний університет садівництва
20300, вул. Інститутська, 1, м. Умань, Україна

[2]ТОВ «Кононівський елеватор» Вікторівська дільниця
20144, вул. Українська, 1, с. Вікторівка, Черкаська область, Україна

[3]ТОВ СП «Ніблон» філія «Зеленодольська»
53842, с. Мар'янське, Дніпропетровська область, Україна

Анотація. Чорна смородина – полівітамінна культура з високими дієтичними та лікувальними властивостями, є джерелом виключно цінної сировини для виробництва соків. Сутність проблеми цієї роботи у науковому обґрунтуванні шляхів і способів ефективного витягування соку зі збереженням природного хімічного складу та біологічно активних речовин. Мета роботи – порівняльне оцінювання способів теплового оброблення плодів чорної смородини для підвищення соковіддачі. Оцінку ефективності виходу соку з плодів чорної смородини варто вести диференційовано за рівнем бажаності Харрінгтона: дуже добра – більше 55 %, добра – 48–55 %, задовільна – 40–48 %, незадовільна – 35–40 %, дуже незадовільна – менше 35 %. З плодів чорної смородини, зазвичай, одержують 18–24 % виходу соку, що позбавлений властивого забарвлення. Теплова обробка сировини збільшує вихід соку в 1,5–2,5 рази, порівняно з подрібненням, й при цьому вже за температури 50–55 °С клітини відмирають протягом 5 хв. Добрі показники виходу соку за пресування м'язги роздавлених плодів (49-55 %), задовільні – за нагрівання цілих плодів з додаванням 15 % води (38–45 %), а також бланшування плодів у воді з температурою 95–100 °С (42–45 %). Витягання соку бланшуванням плодів та вичавок у власному соку не ефективне (33–36 %). За хімічним складом свіжовідпресовані соки, незалежно від способу обробки сировини, близькі до свіжих плодів. Теплова обробка сировини не має негативного впливу на смак та аромат соків. Вміст аскорбінової кислоти у соках (142–225мг/100г) залежить від сорту плодів та погодних умов року. Збереженість її у свіжовідпресованих соках за теплової обробки – 95–97 %, в тому числі, при бланшуванні – 83–90 %. У соках із цукром її вміст в 1,7 рази нижчий, але збереженість – 98–99 %. Під час зберігання соків із цукром, збереженість аскорбінової кислоти знижується протягом перших трьох місяців – на 1,5–2 %, за 6 міс. – на 5,5–7 %, за 9 міс. – на 10–13 %, за 12 місяців – на 16–19 % або в 7–10 разів. Чинниками стабілізації аскорбінової кислоти в соках є цукор, гарячий розлий, нетривале нагрівання за високих температур

Ключові слова: лісова пожежа, гідротермічний коефіцієнт, динаміка поширення пожеж, верхова пожежа, вегетаційний період, сума температур повітря, сума опадів