The fruit of Siberian apple varieties as raw material for juice production

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Abstract. The article reflects the results of studies on juice production from the fruit of apple trees grown in Siberia. Some juice production schemes were tested and the optimal ones were selected for making clarified and pulpy juice. Apple tree varieties with maximum juice yield were also selected. The determination of organoleptic and basic technological parameters of the juice allows to confirm that the juice from Siberian varieties is not inferior, and in some cases, exceeds the parameters of the juice made from the fruit of European varieties. It has been shown that the obtained product is a clear liquid of a light straw colour with a greenish tint, with the characteristic fruit odour and a moderately sour and tart flavour. It corresponds to the acceptable sugar-acid index parameters.

1. Introduction
These days, wellness programs for population have become a priority in Russia, as well as around the globe. We observe a steady increase in the number of research on the creation of functional products for systematic consumption which reduce the risk of diseases, maintain and improve the health due to the content of physiologically functional ingredients [1-4]. Apples are one of the most important sources of phytonutrients that have biological activity and positively affect human health. Apple-based foods exhibit a high antioxidant activity, thanks in large part to polyphenols possessing some healing qualities. A number of publications show the relationship between the consumption of apples and increase of cardiovascular disease treatment effectiveness, reduce of cancer cells formation and level of blood sugar formation, alleviation of symptoms of allergies and other diseases [5-8].

A review of the regional market shows that apple juice, along with orange juice, is the most common and popular. Concentrated juice, mainly supplied by foreign manufacturers, is prevail in the import structure. The fruit of winter-hardy small-fruited apple trees grown in Siberia are more rich in vitamins, antioxidants, minerals and other useful substances compared to imported large-fruited varieties [9-13]. Small-fruited apples are a valuable raw material in terms of the content of pectin...
substances. It allows to use them in therapeutic, prophylactic and functional nutrition. Functional foods are primarily intended for the nutrition of children, elderly people, athletes; persons exposed to significant physical and emotional stress, residents of areas that are not successful in terms of ecology [14-15].

To preserve the valuable components of the raw material it is required to use systematic approach, to take into account the raw material characteristics, its biochemical composition, and to apply only those process operations that minimize the destruction of such components.

When choosing varieties, we were guided by such indicators as winter hardness, high productivity and resistance to various diseases and blasts, technological parameters of the variety.

2. Materials and methods
The juice was made using a laboratory batch press after preliminary grinding of the fruit to a particle size of 2-5 mm.

The determination of organoleptic and basic technological parameters of the juice was carried out according to standard methods (Methods of Technological..., 2002). The content of soluble dry substances (%) — by refractometric method according to GOST R 51433; mass fraction of titratable acids calculated as malic acid (%) — by potentiometric titration according to GOST R 51434; mass fraction of reducing sugars (%) — by photocolorimetric method according to GOST 8756.13; the content of soluble dry substances (%) — by refractometric method according to GOST R 51433-99, vitamin C content – by visual titration method according to GOST 24556. The total flavonoids content was determined by the intensity of the reaction with solutions of sodium nitrite and aluminum chloride. The transmission factor was determined in a Photo Colorimeter at a wavelength of 510 nm. Using the calibration curve, the total flavonoids content was determined. It is expressed in mg of tannin per dm3 of the original juice.

3. Results and discussion
In addition to the variety's characteristics and climatic conditions, the juice yield is greatly influenced by the conditions of the fruit processing. Various process schemes were used for juice extraction. These schemes included heating, adding enzymes and processing of fresh fruit. Four apple tree fruit processing schemes guaranteed different juice yields (figure 1) and its different physical and chemical parameters (table 1).

The adding of Dihydroquercetin into the pulp (Scheme 2) does not affect the juice yield, but inhibits browning, which can be explained by the antioxidant properties of this substance.
The highest juice yield is observed with adding of enzymes (Scheme 3). Application of scheme 4 gives cloudy, thick and viscous juice. Without treatment with enzyme preparations, it does not clarify. It indicates a high content of dry substances extracted from the pulp solids, the majority of which are pectin (mass fraction 1.9%). Thus, scheme 3 is the best scheme for producing clarified juices and juices for concentration. Scheme 4 is the best scheme for making the pectin-enriched juices.

Table 1. Physical and chemical parameters of juice produced by various schemes.

| Parameter                      | Scheme number |
|--------------------------------|---------------|
|                               | 1  | 2  | 3   | 4  |
| Density, g/dm³               | 1.056 | 1.057 | 1.061 | 1.063 |
| Sugar concentration, g/100cm³ | 12.9  | 12.9  | 12.8  | 13.0  |
| Titrated acidity, g/dm³      | 11.0  | 11.2  | 11.3  | 11.3  |
| Crude extract, g/dm³         | 20.0  | 16.0  | 22.0  | 24.0  |

Figure 2. Juice yield of studied apple varieties.

Juice yield is the most important technological parameter determining the profitability of processing enterprises. Despite the fact that the juice content in apples is 90% and more, it usually can be extracted only 60-65% when the material is crushed and pressed [15-16]. Despite the existence of numerous technological methods of raw material processing for juice yield increasing in juice production, the use of varieties with high juice yield remains the main and most economically justified.

The data obtained for the studied varieties (Figure 2) show that the Krasnoyarskiy Snigirek, Purpurovaya, Malinka varieties are characterized by the highest juice yield. The Veselovka, Krasa Buryatii and Ranetka Ermolayeva varieties are significantly inferior.

The juice yield varies widely (71.8-52.8%) and is not directly dependent on the fruit size, but is determined by the mechanical composition – the proportion of seeds, the size of the seed vessel, as well as the skin thickness. Analysis of European apple varieties by juice yield revealed that with an
average value of 60.4%, the juice yield ranged from 44.1% (Pepin Orlovskiy) to 73.9% (Rossoshanskoye Vkusnoye) [17].

The juice extracted from the fruit of Siberian apple trees is a clear liquid of light straw colour with a greenish tint. It has a characteristic fruit odour and a moderately sour and tart flavour. The basis of extractive matter are sugars and acids. Chemical and technological parameters of the juice are shown in table 2.

Juice titratable acidity is a standard parameter (GOST R 52184-2003. Juices from fresh fruits). In the studied samples, it varies from 6.6 (Krasa Buryatii) to 9.9 g/dm³ (Ranetka Purpurovaya) in accordance with GOST 52184 (0.3-1.2% for fruit of early ripening and 0.4-1.4% for fruit of late ripening).

Table 2. Chemical and technological, as well as physical and chemical parameters of the juice of the studied varieties.

| Name of variety         | Content of dry substances, % | The amount of sugars, % | Titrated acidity, g/dm³ | Sugar-acid index | Vitamin C, mg/100 cm³ | The amount of phenolic compounds, mg/dm³ |
|-------------------------|------------------------------|-------------------------|-------------------------|------------------|-----------------------|----------------------------------------|
| Krasnoyarskiy Snigirek  | 12.1                         | 11.5                    | 7.8                     | 15               | 9.5                   | 2900                                   |
| Veselovka               | 20.1                         | 18.5                    | 9.3                     | 20               | 10.5                  | 1540                                   |
| Krasnoyarskiy Seyanets | 12.5                         | 11.4                    | 9.7                     | 12               | 10.6                  | 3050                                   |
| Ranetka Ermolayeva      | 19.5                         | 18.1                    | 6.7                     | 27               | 11.2                  | 1740                                   |
| Malinka                 | 14.3                         | 13.1                    | 7.0                     | 19               | 11.5                  | 3480                                   |
| Palmetta                | 12.8                         | 11.5                    | 8.7                     | 13               | 12.5                  | 1800                                   |
| Krasnaya Grozd         | 13.8                         | 12.5                    | 7.2                     | 17               | 13.7                  | 1660                                   |
| Krasa Buryatii         | 18.1                         | 17.6                    | 6.6                     | 27               | 15.0                  | 1620                                   |
| Ranetka Purpurovaya    | 18.7                         | 17.0                    | 9.9                     | 17               | 21.0                  | 2020                                   |

The mass fraction of sugars in juice is not standardized. However, it is an important technological parameter, as it determines the organoleptic perception and masks high acidity. The highest sugar content was in juice produced from the Veselovka (18.5%) and Ranetka Ermolayeva (18.1%) apple varieties. The less sugary were the juices produced from the Krasnoyarskiy Snigirek, Krasnoyarskiy Seyanets and Palmetta (11.5-11.4%) apple varieties.

It was found that juice taste is determined by the sugar-acid index. It is believed that the most harmonious ratio of sugar: acid is 15-25 units. [18]. But varieties with a sugar-acid index of 10-15 units can also be suitable for juice production: the content of organic acids is 6-9 g/dm³, and the content of sugars is higher than 9% [19-20]. All varieties except high-acid ones – Palmetta and Krasnoyarskiy Seyanets, correspond to these parameters. However, Palmetta and Krasnoyarskiy Seyanets can be used in blends with less acid juices.

This parameter is also vary in European varieties. According to multiannual data, the sugar-acid index for the Antonovka Obyknovennaya variety is 8.9, which explains its acidic taste. The same taste is characteristic to the juice made of the fruit of Vita (10.2), Panirovka (10.2), Zodorovy (10.1), Yubilyar (10.1), Korichnoye Novoye (9.4) and Osenneye Aloye (8.3) apple tree varieties. Juice obtained from the Bolотовское, Afrodita, Prishvinskoe and Spartan varieties is perceived as the sweetest [18].

It can be seen from the data obtained that the studied apple juices differ significantly in physical and chemical parameters (table 2). It was found that juices with a good organoleptic rating are characterized by a high content of dry substances [21]. The dry substance content averaged 17.3%. It
varies between 12.1-20.1%, which is more than the regulated minimum value 10% [8] and corresponds to GOST 2184.

The content of phenolic compounds is not a standardized parameter, but it determines the nutritional and functional value of juices. Their amount depends on the content in the raw material, technological processing modes, enzyme activity (polyphenol oxidase and peroxidase) [22]. For the studied varieties, it varies in the range from 1540 (Veselovka) to 3480 (Malinka) mg/dm³.

The highest content of ascorbic acid was noted in the juice extracted from the Ranetka Purpurovaya variety – 21 mg/100 cm³, for the remaining varieties it differs from 9.5 mg/100 cm³ (Krasnoyarskiy Snigirek) to 15.0 (Krasa Buryatii) mg/100 cm³.

4. Conclusion
The conducted studies have shown that small-fruited apples of Eastern Siberia are perspective raw material for the apple juice production. All 10 studied varieties are characterized by a high level of biologically active substances. They have original taste, they are widespread and highly available.

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