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BIOCHEMICAL COMPOSITION OF SWEET CHERRY (*PRYNUS AVIUM* L.) FRUIT DEPENDING ON THE SCION-STOCK COMBINATIONS

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ABSTRACT

The results of the field and biochemical researches of sweet cherry *Prunus avium* L. scion Chermashnaya fruit grown on 8 clonal stocks (Kolt, Moskoviya, Izmaylovskiy, Stepnoy rodnik, AVCH-2, VSL-2, VTS-13, V-5-88) are presented. Trees productivity, the fruit average weight and the stone- fruit weight relation were studied, fruit degustation evaluation was fulfilled and the main biochemical parameters such as soluble solids, sugars sum, ascorbic acid concentration and antioxidant activity were determined. The influence of the stock on the fruit biochemical composition, the trees productivity and the fruit weight was determined. The sweet cherries productivity was 12,5 kg/tree at average, and depending on the stock it varied from 8,3 kg/tree (V-5-88) to 18,6 kg/tree (Izmaylovskiy). The biggest fruit were found on the trees with stocks VSL-2, Izmaylovskiy and AVCH-2. At average the proportion of the stone in the fruit weight was 5.3% with the variation depending on the stock from 5.2% (Kolt) to 5.5% (V-5-88, Stepnoy rodnik). According to the degustation results the fruit of scion Chermashnaya were characterized by the sweet harmonized taste and smell (4.5 points), there were not found either taste deterioration or bitterness on any stock. The best results according to the degustation evaluation by the parameters complex were found at scion Chermashnaya combinations on stocks Izmaylovskiy, VSL-2 and Kolt. The soluble solids content also depended on the stock and varied from 13.9 (Chermashnaya on AVCH-2) to 17.2% (Chermashnaya on Izmaylovskiy) at average value 16.0%. The sugars content in the sweet cherry fruit was within the range from 9.0 to 12.4%. The sugars higher accumulation belonged to the combinations of Chermashmaya on Stepnoy rodnik (11.1%) and Chermashmaya on Izmaylovskiy (12.4%). The ascorbic acid content in the sweet cherry fruit did not exceed 8 mg.100 g^{-1}. Depending on the stock this parameter varied from 5.9 to 9.3 mg.100 g^{-1}. The highest vitamin C content was found in the fruit at the grafting on the stock Stepnoy rodnik, the lowest one – on the stock Moskoviya. The sweet cherry fruit antioxidant activity according to DPPH method was not high and was in the range from 11.8 to 13.8%.

Keywords: sweet cherry; clonal stock; stock/scion combinations; biochemical structure of fruit; antioxidant activity

INTRODUCTION

Sweet cherry is one of the most perspective and popular stone fruit crops. The advantages of the sweet cherry fruit for the health nutrition are rather high mostly because of the concentration of such phenolic compounds as procyanidins, anthocyans and phenolic acids **(Liu et al., 2011; Usenik et al., 2010)**. Natural antioxidants such as soluble solids and vitamin C make a contribution into the struggle against oxidative stress **(Birt et al., 2001; Harborne and Williams, 2000; Halliwell et al., 2005)**. The researches have shown that the consumption of fruit with high antioxidant activity can low the risk of cancer (Kang et al., 2003) and other diseases **(Jacob et al., 2003)**. At the present time thanks to winter-hardy variety breeding it is cultivated not only in the southern areas, but northward as well – in the Central region of Russia **(Upadysheva, 2009)**. It is appreaciated for the high eating qualities of the fruit, their curative and dietic properties **(Morozova and Upadysheva, 2014)**. The fruit of the northern sweet cherry scions are smaller, but the concentration of the main nutritional and biologically active substances is equal to the southern scions **(Motyleva et al., 2016; Upadyshev, 2008; Zhbanova et al., 2015)**. Everywhere sweet cherry is cultivated in grafted culture, and in the last years generally on clonal stocks. The stock influences the grafted plants growth and development, but there is no consensus about the correlation between the fruitage quality and the stock **(Kamzolova et al., 1999; Upadysheva, Kolpakov, 2009)**. The majority of the stock forms have hybrid parentage and form bitter, not-edible fruit that may cause the deterioration of the grafted scions fruit taste and quality.

The purpose of our work is to study the productivity and sweet cherries fruit quality depending on the stock.

Scientific hypothesis

The biochemical composition, the sweet cherry fruit quality and yield depending on the stock-scion combination are not studied. We have checked the influence of the stock on the formation of yield, quality and nutritional value of scion Chermashnaya fruit grown in Moscow region conditions. We supposed that it is possible to achieve the productivization and the fruit quality characteristics improvement.

MATERIAL AND METHODOLOGY

The researches place and methods

The field researches were held in 2015 – 2017 on the experimental sweet cherry plantations of Federal State Budgetary Scientific Institution "All-Russian Horticultural Institute for Breeding, Agrotechnology and Nursery", Moscow in Figure 1.

The plantations overall area is 0,5 ha. The experimental researches object was the fruit of the sweet cherry scion Chermashnaya grafted on 8 clonal stocks (Kolt, Moskoviya, Izmaylovskiy, Stepnoy rodnik, AVCH-2, VSL-2, VTS-13, V-5-88). Not less than 5 trees on each stock were studied.

The biochemical researches were held in the Laboratory of Physiology and Biochemistry of Federal State Budgetary Scientific Institution "All-Russian Horticultural Institute for Breeding, Agrotechnology and Nursery".

The determination of the productivity and fruit weight and the sensor evaluation

In the period of fruit ripening the trees productivity was determined by the fruitage weighing from each tree in five time repetition. The average fruit weight and the stone-fruit weight relation were determined by the weighing of 100 fruit in three time repetition. The sensor evaluation was fulfilled by the group of high qualified specialists for the evaluating products. They estimated three main quality parameters: taste (sweet, sour, with bitterness), after taste and fruit external appearance – the form, colour, the surface condition.

Chemicals

All chemical substances chosen for the analysis were of analytical sort and were bought from Sigma Aldrich (USA) and Merck KgaA (Germany).

Sample preparation

From average 300 g probe 100 g fruit without stone were prepared and extracted by double-distilled water (to determine antioxidant activity) and metaphosphoric acid (for ascorbic acid determination) with the help of high-speed homogenizer (10 000 rpm, 1 min, UltraTurrax T25 Basic, IKA). After centrifugation at 4000 g (Sigma, Germany) within 10 min the supernatant was used for measuring. The extraction as well as the measurements were held in three time repetition.

Basic chemical analyses

The soluble solids content (SSC) was expressed by the index of refraction (°Bx). The sugars sum content – by Bertran method **(Ermakova, 1987)**.

Ascorbic acid (AsA) determination

Ascorbic acid determination was held using HELC method **(Stan et al., 2014)**, the chromatograph KNAUER (Germany) was used. Chromatoghraphic conditions: HELC column Silasorb C18 (5 mkm), 150 x 4.0 mm (Biohimmac, Russia), the column temperature is 25 ° C, flow speed 1,0 ml min-1, the detector UV, the wave length l = 251 nm, the mobile phase MeOH: water – 5:95 (r./r.), aliquote for injections 20 mkl, the retention time Rt = 4.4 mm.

Antioxidant activity (AA) determination

Antioxidant activity was measured by the **Brand-Williams et al. (1995)** method using a compound DPPH˙ (2,2-diphenyl-1-pikrylhydrazyl). The spectrometr Thermo

Figure 1 The sweet cherry plantations, blooming period.

Figure 2 The fruiting combinations of Chermashmaya on Izmaylovskiy.

Helios Ɣ (USA) was used. The homogenized by the distilled water samples were put on the shaker Lab-PU-01 (Russia) for 8 hours, and then they were filtered and the antioxidant activity was measured in 10 minutes after interaction between the extract and reagent at wavelength 515 nm.

The calculation of antioxidant activity values was fulfilled using the formula:

Inhibiting DPPH = (AC - AAt) = AC / 100 (%),

where:

AC – DPPH solution absorption;

AAt – absorption at the antioxidant presence.

Three time repetition.

Statisic analysis

As a minimum three repetitions of the analysis were held and the results were shown as arithmetic average with standard deviation (±SD). To determine the differences significance between the data one-way ANOVA test was used (p <0.05) via the program Statgraphics Centurion XV (USA).

RESULTS AND DISCUSSION

As a result it was determined that the sweet cherry trees productivity 12,5 kg/tr. at average and depending on the stock varied from 8,3 kg/tr. (V-5-88) to 18.6 kg/tr. (Izmaylovskiy) Figure 2.

Higher than the average value this parameter was at the trees grafted on the stocks Izmaylovskiy, VSL-2, Moscoviya and AVCH-2. It should be noted that the single tree fruitage reduction was observed not only for the weak-grown combination with stock V-5-88, but for the strong-grown VTS-13 stocks (Table 1). Scion Chermashnaya as the majority of early ripening northern scions has medium-sized fruit. A single fruit weight at average value of 4.1 g depending on the stock changed from 3.6 g (V-5-88) to 4.4 g (VSL-2). The fruit were significantly bigger under the influence of stocks VSL-2, Izmaylovskiy and AVCH-2. The portion of the stone in the fruit weight was 5.3% at average with variation depending on the stock from 5.2% (Kolt) to 5.5% (V-5-88, Stepnoy rodnik). According to the degustation results the fruit of scion Chermashnaya were characterized by the sweet harmonized taste and smell (4.5 points), no taste deterioration was observed on either of the stocks. The best degustation evaluation parameters in the complex were found at Chermashnaya combinations on stocks Izmailovskiy, VSL-2 and Kolt.

Sweet cherry fruit were characterized by the high content of soluble solids and sugars, which depended on the stock-scion combination. The soluble solids content variated from 13.9% (Chermashnaya on AVCH-2) to 17.2% (Chermashnaya on Izmaylovskiy) at average value of 16.0% (Figure 3).

The sugars content in the fruit were within 9.0 – 12.4%. The sugars higher accumuilation were found at Chermashnaya on Stepnoy rodnik (11.1%) and Chermashnaya on Izmaylovskiy (12.4%) (Figure 4).

Table 1 The productivity and organoleptic estimation of sweet cherry scion Chermashnaya fruit depending on the stock at average in 2015 – 2017.

Stock	Productivity, kg/tree	Parameters under study		
		Average fruit weight, g	Stone-fruit weight relation, %	Degustation evaluation, point
VSL-2	12.7	4.4	5.4	4.7
V-5-88	8.3	3.6	5.5	4.0
Izmaylovskiy	18.6	4.3	5.3	4.7
Moskoviya	13.4	4.0	5.2	4.3
AVCH-2	13.1	4.3	5.3	4.3
VTS-13	10.9	4.1	5.3	4.4
Stepnoy rodnik	11.6	4.1	5.5	4.5
Kolt	11.5	4.0	5.2	4.7
NSR_{05}	1.7	0.1	0.05	0.2

While evaluating the stock influence there should be noted the reduction of the soluble solids content on stocks AVCH-2, Moskoviya, VSL-2 and VTS-13 on 10% at average and the sugars content on AVCH-2, Moskoviya, VCL-2 and V-5-88 on 14.4% in comparison with Kolt, Stepnoy rodnik and Izmaylovskiy. The correlation coefficient between the soluble solids content and the sugars sum is high, r 0.88.

At average AsA content in sweet cherry scion Chermashnaya fruit is not relatively high – 8.1 mg.100 g^{-1}. However, depending on the stock this parameter was varied from from 5.9 to 9.3 mg.100 g^{-1}. The highest AsA content was fixed on the stock-scion combination Chermashnaya on Stepnoy rodnik. The lowest

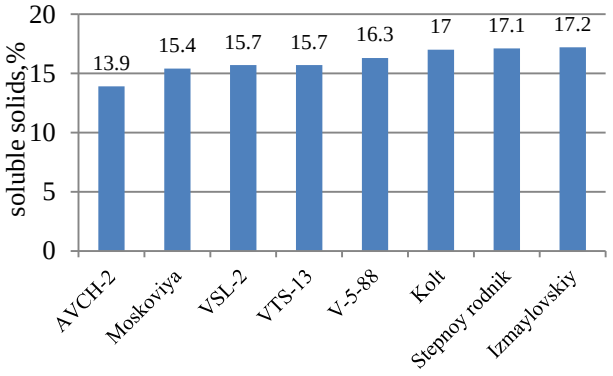

Figure 3 SS content in sweet cherry scion Chermashnaya fruit on different stocks.

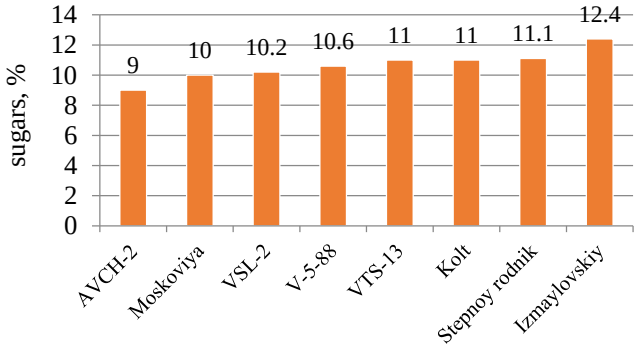

Figure 4 The sugars sum content in sweet cherry scion Chermashnay fruit on different stocks.

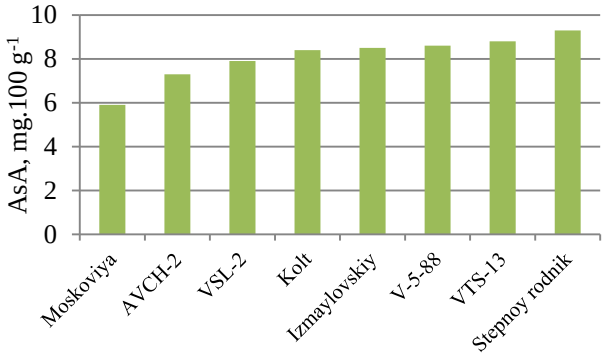

Figure 5 AsA content in sweet cherry scion Chermashnaya on different stocks.

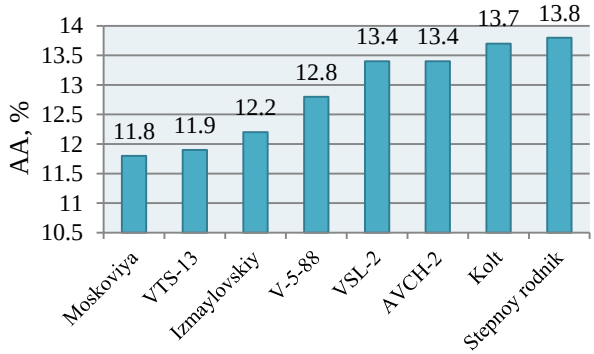

Figure 6 AA content in sweet cherry scion Chermashnaya fruit on different stocks.

accumulation was marked on Chermashnay on Moskoviya combination (Figure 5).

AA of sweet cherry fruit liquid extracts that determines their value for the functional nutrition was nearly 12,9% at average. The range of values depending on the used stock was - 9% (Moskoviya and VTS-13) and +7% (Kolt and Stepnoy rodnik) (Figure 6).

CONCLUSION

In the present paper the main focus was given to the study of the essential biochemical parameters that characterize the nutritional and dietic value of sweet cherry scion Chermashnaya fruit grown on different stocks. As the result of the researches the stock influence on the sweet cherry scion Chermashnaya fruit biochemical composition was identified, the limits of AsA, AA, sugars and soluble solids content variation depending on the used stock were determined. AsA and AA highest content was found in sweet cherry fruit on Stepnoy rodnik stock. According to the sugars sum values Chermashnaya on Izmaylovskiy stock-scion combination can be emphasized. While grafting on Moskoviya and AVCH-2 stocks the reduction of the parameters under study was observed. Using the data of the field and laboratory researches the conclusion can be made that the optimal stocks for scion Chermashnaya are Stepnoy rodnik, Izmaylovskiy and Kolt. The results received while working at this paper give new information about the stock influence on the biochemical characteristics of the scion fruit.

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