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POMOLOGICAL AND CHEMICAL CHARACTERISTICS OF FRUIT OF SOME SOUR CHERRY CULTIVARS GROWN IN THE CONDITIONS OF BIJELO POLJE

Gordana Šebek[1*]

[1]Biotechnical Faculty, University of Montenegro, Mihaila Lalića 15, 81000, Podgorica, Montenegro

[*]e-mail: sebek@t-com.me

Abstract

This study described some pomological and chemical traits of fruits in 6 sour cherry cultivars (Rexelle, Heimanns Konservenweichsel, Heimanns Rubin, Kelleris 14, Čačanski Rubin and Oblačinska) grown in ecological conditions of Bijelo Polje in the period from 2010 to 2012. The study focused on few segments. Very first one included recording of the phenological traits - first flowering, full flowering, end of flowering and harvest date. The other segment comprised pomological and chemical characteristics of fruit [fruit weight (g), stone weight (g), percentage of flesh (%), petiole length (mm), total soluble solids (%) and total acidity (%)].

Phenological characteristics were determined as below: the beginning of flowering was recorded when at least 5% of the flowers bloomed; full flowering was accepted when at least 80% of the flowers bloomed, the end of flowering was determined when 90% of the flowers bloomed and corollas began to fall off, and harvest date was established when the fruits were sufficiently colored and soft. Fruit weight and stone weight were determined by measuring by the electric scale Metler 1200. Petiole length were measured by Vernier scale. Total soluble solid content was determined by refractometer. The acidity was measured by titration with 0.1 N NaOH.

The earliest flowering was recorded in Oblačinska sour cherry and the latest in Kelleris 14. Except Oblačinska sour cherry and Čačanski rubin, all the other cultivars ripened in the first decade of July. The values for fruit weights ranged from 2.9 ± 0.28 g to 5.6 ± 0.36 g, stone weight ranged from 0.27 g ± 0.07 g to 0.41 ± 0.05 mm and petiole length ranged from 29.1 ± 2.14 mm to 37.1 ± 2.19 mm. The values for fruit total soluble solid contents ranged from 13.71% ± 0.35 to 15.00% ± 0.44 and titrable acid contents ranged from 1.49% ± 0.3 to 1.71 % ± 0.5.

Agro-ecological conditions of Bijelo Polje and its surrounding environment fully correlate to the intensive sour cherry production, hence the agro-biological characteristics of researched cultivars can be demonstrated in an economically justified manner.

***Key words**: Sour cherry, Cultivar, Chemical characteristics, Pomological characteristics.*

1. Introduction

Sour cherry (*Prunus cerasus L.*) belongs to the oldest fruits used by men. The creation of sour cherry is thought to have been caused by spontaneous hybridisation between steppe cherry (*Prunus fruticosa Pall.*) and wild cherry (*Prunus avium L.*). Sour cherry belongs to the *Rosaceae* family, *Pruniodeae* subfamily (stone fruit), *Prunus L.* genus, *Cerasus Pers*. subgenus and *Eucerasus Koehne* section (Rehder, [1]). De Candolle [2], considers that sour cherry originates from the area that extends from the Caspian Sea to Istanbul, while Hedrick, [3], points out that this area is much wider and that it spreads from Swiss and Adriatic Sea in the west, Germany in the north, to the Caspian Sea in the southeast. Vavilov, [4], states that sour cherry originates from the Middle East gencenter, which includes Asia Minor, Transcaucasia, Iran and the plateaus of Turkmenistan, where the cherry and steppe cherry distribution ranges are overlapping.

Observed by continents, the largest diversity of sour cherry can be found in Europe. For centuries, people have selected and reproduced types of sour cherry in a vegetative way or by grafting, which were proven to have highest level of fruitfulness and the best fruit quality, and were at the same time best adapted to

local ecological conditions. Thus, numerous autochthonous sour cherry ecotypes were created. The sour cherry assortment is slightly less dynamic compared to most other fruit trees. The exact number of sour cherry cultivars in the world is unknown, but it is significantly lower in comparison to cherry. According to some estimates, there are about 500 cultivars of cherries.

When it comes to production of continental fruits, sour cherry is in the seventh place in the world. According to data from Faostat, [5], the average sour cherry world production in period from 2008 to 2012 amounted to 1.25 million t. The main producer was Turkey with 188,661 t, which makes 15.1% of the total world production, followed by: Russia (14.6%), Poland (14.3%), Ukraine (12.0%), Iran (8.4%), USA (7.9%), Serbia (6.8%), Hungary (5.0%), Belarus (2.8%), Uzbekistan (2.4%), and so on.

Total surface on which sour cherry fruit trees are planted in Montenegro is 2,551.4 ha. Extensive production is applied to 1,217.6 ha, while plantations occupy 1,333.8 ha (Monstat, [6]). Statistical data relating to the number of sour cherry trees (total and fruitful) and the production of sour cherry as fruit cultivar are not available. So, statistical data exist solely for cultivars of: apple, pear, plum, walnut, citrus fruits and cherry. The aforementioned statistical data point out the unjustified neglect of sour cherry as a fruit cultivar in Montenegro. As for the Municipality of Bijelo Polje, according to 2010 data, total agricultural surface occupies 40,392 ha, out of which 1,866 ha are with orchards. The number of apple fruitful trees is 100,000, pear 40,000 and plum 357,000 (Monstat, [7]). The data for sour cherry trees in the territory of Bijelo Polje are not statistically processed, which refers to the fact that the cultivation of this fruit cultivar is very low. We certainly want to make the existing situation less severe by presenting data for the quality of the fruits of certain cultivars, which exist in smaller family orchards in the territory of Bijelo Polje municipality. Very large number of researchers in Serbia studied the pomological characteristics of sour cherry cultivars, such as: Stančević, [8, 9]; Janda, [10], Milovankić, [11], and Ninkovski [12].

2. Materials and Methods

Bijelo Polje is situated between 43° and 43°5' north latitude and 19°40' and 19°50' east longitude. The municipality of Bijelo Polje is situated at the altitude from 520 m (estuary of the River Kanjska to River Lim) to 2,017 m (Komovi Mountain). The terrain of Bijelo Polje municipality is following the direction of River Lim flow, i.e. the north and northwest direction. Larger and better-quality agricultural land is located on the near proximity of the River Lim, and its tributaries (Šebek. [13]).

The municipality of Bijelo Polje has average annual temperature of 8.9 ^{0}C. The warmest period is during the months of June, July and August, with an average temperature from 16.3 to 18.1 ^{0}C. The coldest period is during the months of December and January, with an average temperature from 0.1 to -1.6 ^{0}C. The lowest daily temperatures on annual level are around -3 ^{0}C. The winter period is characterized with intense negative temperatures, which can reach up to -27.6 ^{0}C. The spring period is characterized with low temperatures, which can be more than critical when it comes to fruit production (late spring frosts). Namely, the month of April was recorded in some years with the lowest temperature of up to -8 ^{0}. The average minimal temperature during April is -2.8 ^{0}C for the Bijelo Polje territory.

The annual precipitation level in Bijelo Polje municipality is 893.7 mm/m^2. The maximum precipitation is occurring during the period of October - December, while the period with the lowest precipitation is from June - August. The dominance of the cold and rainy period over the warm and dry one is expressed in relation of 54% vs. 46%.

During the three year period (2010 - 2012) the characteristics of 6 commercial sour cherry cultivars were researched. Those cultivars are the following: Rexelle, Heimanns Konservenweichsel, Heimanns Rubin, Kelleris 14, Čačanski Rubin, Oblačinska.

These researches were conducted on a larger number of private production orchards, which are in near proximity one from another and are all situated within the territory of Bijelo Polje. All cultivars were grafted on the generative rootstock of wild cherry (*Prunus avium* L.). The Oblačinska cultivar is the exception, having in mind it was cultivated by vegetative reproduction (by its own rootstock). Their tree shape was formed according to the system of an improved pyramidal crown. The orchards were of mixed type, and the trees of researched cultivars were with average age of 7 - 10 years, and were in the fruiting period. When it comes to agro-technical measures, winter cutting and winter spraying were applied.

The study focused on few segments. Very first one included recording of the chemical traits - dry matter, total soluble solids (TSS), and total acidity. The other segment comprised pomological traits: fruit weight (g), stone weight (g), percentage of flesh (%), petiole length (mm) and mass of petiole length (100 piece).

Dry mater was determined by drying at 105 ^{0}C. Total soluble solids were determined by refractometer. The acidity was measured by titration with 0.1 N NaOH. Fruit weight, stone weight and mass of petiole length (100 pieces) was determined by measuring by the electric scale Metler 1200. Analyses of the fruit were done on an average sample of 40 fruits per cultivar. The result are shown in grams with the accuracy of 0.01 g. Petiole length were measured by Vernier scale.

3. Results and Discussion

Researched sour cherry cultivars are characterized with an explosive start of flowering, which slightly differs among cultivars. Based on the data in Table 1, the starting phase of flowering happens in the interval from 11th till 18th April. The start of flowering is earliest in Oblačinska cultivar, while the Keleris 14 cultivar flowers last. The full phase of flowering comes 3 or 4 days later, in the period from 14th till 22nd April. The end of flowering is from 20th till 28th April, and the order is identical as with the starting phase of flowering.

The time of flowering depend from cultivar to cultivar, but are also influenced by climatic conditions. Since the municipality of Bijelo Polje has continental climate, which has a possibility of great variation of minimum and average daily temperatures, the differences in time and duration of flowering are present as well, compared to some other sour cherry growing localities.

Stančević, [8], states that cultivars Heimanns Rubin and Heimanns Konservenweichsel start the flowering phase one day apart, while the end of flowering phase is at the same day, which is similar to results of our research.

The fruit ripening happens in the interval from 28th June till 11th July. Except for the Oblačinska and Čačanski rubin cultivars, all other cultivars ripe in the first 10 days of July. Our results are slightly different when it comes to time of ripening, and not the order, from the results of Stančević, [8], Janda, [10], and Ninkovski [12]. This is not out of the ordinary, since the researches were conducted in different agroecological conditions.

The results of chemical and morphological characteristics of fruits of sour cherry cultivars are shown in Table 2 and 3. Fruit dry mater, total soluble solids and titrable acidity content of 6 sour cherry cultivars are shown in Table 2.

The values for fruit dry mater ranged from 14.10% ± 0.29 (cv. Rexelle) to 15.40% ± 0.32 (cv. Čačanski Rubin); total soluble solid contents ranged from 8.80% ± 0.12

Table 1. Flowering time and fruit ripening of researched sour cherry cultivars

Cultivar	Flowering			Harvest (date)
	onset	full	end	
Rexelle	15.04	20.04	25.04	06.07
Heimanns Konservenweichsel	15.04	19.04	24.04	05.07
Heimanns Rubin	15.04	19.04	25.04	06.07
Kelleris 14	18.04	22.04	28.04	11.07
Čačanski Rubin	13.04	17.04	21.04	30.06
Oblačinska	11.04	14.04	20.04	28.06

Table 2. Chemical characteristics of fruit of some commercial sour cherry cultivars

Cultivar	Fruit dry mater (%) mean ± SD	Total soluble solids (%) (TSS) mean ± SD	Total acidity (%) (TA) mean ± SD
Rexelle	14.10 ± 0.29	8.90 ± 0.17	1.58 ± 0.12
Heimanns Konservenweichsel	15.00 ± 0.36	10.05 ± 0.25	1.81 ± 0.15
Heimanns Rubin	14.75 ± 0.34	9.60 ± 0.14	1.82 ± 0.15
Kelleris 14	15.20 ± 0.35	9.80 ± 0.40	1.84 ± 0.20
Čačanski Rubin	15.40 ± 0.32	9.10 ± 0.17	1.65 ± 0.13
Oblačinska	14.60 ± 0.28	8.80 ± 0.12	1.73 ± 0.16
LSD 0.05 **LSD 0.01**	**1.25** **2.05**	**1.02** **1.26**	**0.11** **0.19**

Table 3. Morphological characteristics of fruit of some commercial sour cherry cultivars

Cultivar	Fruit weight (g) mean ± SD	Stone weight (g) mean ± SD	Percentage of flesh (%) mean ± SD	Petiole length (mm) mean±SD	Mass of petiole (100 piece)
Rexelle	5.5 ± 0.25	0.42 ± 0.88	92.3 ± 1.52	37.2 ± 0.20	9.9 ± 0.12
Heimanns Konservenweichsel	5.7 ± 0.95	0.37 ± 0.55	93.4 ± 1.58	34.0 ± 0.22	8.7± 0.09
Heimanns Rubin	5.1 ± 0.85	0.38 ± 1.55	92.4 ± 1.58	44.9 ± 0.21	9.3± 0.09
Kelleris 14	4.7 ± 0.98	0.27 ± 1.65	94.0 ± 1.45	29.3 ± 0.16	7.8 ± 0.08
Čačanski Rubin	5.5 ± 1.26	0.32 ± 0.74	94.0 ± 1.42	34.2 ± 0.19	9.6 ± 0.10
Oblačinska	3.0 ± 0.80	0.26 ± 0.25	91.2 ± 1.41	27.8 ± 0.14	7.2 ± 0.08
LSD 0.05 **LSD 0.01**	**0.79** **0.69**	**0.65** **0.93**	**1.22** **1.69**	**2.48** **3.29**	**0.52** **0.84**

(cv. Oblačinska) to 10.05% ± 0.25 (cv. Heimanns Konservenweichsel); titrable acid contents ranged from 1.58% ± 0.12 (cv. Rexelle) to 1.84 % ± 0.20 (cv. Kelleris 14).

Among researched cultivars, the fruits of Oblačinska cultivar are with the smallest fruit weight (3.0 g), while the fruits of Heimanns Konservenweichsel are with the largest fruit weight (5.7 g). Except Oblačinska cultivar, other cultivars are with the fruit mass above 4.5 g (Kelleris 14) and above 5 g (Rexelle, Heimanns Konservenweichsel, Heimanns Rubin, Čačanski rubin). The stone weight is the smallest in Oblačinska cultivar (0.26 g), and the biggest is with the cultivar Roxelle (0.42 g), which is not in correlation to its fruit mass.

Percentage of flesh was from 92.1% (Oblačinska) to 94.0% (Kelleris 14 and Čačanski rubin). The high percentage of flesh was in Heimanns Konservenweichsel cultivar (93.4%), while cultivars Rexelle and Heimanns Rubin have slightly smaller percentage of flesh (92.3% and 92.4%, respectively). When it comes to flesh percentage, all cultivars fulfil Đorović [14] criteria, since Đorović stated that the percentage of the stone is under 10.

The fruit mass is a characteristic that depends from cultivar to cultivar, but is also influenced by agroecological conditions and pomotechnical measures. Having this said, our results are different to a certain extent, and are mostly higher, from the results of Stančević, [8], Janda, [10], and Milovankić, [11].

The shortest petiole length are for Oblačinska cultivar (27.8 mm), while Heimanns Rubin cultivar has the longest petiole length (44.9 mm). As stated by Vercier (quote according to Đurović, [15]), the average length of the petiole length is for Rexelle and Heimanns Rubin cultivars (35 - 50 mm), while other cultivars are with a small petiole length (below 35 mm).

The mass of 100 piece (stems) was from 7.2 g for Oblačinska cultivar, to 9.9 g for Rexelle cultivar, and was in average 8.6 g.

4. Conclusions

Based on the obtained results on phonological, morphological and chemical characteristics of researched sour cherry cultivars (Rexelle, Heimanns Konservenweichsel, Heimanns Rubin, Kelleris 14, Čačanski Rubin and Oblačinska), the following conclusions can be made:

- The starting phase of flowering happens in the interval from 11th till 18th April. The start of flowering is earliest in Oblačinska cultivar, while the Keleris 14 cultivar flowers last. The full phase of flowering comes 3 or 4 days later, in the period from 14th till 22nd April. The end of flowering is from 20th till 28th April, and the order is identical as with the starting phase of flowering.

- The values for fruit dry mater ranged from 14.10% ± 0.29 (cv. Rexelle) to 15.40% ± 0.32 (cv. Čačanski Rubin); total soluble solid contents ranged from 8.80% ± 0.12 (cv. Oblačinska) to 10.05% ± 0.25 (cv. Heimanns Konservenweichsel); titrable acid contents ranged from 1.58% ± 0.12 (cv. Rexelle) to 1.84 % ± 0.20 (cv. Kelleris 14').

- Among researched cultivars, the fruits of Oblačinska cultivar are with the smallest fruit weight (3.0 g), while the fruits of Heimanns Konservenweichsel are with the largest fruit weight (5.7 g). Except Oblačinska cultivar, other cultivars are with the fruit mass above 4.5 g (Kelleris 14) and above 5.0 g (Rexelle, Heimanns Konservenweichsel, Heimanns Rubin, Čačanski rubin). The stone weight is the smallest in Oblačinska cultivar (0.26 g), and the biggest is with the cultivar Roxelle (0.42 g), which is not in correlation to its fruit mass. Percentage of flesh was from 92.1% (Oblačinska) to 94% (Kelleris 14 and Čačanski rubin).

- At the end of these studies, one general conclusion can be made, as an answer to set goals and the very task of our research: agro-ecological conditions of Bijelo Polje and its surrounding environment fully correlate to the intensive sour cherry production, hence the agro-biological characteristics of researched cultivars can be demonstrated in an economically justified manner.

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