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MECHANICAL PROPERTIES OF THE FRUITS OF SOME PERSPECTIVE SWEET CHERRY CULTIVARS

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Abstract

It was performed a research on the resistance of sweet cherry fruits to mechanical pressure and detachment force from their fruits stem for the cultivars 'Merchant', 'Pobeda Krimska', 'Summit', 'Vanda', 'Stella', 'Sunburst', 'Rainier', 'Bing', 'Mizia', 'Kozerska', 'Vasinika', 'Alexton' and control cultivar 'Van'. The survey was conducted during harvesting maturity of the fruits. These indicators characterize the transportability of the sweet cherry fruits and suitability of the cultivars for mechanized harvesting. The results show that the fruits of all investigated cultivars had from „good" to „very good" transportability, with the exception of 'Pobeda Krimska' and 'Sunburst'. The cultivar 'Vasinika', created at the Institute of Agriculture - Kyustendil, Bulgaria stands out with easily removable fruits, without leakage of juice. This cultivar was the most suitable for mechanized harvesting from all investigated cultivars.

Key words*: cultivar, mechanized harvesting, sweet cherry, transportability.*

INTRODUCTION

Along with the size and flavor, the density of sweet cherry fruits is one of the main criteria determining the quality of fruits for fresh consumption (Guyer et al., 1993; Bernalte et al., 1999; Vursavuş et al., 2006).

In some cultivars, the fruit flesh can be soft, in others - tight in different degree (Georgiev et al., 2007).

According to Zhivondov et al. (2011), the later ripening cultivars are characterized by good density, crispness, tender skin, juiciness and separability of the stone, while the early ones always have a soft or semi-thick texture.

In general the market preferences are targeted at sweet cherry cultivars having hard-fleshed fruits, mainly because of their better transportability, storage and resistance to manipulation.

The strength of attachment of the fruits to the fruit stems is directly related to the suitability of the cultivar for mechanized harvesting. When detached, the fruit stem may tear the fruit flesh or skin, and cause leakage of juice.

The cultivars, which fruits are easily detached from the stem, without tearing the skin and flesh and no juice leakage, are suitable for mechanized harvesting (Georgiev et al., 2007).

In the investigation carried out by the same authors was found that the cultivar 'Volsko' had the weakest detachment force of the fruits from the stems-less than 250 g.

It was most difficult to detach the fruit stems from fruits in cultivars 'Badaconi' and 'Poznanska' - from 531 to 740 g.

The purpose of this study was to establish the theoretical transportability and suitability for mechanized harvesting of some promising sweet cherry cultivars.

MATERIALS AND METHODS

The research was conducted during the period 2014-2016 at the experimental sweet cherry plantation of the Institute of Agriculture - Kyustendil, Bulgaria.

The object of the study were cultivars 'Merchant', 'Pobeda Krimska', 'Summit', 'Vanda', 'Stella', 'Sunburst', 'Rainier', 'Bing', 'Mizia', 'Kozerska', 'Vasinika' and 'Alexton'. The cultivar 'Van' was used as control.

The trees were planted in the spring of 2002 at distance of 6 x 5 m in the rows and formed in free growing crown.

They are grafted on *P. mahaleb* rootstock IK-M9, grown without irrigation. Each sweet cherry cultivar was represented by 5 trees.

The soil in the experimental plantation is highly leached, slightly sandy-clay cinnamon forest soil with a neutral reaction.

The fruit transportability was experimentally determined by measuring the resistance of the fruits to mechanical pressure until cracking of the skin, and by measuring the detachment force from their fruit stems.

The measurements were carried out during physiological maturity of the fruits, with a device made for this purpose, similar to the apparatus AC 2 (Georgiev et al., 2007).

The mechanical resistances most closely imitate the transport pressures and the force of detachment of the fruits from their fruit stems during harvesting.

The indicators are measured in grams. After detachment of the fruit stems, it has been reported whether there was observed any tearing of the skin and leakage of juice. The indicator is presented as a percentage of the total number of fruits recorded.

There were investigated 3 replicates of 50 fruits per each cultivar.

The obtained experimental results were processed by the method of analysis of variance, using the LSD-test to prove statistical significance of the differences found between the control and the variants. The evaluation was made at levels of significance $P < 0.05$, $P < 0.01$ and $P < 0.001$ (Maneva, 2007).

RESULTS AND DISCUSSIONS

The transportability of sweet cherry fruits is defined to a large extent by the biological characteristics of the cultivar. The rainfalls and their amount during the ripening period, as well as the applied agro-technology, also have an impact.

The results of our study show that, with the exception of ‘Pobeda Krimska’ and ‘Sunburst’, the fruits of other sweet cherry cultivars had good to very good transportability (Table 1). As an average for the period of study with the highest endurance of mechanical pressure, exceeding the value of the control ‘Van’ (2151 g), were the fruits of the cultivars ‘Mizia’ (2278.3 g) and ‘Summit’ (2214.1 g). "Very good" transportable qualities, and resistance to pressures from 1812.9 to 2036.3 g had also the fruits of ‘Bing’, ‘Alexton’, ‘Kozerska’, ‘Rainier’ and ‘Vanda’. The cultivars ‘Vasinika’ (1675.7 g), ‘Stella’ (1495.0 g) and ‘Merchant’ (1461.0 g) are characterized by "good" transportability.

Relatively low resistance to pressure and "low" transportability, respectively, were found for fruits of the cultivars ‘Pobeda Krimska’ (977.1 g) and ‘Sunburst’ (1277.7 g).

The strength of attachment of the fruit to the fruit stem has a great practical importance.

The cultivars, which fruits are easily to detach from the fruit stems, without tearing the skin and no leakage of juice, are suitable for mechanized harvesting.

The data showed that during the study period the smallest force of detachment of the fruits from their fruit stem was found in cultivar ‘Pobeda Krimska’ - from 220.5 to 240.7 g, followed by ‘Vasinika’ - from 335.0 g to 459.3 g. With "easy to medium hard" detachment of the fruits were the cultivars ‘Merchant’ (from 409.6 g to 505.3 g), ‘Van’ (from 359.1 g to 578.0 g), ‘Sunburst’ (from 399.0 g to 595.3 g) and ‘Stella’ (from 447.0 g to 571.3 g). For the cultivars ‘Alexton’ (from 379.3 g to 610.0 g) and ‘Rainier’ (from 450.2 g to 590.0 g), detachment of the fruits was "medium hard". An average of 580.9 g to 622.3 g of force was needed for cultivars with "hard" detachment of the fruits – ‘Vanda’, ‘Summit’ and ‘Mizia’. "The most hard" was detachment of the fruits in a cultivar ‘Kozerska’ from 689.5 to 871.7 g (Table. 1).

The lower the value of this indicator, the more suitable the cultivar for mechanized harvesting.

The statistical analysis of the results showed that proven differences were established between the cultivars ‘Mizia’ and ‘Summit’, and the control in regard to resistance of the fruits to mechanical pressure.

For the other cultivars the statistical proof is negative or insignificant.

The force of detachment of the fruits from their stems was less than the control for cultivars ‘Pobeda Krimska’, ‘Vasinika’ and ‘Merchant’.

The difference between ‘Sunburst’ and the control ‘Van’ was insignificant, and for other cultivars - positively proven (Table 1).

Table 1. Mechanical properties of sweet cherry fruits, 2014-2016

Cultivar	Mechanical properties							
	The force of mechanical pressure of the fruits to crack				The force of detachment of the fruits from the fruit stems			
	g				*g*			
	2014	2015	2016	x*	2014	2015	2016	x*
'Merchant'	1520.7 − − −	1427.9 − − −	1421.7 − − −	1461.0 − − −	505.3 −	409.6 −	358.0 n.s.	424.3 −
'Pobeda Krimska'	1020.2 − − −	967.2 − − −	944.0 − − −	977.1 − − −	240.7 − − −	230.9 − − −	220.5 − − −	230.7 − − −
'Summit'	2820.5 + + +	2031.8 − − −	1790.0 − − −	2214.1 +	784.2 + + +	581.1 + + +	396.0 n.s.	586.7 + + +
'Vanda'	1871.9 − − −	1801.9 − − −	1765.0 − − −	1812.9 − − −	753.1 + + +	560.4 + + +	429.2 + +	580.9 + + +
'Stella'	1650.0 − − −	1469.9 − − −	1365.0 − − −	1495.0 − − −	571.3 n.s.	465.0 n.s.	447.0 + + +	494.4 +
'Sunburst'	1168.7 − − −	1249.5 − − −	1415.0 − − −	1277.7 − − −	595.3 n.s.	420.0 n.s.	399.0 n.s.	471.4 ns
'Vasinika'	1680.1 − − −	1640.0 − − −	1707.0 − − −	1675.7	459.3 − − −	351.6 − − −	335.0 n.s.	382.0 − − −
'Alexton'	2148.2 − −	1970.0 − − −	1833.0 n.s.	1983.7 − − −	610.0 n.s.	514.9 + + +	379,3 n.s.	501.4 +
'Mizia'	2700.5 + + +	2249.5 n.s.	1885.0 n.s.	2278.3 + + +	750.2 + + +	569.8 + + +	547.0 + + +	622.3 + + +
'Rainier'	1926.5 − − −	1990.0 − − −	1897.0 n.s.	1937.8 − − −	590.0 n.s.	450.2 n.s.	504.0 + + +	514.7 + +
'Kozerska'	2116.0 − − −	2000.0 − − −	1800.0 − −	1972.0 − − −	871.7 + + +	710.0 + + +	689.5 + + +	757.0
'Bing'	2222.6 −	1999.0 − − −	1887.3 n.s.	2036.3 − − −	610.1 n.s.	541.7 + + +	462.0 + + +	537.9 + + +
'Van' (control)	2372.0	2195.5	1880.0	2149.1	578.0	445.0	359.1	460.7
F	133.6	275.3	222.9	384.1	53.9	106.2	63.4	124.2
SD	65.7	33.1	27.4	28.2	31.0	16.4	20.2	16.0
LSD (0.05)	135.4	68.2	56.4	58.1	63.9	33.9	41.6	32.9

* Average for the period 2014-2016

Figure 1 shows the average data for the presence of skin tearing after detachment of the fruit stem from the fruit, as well as leakage of juice. For the cultivars with "medium hard" and "hard" detachment of the fruits, the value of the indicators was low, and in five of them - 'Summit', 'Misia', 'Kozerska', 'Bing' and 'Van' control - zero.

An exception were 'Sunburst' and 'Rainier', where it was found that about 20% of the fruits had torn skin and leakage of juice. From the cultivars with easily detached fruits, 'Vasinika' stood out with only 5.0% tearing of the skin and without leakage of juice. As a result of the biological cultivar characteristics, the differences between the cultivars included in the experimental work are significant.

The variation of the indicators over the years is in a relatively narrow range. The absence of big variations in the values means that the studied cultivars are stable in terms of these important mechanical parameters.

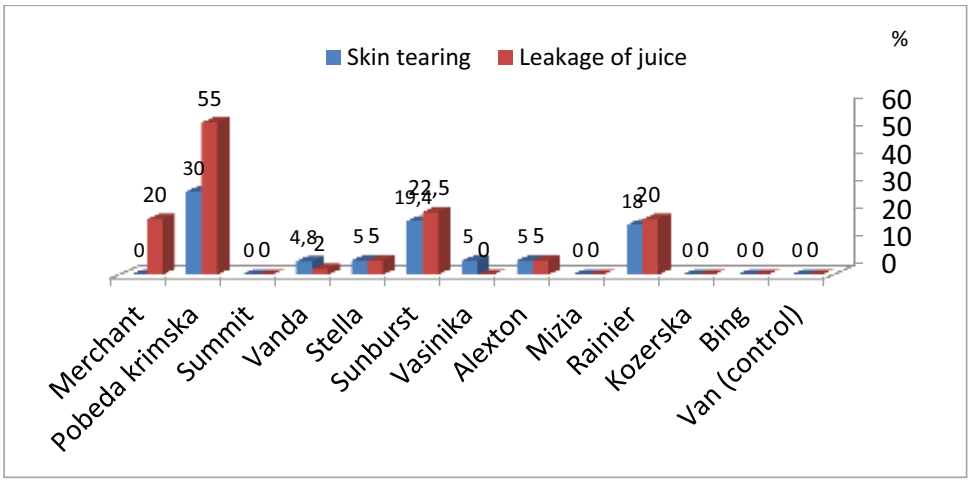

Figure 1. Condition of the fruits after detachment from the fruit stems

CONCLUSIONS

The transportability of sweet cherry fruits is defined to a large extent by the biological characteristics of the cultivar. The fruits of the investigated cultivars 'Mizia', 'Summit', 'Bing', 'Alexton', 'Kozerska', 'Rainier' and 'Vanda' had a "very good" transportability. With "good" transportable qualities were characterized the fruits of 'Vasinika', 'Stella' and 'Merchant', and with "low" - 'Pobeda Krimska' and 'Sunburst'.

A relatively "easy" picking of the fruits from their stems was found for the cultivars 'Pobeda Krimska' and 'Vasinika'. "Easy to medium hard" for 'Merchant', 'Van', 'Sunburst' and 'Stella'. "Medium hard" for 'Alexton' and 'Raineer'. "Hard" detachment was found for the cultivars 'Vanda', 'Summit' and 'Mizia', and "the most hard" - for the 'Kozerska'.

The absence of big variations in the values means that the studied cultivars are stable regarding these important mechanical parameters.

There are statistically proven differences between the cultivars 'Mizia' and 'Summit' and the control in regard to resistance of the fruits to mechanical pressure.

The force of detachment of the fruits from their stems is lower for the cultivars 'Pobeda Krimska', 'Vasinika' and 'Merchant' than in the control 'Van'.

The sweet cherry cultivar 'Vasinika', created at the Institute of Agriculture - Kyustendil, Bulgaria stands out by "easily" detached fruits from stems, without leakage of juice. These qualities define it as the most suitable cultivar for mechanized harvesting.

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