https://doi.org/10.17221/73/2021-HORTSCI

Romanian wild cherry genotypes (*Prunus avium* var. *sylvestris* Ser.) suitable for processing

Margareta Corneanu, Elena Iurea, Sorina Sîrbu*

Department Plant Breeding, Fruit Growing Research Station, Iasi, Romania

**Corresponding author: iurea_elena@yahoo.com*

Citation: Corneanu M., Iurea E., Sîrbu S. (2022): Romanian wild cherry genotypes (*Prunus avium* var. *sylvestris* Ser.) suitable for processing. Hort. Sci. (Prague), 49: 95–101.

Abstract: This paper presents the important features of indigenous wild cherry genotypes suitable for processing. The research took place between 2017–2020, having ten Romanian wild cherry genotypes as study material. The harvesting maturity was recorded in the first decade of June for the early cultivar (G10) and decades two and three of June for the other studied genotypes, all of them with a middle season maturation. The number of days between the end of the flowering and the maturation was between 54 days (G10) and 66 days (G9). The average weight of the fruit and the equatorial diameter varied between 2.1 g and 13.80 mm for G4, respectively, and 5.5 g and 21.35 mm for G10. The proportion (%) between the pulp and waste (stone and peduncle) was measured as 81.95% pulp (G4) and 93.64% pulp (G10). The values of the soluble dry substance content were between 13.1–24.0 °Brix, the titratable acidity was between 0.48–1.16 mg malic acid/100 mL juice and the total content of the polyphenols was between 229.00–720.00 mg GAE/100 mL fresh juice. In terms of the bitter taste intensity, G10 has a weak intensity, G3, G7, G8 and G9 have an average intensity and G1, G3, G4, G5 and G6 have a high intensity.

Keywords: fruit; jam; liquors; polyphenols; taste

Amongst all the fruit trees that grow across Romania, the cherry tree is exposed to the optimal agro-biological conditions, making it one of the most valuable species (Budan, Grădinariu 2000). In comparison with other fruits, cherries are highly valuable due to their early display in the markets and due to their high nutritive values (Quero-García et al. 2017). The cherry processing industry is particularly important due to the seasonal nature of the fruits, the imbalance between the production and consumption during certain time periods and due to the fruit intake needed throughout the year (Jensen 2017). The products resulting from the cherry processing are increasingly diversified: concentrated natural juices, nectars, syrups, refreshments, compote, jellies, jams, marmalade, sweets, ice cream, dry fruits, frozen fruits, etc (Hui 2006). Bitter cherries (*Prunus avium* var. *sylvestris* Ser.) represent a valuable raw material in obtaining traditional Romanian products, such as jams, liquors or concentrated juice used for colouring bitters (Beceanu 2009; Budan 2014). Internationally, bitter cherry syrups and liquors represent research topics, as these products are specific to the southern and south-eastern Europe (Nikolić et. al 1998), while jams are less looked into (Jamba, Carabulea 2002).

Alongside many cultivars and other indigenous genotypes, breeders in Romania have selected, multiplied and planted the most valuable bitter cherry biotypes with fruits of different colours (yel-

Supported by the Romanian Academy of Agricultural and Forestry Sciences, Grant No. ASAS 1-1.4. with title 'Zonation and microzonation of varieties and rootstocks of fruit tree species'.

https://doi.org/10.17221/73/2021-HORTSCI

low, bicoloured, red or black), found both in the grown and spontaneous flora (Petre et al. 1997).

This paper presents the important features of the fruits in the indigenous Romanian bitter cherry genotypes suitable for processing.

MATERIAL AND METHODS

The research was performed between 2017–2020, using the following ten Romanian bitter cherry genotypes (G) as the study material: G1 – 'Silva', G2 – 'Amar 153', G3 – 'Roz amar de Mărculeşti', G4 - 'Amar negru 15 Iaşi', G5 – 'Amara', G6 – 'Amar Maxut', G7 – 'Amar negru Adamache', G8 – 'Amar 166 Geoagiu', G9 – 'Amar Galata' and G10 – 'Amaris'. Five out of the ten genotypes were approved as new cultivars from 1983 to 2016 (G1, G5, G6, G9 and G10). The study was performed in the experimental field at the Fruit Growing Research Station (FGRS) Iaşi – Romania, on trees grafted on seedlings *Prunus mahaleb* L. as the rootstock and planted at a 5 × 4 m distance. Each genotype has nine trees *ex situ* collected, structured in three repetitions with three trees per repetition. The phenophases of the bloom and fructification were determined using the BBCH monograph (Julius Kühn-Institut (JKI), Quedlinburg, Germany) (Meier 2001).

In order to determine the degree of damage of the generative organs, the flowers were sectioned (100 flowers from the inferior, average and superior third of the tree's crown, for each genotype). The average percentage of damaged flowers in the studied genotypes was determined by calculating the average of the affected samples for all three levels of height.

The cultivars with a fertility index (percent of fruits obtained at 25–30 days after the petals fall) having values above 30–35% are considered productive cultivars (Cociu, Oprea 1989).

The description of the fruits and tree's vigour was undertaken using the descriptors for *Prunus avium* L. according to the UPOV TG/35/7 questionnaire (UPOV 2006).

To determine the average weight of the fruit, stone and peduncle (g), 25 fruits, 25 stones and 25 peduncles were weighed three times in a row using an electronic Radwag scale with 0.01 g precision. The equatorial diameter of the fruit (D) and the peduncle thickness (mm) were determined with Luumytools digital callipers for 25 items in three repetitions. The fruits were tasted and marked as follows: pulp firmness from 1 – very soft to 9 – very firm, fruit juiciness from 3 – weak to 7 – strong (Delmas et al. 2013 adapted) and bitter taste from 1 – extremely poor to 9 – extremely strong (Delmas et al. 2018, adapted). The peduncle detachment force from the fruit and the detachment of the pulp from the stone were estimated through a sensory assessment of the quantitative trait recorded on a 1–9 and a 1–3 scale, respectively (Delmas et al. 2018).

The resistance of the fruits to cracking was measured using the Christensen method, counting the cracked fruits after immersing them into distilled water for six hours at 20 °C (Webster, Looney 1996).

Fresh juice was obtained from the selected fresh fruits in order to have sample uniformity, then pitted and smashed by pressing and then filtered. The soluble dry substance (SDS) in the fresh juice was measured with a Zeiss portable digital refractometer (portable digital refractometer Zeiss, Jena , Germany) (%) and the titratable acidity (TA) was measured using the potentiometric method. The results were used to calculate the SDS/TA ratio. The total content of the polyphenols was measured using the Folin-Ciocalteu method (Jayaprakasha et al. 2001). The fruit dry matter content was determined gravimetrically by drying the cherry samples to a constant weight at a temperature of 105 °C (using oven CL 53, POL-EKO-Aparatura, Poland). The moisture percentage was calculated by subtracting the dry matter content value from 100.

The experimental data from all four years taken as the repetition were statistically interpreted using a multiple comparisons method (Duncan test, $P = 0.05$).

RESULTS AND DISCUSSION

Tree vigour and resistance to frost. Out of the ten studied genotypes, a low tree vigour was recorded only for genotype G10, while all the other ones were determined to have a medium vigour (Table 1). Besides the hereditary traits of the cherry species, the climate and various technological elements (as tree training system or rootstock used) act simultaneously on the biological processes. Hence, in 2017 and 2020, during April, when the cherry tree was in bloom, the minimum temperatures recorded were between –2.5 °C and –5.9 °C. Under these conditions, the recently fertilised ovary is affected and the fruits production risks to be compromised in large numbers (Prskavec, Kloutvor 1986). Analysing the data regard-

https://doi.org/10.17221/73/2021-HORTSCI

Table 1. The tree's vigour, resistance to frost, phenological phases and natural fertility in the bitter cherry genotypes (FGRS Iasi; 2017–2020; n = 4)

Genotype	Tree's vigour[1]	Resistance to frost in the complete flowering phenophase (% affected ovaries)[2]	Beginning of bloom (61[3])	End of bloom (69[4])	Bloom duration (days)[2]	Natural fertility (%)	Harvesting maturity (87[5])	Duration between 61 and 87 stages (days)
			limit data (the earliest to the latest)					
G1	5	27.2^{a}	05–09 IV	11–19 IV	11^{b}	30.2	11–17 VI	61^{cd}
G2	5	20.0^{ab}	02–12 IV	12–21 IV	12^{ab}	34.8	15–19 VI	63^{b}
G3	5	19.3^{bc}	01–10 IV	14–19 IV	12^{a}	31.1	11– 21 VI	62^{bc}
G4	5	17.4^{cd}	03– 10 IV	11–20 IV	11^{b}	30.3	04–16 VI	57^{e}
G5	5	16.5^{d}	03– 11 IV	14–21 IV	11^{b}	36.2	07–16 VI	56^{e}
G6	5	14.0^{de}	05–11 IV	12–19 IV	10^{b}	35.0	05–18 VI	58de
G7	5	13.8^{e}	06–12 IV	12–19 IV	8^{b}	36.6	05–18 VI	58^{e}
G8	5	11.9^{e}	04–10 IV	13–19 IV	11^{b}	41.0	13–20 VI	63^{ab}
G9	5	10.4^{e}	08–11 IV	11–19 IV	8^{b}	37.3	17–21 VI	66^{a}
G10	3	9.0^{e}	02–15 IV	12–21 IV	9^{b}	30.0	01–07 VI	54^{e}

[1]UPOV test: the tree's vigour mark on a scale of 1–5: 3 – low; 5 – medium (UPOV 2006); [2]different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test; [3]61– beginning of flowering (about 10% of flowers open); [4]69 – end of flowering (all petals fallen);[5]87 – fruit ripe for picking (Meier 2001); FGRS Iasi – Fruit Growing Research Station IASI

ing the degree of damage to the generative organs in the studied cultivars, they oscillated within tight limits (9.0%– 27.2%), the average for the ten genotypes showed 15.9% damage to the flowers. Statistically, the most affected were G1 (27.2%) and G2 (20.0%) (Table 1).

Phenological phases and natural fertility. The blooming, as the main fructification phenophase, that takes place is closely related to the evolution of the climatic factors (Stepulaitienė et al. 2013) and especially to the succession of active temperatures (temperatures over +5 °C) (Budan et al. 2000). The phenophase (blooming) for the studied cultivars took place between the 2nd and the 21st of April 2018, respectively 2019, for 8–12 days, a time period that overlaps with the blooming of the other cultivars, making interpollination possible. All the studied cultivars are highly productive because the values of this indicator are above 30%.

Physical and quality features of the fruits. Simard (1998) and Usenik et al. (2005) claim that the colour, firmness, sugar content and fruit's acidity parameters reflect the degree of maturity in cherries and help decide when the optimal moment for harvesting is. The harvesting maturity was recorded in the first decade of June for the early cultivars (G10) and the second and third decades of June for the cultivars with a maturation during the middle season (G1, G2, G4, G5, G6, G7, G8, G3 and G9). The number of days between the end of bloom and the maturation was between 54 days (G10) and 66 days (G9) and the time interval for the fruits' maturation was between 6–14 days (Table 1).

The weight and the equatorial diameter of the fruits are parameters not only influenced by the climatic conditions and the biological traits of each cultivar (Ruisa 2008; Kaldmäe et al. 2013), but also by the pruning regimes applied (Rutkowski et al. 2015). Branişte et al. (2007) asserts the fact that bitter cherries are smaller in size (weight and equatorial diameter) than sweet cherries which are used for fresh consumption. The analysis of the data highlights the genotypes with a weight over 3.0 g and an equatorial diameter over 16.0 mm (G10, G9, G2, G8, G1, G5, G6 and G7), classifying them as big fruits (3.0–5.5 g) for the bitter cherry genotypes. Except the G2, G8 and G1 genotypes that have a big stone, the other genotypes have a stone of average size (0.25–0.40 g) and, thus, a high percentage of pulp (over 88%). Analysing the proportion between the pulp and the waste (stone and peduncle), it was noticed that the pulp recorded values between 81.953% (G4) and 93.637% (G10). Prvulović et al. (2012) asserts that cherry peduncles have a detoxifying and diuretic role, representing a good source of natural antioxidants.

The cracking of the fruit is a characteristic of the cherry species that can lead to a loss of 90% of the

https://doi.org/10.17221/73/2021-HORTSCI

Table 2. The physical and quality features of the fruits in the bitter cherry genotypes (2017–2020 average; n = 4)

Genotype	Average weight of the fruit (g)	Equatorial diameter of fruit (mm)	Average weight of stone (g)	Fruit/stone ratio	Stone in fruit's weight (%)	Peduncle average weight (g)	Waste total weight (g)	Pulp/waste proportion (%)		Fruit's resistance to cracking (%)
								pulp	waste	
G1	3.8^{b}	16.4^{c}	0.4^{ab}	9.0^{b}	10.9^{c}	0.08^{bc}	0.49	87.05	12.95	4.1^{d}
G2	4.0^{b}	17.0^{c}	0.5^{a}	8.0^{b}	12.5^{bc}	0.09^{a}	0.59	85.20	14.80	10.4^{bc}
G3	2.5^{bc}	14.0^{cd}	0.4^{bc}	7.3^{b}	14.8^{a}	0.07^{d}	0.44	82.32	17.68	15.0^{ab}
G4	2.1^{c}	13.8^{d}	0.3^{cd}	6.9^{b}	14.8^{ab}	0.07^{d}	0.38	81.95	18.05	6.9^{c}
G5	3.5^{b}	16.4^{c}	0.4^{b}	8.8^{b}	11.4^{c}	0.07^{d}	0.47	86.63	13.37	5.0^{cd}
G6	3.4^{b}	16.9^{c}	0.3^{d}	13.5^{ab}	7.4^{d}	0.07^{d}	0.32	90.74	9.26	2.7^{d}
G7	3.4^{b}	17.5^{bc}	0.4^{b}	8.8^{b}	11.5^{c}	0.07^{cd}	0.46	86.38	13.62	20.0^{a}
G8	3.9^{b}	16.8^{c}	0.5^{a}	8.3^{b}	12.1^{c}	0.09^{ab}	0.56	85.64	14.36	13.0^{b}
G9	4.1^{ab}	18.1^{ab}	0.3^{c}	12.8^{b}	8.1^{cd}	0.07^{d}	0.39	90.27	9.73	3.3^{d}
G10	5.5^{a}	21.4^{a}	0.3^{d}	18.7^{a}	5.5^{de}	0.05^{de}	0.35	93.64	6.36	0.3^{d}

Different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test

production (Milatović 2011) and depends on various factors: genetic, physiological, climatic and technical (Iezzoni et al. 1991). All the genotypes in our study are in the group of genotypes with good resistance to fruit cracking (Table 2).

Each cultivar is characterised by a particular taste and flavour; hence the fruits of a cultivar are unmistakable (Botu 2008).

Chemical composition of the fruits. The ten studied genotypes were observed to differ in terms of the fruit's chemical composition, making it a characteristic of the cultivar. The content of the soluble dry substance was over 13% (Table 3). Dolenc and Štampar (1998) claim that, due to the climatic conditions of central Europe, a soluble dry substance content of over 15% in cherry cultivars can be considered satisfactory. Six genotypes in the current study recorded values between 18–24% soluble dry solids. Sestraş (2004) asserts that a high content of soluble substances in a fruit is advantageous for industrial processing, sometimes excluding the necessity of adding sugar.

The titratable acidity varied within very large limits amongst the cultivars, 0.48–1.21 mg malic acid/100 mL juice. These values fit within the limits reported by other authors: 0.353–0.812 mg malic

Table 3. The chemical composition of the fruits in the bitter cherry genotypes (FGRS Iasi, 2017–2020; n = 4)

Genotypes	SDS (%Brix)	TA (mg malic acid/100 mL)[3]	SDS/TA[4]	TDS (%)[5]	Moisture (%)	TCP (mg GAE/ 100 mL)[6]
G1	15.40^{e}	0.82^{bc}	18.78^{c}	16.28^{e}	83.72^{a}	532.40^{cd}
G2	20.00^{b}	0.72^{c}	27.78^{ab}	25.68^{a}	74.32^{cd}	590.40^{c}
G3	13.10^{ef}	0.80^{c}	16.25^{c}	18.29^{d}	81.71^{b}	254.00^{g}
G4	20.00^{b}	1.21^{a}	16.53^{c}	21.71^{ab}	78.29^{c}	499.30^{de}
G5	18.00^{cd}	0.76^{c}	23.68^{bc}	20.36^{c}	79.64^{c}	615.90^{bc}
G6	20.13^{ab}	0.73^{c}	27.35^{b}	20.61^{bc}	79.39^{c}	720.00^{a}
G7	16.00^{e}	0.73^{c}	21.92^{c}	17.80^{de}	82.20^{ab}	654.60^{ab}
G8	24.00^{a}	1.12^{b}	21.43^{c}	25.76^{a}	74.24^{d}	354.60^{ef}
G9	16.65^{de}	1.16^{ab}	14.26^{c}	18.38^{d}	81.62^{b}	229.00^{g}
G10	18.28^{bc}	0.48^{c}	38.79^{a}	19.16^{cd}	80.84^{bc}	326.20^{fg}

Different letters correspond with the significant statistical difference for P ≤ 5 %, Duncan test; SDS – the soluble dry solids; TA – titratable acidity; SDS/TA – soluble dry solids and titratable acidity ratio; TDS – total dry solids; TCP – total content of polyphenols

https://doi.org/10.17221/73/2021-HORTSCI

acid/100 mL juice (Usenik et al. 2008). A high titratable acidity lowers the degree of appreciation only when the soluble dry substance is lower than 13% (Diaz-Mula et al. 2009).

The SDS/TA ratio has an important role in setting the values for capitalisation, especially for the juice and fresh consumption. Crisosto et al. (2002) claims that the SDS/TA ratio determines the fruits' taste, offering a balance between sweet and sour. From this point of view, the studied cultivars had a relatively high SDS/TA ratio, but the taste was bitter. In Table 3, it can be noticed that four genotypes recorded a value lower than 20 for this parameter (G9, G3, G4 and G1) and six of them were between 21.43-38.79 (G8, G7, G5, G6, G2 and G10).

Values between 16.28% (G1) and 25.76% (G8) were recorded for the total dry substance. Reduced humidity percentage values were recorded for G8 with 74.24% and G2 with 74.32%. Alén-Ruiz et al. (2008) claim that a high polyphenol content is associated with the intense colour of the fruit, the high dry substance content, the more intense flavour and bitter and astringent taste.

These genotypes are of high interest because a high content of phenolic compounds is associated with a very high antioxidant activity, being extremely beneficial for a healthy organism (Prvulović et al. 2011; Rodrigues et al. 2011). Analysing the results presented in Table 3, it can be noticed that the values of the total polyphenols fit between 229.00–720.00 mg malic acid GAE/100 mL of fresh juice, hence two categories of genotypes: the first category with a high polyphenol content with values between 200–400 mg/100 mL of fresh juice and the second category with a very high polyphenol content of over 400 mg/100 mL of fresh juice.

Morpho-physiologic, organoleptic and quality traits of the fruits. The colour of the fruit, pulp and juice is a limiting factor for particular processing modes. The fruits' colour is important not only for the quality of the obtained products, but also for their stability during storage till the moment of processing. The more intense the colour of the raw material, the longer the duration of keeping this feature is (Chiriac et al. 1988).

In terms of the fruit's shape, five genotypes have a heart shape (G3, G5, G6, G9 and G10), two of them have a kidney shape (G7 and G8) and three genotypes have a circular shape (G1, G2 and G4). The colour of the fruit varied from reddish yellow to pink, dark red and black. The colour of the pulp and juice was yellow pulp with colourless juice (G3 and G9), red pulp with red juice (G10) and red pulp with purple juice for all the other genotypes. The G1 and G5 genotypes were noticed to have high succulence and the pulp easily detached from

Table 4. Morpho-physiological, organoleptic and quality traits of the fruits in the bitter cherry genotypes (FGRS Iasi, 2017–2020)

Genotype	FS	EC	PC	JC	PF	PJ	BTI	PL (mm)	PT (mm)	S	SR	DPS
G1	4	8	5	5	5	7	7	7	5	1	5	2
G2	4	8	5	5	5	5	7	9	5	9	5	2
G3	1	3	2	1	5	5	5	5	5	9	5	1
G4	4	8	5	5	5	5	7	7	5	9	5	2
G5	1	8	5	5	5	7	7	7	5	1	5	2
G6	1	8	5	5	5	5	7	7	5	1	5	2
G7	2	8	5	5	5	5	5	5	5	1	5	2
G8	2	8	5	5	5	5	5	9	5	9	5	2
G9	1	2	2	1	5	5	5	7	5	9	5	2
G10	1	7	5	4	5	5	3	5	5	9	5	1

FS – fruit's shape: 1 – heart-shaped; 2 – kidney-shaped; 4 – circular; EC – epidermis colour: 2 – reddish yellow; 3 – pink; 7 – dark red; 8 – black; PC – pulp colour: 2 – yellow; 5 – dark red; JC – juice colour: 1 – colourless; 4 – red; 5 – purple; PF – pulp firmness: 3 – soft; 5 – medium; 7 – firm; PJ – pulp juiceness: 5 – medium; 7 – high; BTI – bitter taste: 3 – weak; 5 – medium; 7 – strong; PL – peduncle length: 5 – medium (40.1–50.0 mm); 7 – long (50.1–60.0 mm); 9 – very long (over 60.1 mm);[9]PT – peduncle thickness: 3 – thin; 5 – medium; S – suber between peduncle and fruit: 1 – absent; 9 – present; SR – stalk removal force from the fruit by sensorial assessment: 3 – weak; 5 – medium; 7 – wide; DPS – detachment of the flesh from the stone by sensorial assessment: 1 – easy; 2 – medium; 3 – difficult (Delmas et al. 2018)

https://doi.org/10.17221/73/2021-HORTSCI

the stone, valuable processing characteristics for liqueur (Table 4).

Five genotypes presented a strong bitter taste (G1, G2, G4, G5 and G6). In terms of the peduncle thickness and its detachment from the fruit, the genotypes presented average values, while in terms of the peduncle length, two genotypes had very long peduncle, five of them had a long peduncle and three genotypes had a medium peduncle. In terms of the existence of a suber between the peduncle and fruit, it was absent in four genotypes and present in the other six genotypes (Table 4). The presence of the corck is a positive characteristic because suberin is part of the suber's content and it scars the peduncular cavity when the peduncle gets detached, avoiding the loss of the juice and its oxidation (Lugli 2003).

CONCLUSION

The genetic variability of the cherry species and particularly of the genotypes selected from the spontaneous and grown flora that have superior resistance to biotic and abiotic factors in their genes is reflected in all the measured and analysed parameters.

The genotypes were highlighted by the tree's low vigour, good resistance to frost, quality of the fruits targeted for processing and resistance to cracking.

All the studied bitter cherry genotypes match the main quality indices of the fruits targeted for processing: the physical indices (colour, weight, density and firmness), chemical indices (high soluble dry substance content, average acidity, high polyphenol content), organoleptic indices (taste, flavour, texture) and technological indices (high pulp percentage, small stone easily detachable from the pulp, intensely coloured juice and resistance to oxidation).

REFERENCES

Alén-Ruiz F., Pérez-Gregorio M.R., Martinez-Carballo E., Garcia-Falcón M.S., Simal-Gándara J. (2008): Influence of polyphenols on color and antioxidant value in plant foods. Electronic Journal of Environmental, Agricultural and Food Chemistry, 7: 3171–3176.

Beceanu D. (2009): Raw horticultural materials for the food industry: grapes, fruits and vegetables. Iaşi, Edititura Pim. (in Romanian)

Botu M. (2008): Modern and conventional methods in horticultural plant breeding. Editura Conphys, Râmnicu Vâlcea. (in Romanian)

Budan S. (2014): Romanian cherry varieties with bitter fruit - tradition and present. Acta Horticulturae (ISHS), 1032: 25–28.

Budan S., Grădinariu G. (2000): The cherry tree. Iaşi, Editura Ion Ionescu de la Brad. (in Romanian)

Braniște N., Budan S., Butac M., Militaru M. (2007): Fruit tree, small fruits and strawberry cultivars released in Romania. Pitești, Edititura Paralela 45. (in Romanian)

Chiriac S., Rudi E., Micu C. (1988): Evaluation of the technological properties of fruits in cherry varieties from the current assortment: In: Technological contributions to the modernization of sweet and sour cherry growing. Iași, Întreprinderea Poligrafică Iași. (in Romanian)

Cociu V., Oprea Ş. (1989): Research methods of breeding of the fruit tree species. Cluj-Napoca, Edititura Dacia. (in Romanian).

Crisosto C.H., Crisosto G.M., Ritenour M.A. (2002): Testing the reliability of skin color as an indicator of quality forearly season 'Brooks' (*Prunus avium* L.) cherry. Postharvest Biology and Technology, 24: 147–154.

Delmas M., Hofer M., Giovanini D. (2018): Passport and Priority Descriptors for Cherry – version 1 (EU.CHERRY version).

Diaz-Mula H.M., Castillo S., Martinez-Romero D., Valero D., Zapata P.J., Guillen F., Serrano M. (2009): Sensory, nutritive and funcțional properties of sweet cherryas affected by cultivar and ripening stage. Food Science and Technology International, 15: 535–544.

Dolenc K., Štampar F. (1998): Determining the quality of different cherry cultivars using the HPLC method. Acta Horticulturae (ISHS), 468: 705–712.

Ghimicescu G. (1977): Chemistry and analysis of food, beverages and spices. Iaşi, Editura Junimea. (in Romanian)

Hui Y. H. (2006): Handbook of Fruits and Fruit Processing. New Jersey, Blackwell Publishing .

Iezzoni A., Schmidt H., Albertini A. (1991): Cherries (*Prunus*). Acta Horticulturae (ISHS), 290: 111–176.

Jamba A., Carabulea B. (2002): Technology for storage and processing of horticultural products. Chişinău, Edititura Cartea Moldovei. (in Romanian)

Jayaprakasha G.K., Singh R.P., Sakariah K.K. (2001): Antioxidant activity of grape seed (*Vitis vinifera*) extracted on peroxidation models *in vitro*. Food Chemistry, 73: 285–290.

Jensen M. (2017): Processing for industrial use. In: Quero-García J. et al. (eds): Cherries: Botany, Production and Uses. Boston, CABI: 485–506.

Kaldmäe H., Kikas A., Arus L., Libek A.-V. (2013): Genotype and microclimate conditions influence ripening pattern and quality of blackcurrant (*Ribes nigrum* L.) fruit. Zemdirbyste-Agriculture, 100: 167–174.

https://doi.org/10.17221/73/2021-HORTSCI

Lugli S. (2003): The genetic improvement of sweet cherry in Italy and in the world. Rome, Bologna, Frutticoltura, 6. (in Italian)

Meier U. (2001): Growth stages of mono- and dicotyledonous plants – BBCH Monograph. Julius Kühn-Institute (JKI). Available at http://www.jki.bund.de

Milatović D. (2011): Breeding and cultivars in cherry. In: Sweet and sour cherry. Naučno voćarsko društvo Srbije: 119–213. (in Serbian)

Nikolic M., Duric G., Cerovic R. (1998): Sweet cherry research and production in Yugoslavia. Acta Horticulturae (ISHS), 468: 757–762.

Petre L., Roşca C., Rominger E. (1997): The behaviour of some bitter cherry genotypes in the Iaşi area conditions. Buletin ştiinţific ICPP Piteşti-Mărăcineni, 55: 1–8. (in Romanian)

Prvulović D., Malenčić Đ., Popović M., Ljubojević M., Ognjanov V. (2011): Antioxidant properties of sweet cherries (*Prunus avium* L.) – Role of phenolic compounds. World Academy of Science, Engineering and Technology, 59: 1149–1152.

Prvulović D., Popović M., Malenčić D., Ljubojević M., Ognjanov V. (2012): Phenolic compounds in sweet cherry (*Prunus avium* L.) petioles and their antioxidant properties. Research Journal of Agricultural Science, 44 :198–202.

Prskavec K., Kloutvor J. (1986): 30 years survey of spring frost occurrence during cherry blossom period. In: New Trends in Cherry Growing. Prague, Sempra.

Rodrigues A.S., Pérez-Gregorio, Garcia-Falcón M.S., Simal-Gándara J., Almeida D.P.F. (2011): Effect of meteorological conditions on antioxidant flavonoids in Portuguese cultivars of white and red onions. Food Chemistry, 124: 303–308.

Ruisa S. (2008): Fruit quality of sweet cherries grown in Latvia. Acta Horticulturae (ISHS), 795: 883–888.

Rutkowski K., Zydlik Z., Pacholak E. (2015): Effect of tree pruning intensity on the yield and fruit quality of the sour cherry. Zemdirbyste-Agriculture, 102: 417–422. Quero-García J., Iezzoni A., Pulawska J., Lang G. (2017): Cherries: Botany, Production and Uses. Boston, CABI.

Sestraş R. (2004): Improvement of horticultural species. Cluj-Napoca, Editura Academicpres. (in Romanian)

Simard V. (1998): Knowing how to harvest at the right time. Réussir Fruits et Légumes, 5: 12–13. (in French)

Stepulaitienė I., Žebrauskienė A., Stanys V. (2013): Frost resistance is associated with development of sour cherry (*Prunus cerasus* L.) generative buds. Zemdirbyste-Agriculture, 100: 175–178.

UPOV (2006): Protocol for distinctness, uniformity and stability tests of sweet cherry (*Prunus avium* L.) http://www.cpvo.europa.eu.

Usenik V., Štampar F., Šturm K., Fajt N. (2005): Rootstocks affect leaf mineral composition and fruit quality of 'Lapins' sweet cherry. Acta Horticulturae (ISHS), 667: 247–252.

Usenik V., Fabčič J., Štampar F. (2008): Sugars, organics acids, phenolic composition and antioxidant activity of sweet cherry (*Prunus avium* L.). Food Chemistry, 107: 185–192.

Webster A.D., Looney N.E. (1996): Cherries: Crop Physiology. Production and Uses. Wallingford, UK: KAB International.

Received: July 28, 2021
Accepted: January 21, 2022
Published online: May 13, 2022