Available online: www.notulaebiologicae.ro
Print ISSN 2067-3205; Electronic 2067-3264
Not Sci Biol, 2017, 9(4):577-581. DOI: 10.15835/nsb9410161
Original Article

Morphological and Biochemical Characteristics of Fruits of Different Cornelian Cherry (*Cornus mas* L.) Genotypes from Spontaneous Flora

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Abstract

The current study was carried out on six local cornelian cherry (*Cornus mas* L.) genotypes, grown in Turceni town (Gorj county) and Baita village (Hunedoara county), in Romania. Several morphological and biochemical characteristics of cultivars were determined. Fruit weight and fruit flesh ratio of the analyzed genotypes ranged from 1.33 to 2.31 g and 61.53 to 78.58% respectively. Soluble solid contents were determined, the lowest noted as 10% and the highest as 25.5%. Results have shown that there was a high diversity in cornelian cherry populations within different ecological areas. Differences were exhibited in terms of fruit size and biochemical characteristics. The results of the study are useful for attempting to select superior genotypes of cornelian cherry for culture.

Keywords: cornelian cherry, *Cornus mas L.*, traits variability, wild-growing population

Introduction

Cornelian cherry (*Cornus mas* L.) belongs to the family Cornaceae, is a tall deciduous shrub or small tree from five to eight m high. This plant is popular in southern Europe with the northern limit being southern Belgium and central Germany (Mamedov and Craker, 2004). At present, this species is less known and is an important source for the food and medicine industry. Consumers around the world have shown a high interest in cornelian cherry fruits. Up to now cornelian cherry has been considered, in most cases, as an ornamental and medicinal plant. Over the last decades, breeding and selection programs have been initiated in several countries, aimed at obtaining high yield genotypes with large fruits and high yields (Bijelic *et al*., 2012). In Turkey, cornelian cherry fruits are consumed fresh or processed in various products such as syrup/fruit juice, jam, marmalade, pestil (cornelian cherry fruit paste), sherbet or in dry form (Celik *et al*., 2006). In Serbia, cornelian cherry jam is of high interest for diabetes patients (Bijelic *et al*., 2011a). Cornelian cherry is also indicated in the formation of hedges, for protection against soil erosion, but also in urban areas because they tolerate high levels of air pollution (Bijelic *et al*., 2012). In Central Europe, the use of cornelian cherry fruit has taken place for a long time. Due to the increased antioxidant capacity, the interest in these fruits is raising. Their technological parameters are important in the processing of food products (Sochor *et al*., 2014). Human health and nutrition are still one of the most studied and also interesting topics. One of the current trends of food processing is searching and enriching the raw plant material. One of the possibilities is cornelian cherry (*Cornus mas* L.), woody plant, originated in Central Europe (Sochor *et al*., 2014). Cornelian cherry fruits are used in the preparation of beverages in Europe and also in treatment of diabetes-related disorders in Asia (Jayaprakasam *et al*., 2006). Fruits and vegetables are a good source of natural antioxidants, which provide protection against harmful-free radicals and are therefore associated with lower incidence and mortality rates of cancer and heart diseases, in addition to a number of other health benefits (Shui and Leong, 2006). In recent years, an increasing attention has been paid by consumers to lesser known fruits, such as cornelian cherry, which possess unusual flavour, and which are rich in antioxidants and anthocyanins. *C. mas* fruits have been used for the treatment of gastrointestinal disorder and diarrhoea (Celik and Bakirci, 2006). Collection and study of cornelian cherry genotypes, introduction of best selections in commercial production, and preservation of genetic variability are activities that could improve the existing fruit gene pool (Demir *et al*., 2003; Ercisli *et al*., 2006; Brindza *et al*., 2009; Bijelic *et al*., 2011, 2016). The aim of the hereby paper was to provide information on diversity of genetic resources of *Cornus mas* species in different ecological areas in Romania, in terms of fruit characteristics.

Received: 29 Sep 2017. Received in revised form: May 2016. Accepted: 16 Nov 2017. Published online: 20 Dec 2017.

Materials and Methods

Materials

The study was conducted on six genotypes of cornelian cherry (*Cornus mas* L.) selected from spontaneous flora in the following areas: Strimba-Jiu (S1) and Calaparu (C1 and C2) in the town of Turceni, Gorj county (44°40'0"N 23°23'0"E) and from the village Hartagani (H1, H2 and H3), Baita village from Hunedoara county (46°01'52"N 22°53'34"E). The fruits were harvested at full maturity and transported to the laboratory for morphological and biochemical analysis. Cornelian cherry fruits from these six genotypes were harvested and analyzed during the ripening period in 2016.

Methods

The study was carried out on 50 fruits of each selected genotype. Biometrical measurements were carried out on fruits, such as fruit weight, fruit length, large diameter and small diameter of fruit, based on which the pulp-kernel ratio, the fruit size index and shape index, as well as pulp percentage were calculated. Average fruit weight and fruit size were determined on randomly chosen 50 fruit/ genotype samples, and percentage of pulp was calculated using (stone weight/fruit weight × 100) formula. The size index was calculated by adding to the large diameter, small diameter and height of the fruit, and then all divided to three. The shape index calculation was made by making the ratio of the fruit height to its large diameter (Ionica, 2014).

Biochemical characteristics of fruits were also assessed: total acidity (TA), total dry substance (TDS) and soluble dry substance (SDS). Determination of total acidity was carried out using the method described by Ionica (2014). Expression of results was conventionally done in ml of NaOH n/10 100^{-1} grams of material. For determination of total dry substance (TDS) and soluble dry substance (SDS), a method based on water elimination by evaporation from the analytical mean sample was used, by keeping it in an oven at temperatures of 85-105 °C. Expression of results is made in percentages. The soluble dry substance is represented by a series of organic substances dissolved in the water in vacuoles. Determination of this type of substance can be achieved by refractometric method based on the measurement of light refraction index by dissolved substances in the analyzed products by means of digital or handheld refractometers (Ionica, 2014). Expression of the results is made in ml of NaOH n/10 $100g^{-1}$ of material.

Statistical analysis

The data obtained from the measurements were statistically processed using the descriptive statistical program (StatPoint Technologies, Warrenton, VA, USA).

Results and Discussion

The biometric values for the length, diameter, size index and shape index of fruit in the six cornelian cherry genotypes are shown in Table 1. Variation limits for fruit height (H) varied between 10.7 mm for genotype C2 and 31.8 mm for genotype H3. The value of large diameter (D) varied between 7.2 mm (H2) and 25.9 mm (H3), while the small diameter (d) varied between 6.1 mm (C2) and 25.8 mm (H3). The variation coefficient ranged between 6.71 mm (H1) and 15.89 mm (H3) for fruit height, between 7.02 mm (S1) and 26.15 mm ($H3_3$) for large diameters, between 7.07 mm (S1) and 26.57 mm (H3) for small diameter, between 6.43 mm (C2) and 21.28 mm (H3) for the size index, and between 6.62 mm (H1) and 14.05 mm (H3) for the shape index. The average fruit height was between 13.74 mm (C2) and 21.48 mm (H3). The large diameter had an average value of 8.85 mm (C2) and 14.66 mm (H3), while and the small diameter varied between 8.36 mm (C2) and 14.33 mm (H3).

To some selected cornelian cherry fruits (*Cornus mas L.*) from Konya (Kurucuova) the average length, width and geometric diameter ranged from 15.95 to 20.77 mm, 10.91 to 16.40 mm and 12.57 to 17.69 mm, respectively (Demir and Kalyoncu, 2003). Similar studies on cornelian cherry genotypes in Golbasi (Erzurum, Turcia) have shown that fruit length and width varied between 17.53-22.96 mm and 10.80 - 16.83 mm, respectively (Ercisli, 2006). Mean value of the size index, for the six selected genotypes, varied between 10.31 mm (C2) and 16.81 mm (H3), while the value of the shape index varied between 1.37 mm (H1) and 1.55 mm (C2).

In order to determine the commercial value of the cornelian cherry populations in Gemer (Slovakia), 260 selected genotypes were evaluated for fruit characteristics, recording significant differences: for fruit weight in the range 0.5-3.4 g, fruit length 12.0-19.5 mm, fruit width 7.4-15.2 mm, kernel length 9.5-15.9 mm and kernel width 4.5-8.9 mm (Brindza *et al*., 2009).

With regard to quantitative characteristics related to fruit weight, and to pulp percentage and pulp/kernel ratio, the results are shown in Table 2. It can be noticed that the average fruit weight varied between 1.31 g (C2) and 2.31 g (H3), the minimum limit of this parameter being 0.8 g (H2) and the maximum value is 3.5 g (H3). The pulp weight varied between 0.6 g (H2) and 2.8 g (H3). The kernel weighed between 0.34 g (C2) and 0.59 g (H3), the lowest value being recorded in genotypes H1, C1 and C2, ie 0.2 g, while the highest of 0.8 g was found in genotype H3.

Previous research conducted by Tural and Koca (2008) at genotypes in Samsun (Turkey) showed that the average fruit weight varied between 0.39 g and 1.03 g, the values being lower than those found in the genotypes studied. As for the percentage of pulp, it varied between 72.08% (H2) and 79.27% (C1). The lowest pulp percentage was 60% (H2), and the highest was 86.66%. Regarding the pulp percentage of some cornelian cherry genotypes, Ercisli *et al*. (2006) found values between 79.26 and 88.34%. The fruit weight variation coefficient ranged between 12.27% (H1) and 18.54% (H2), for pulp weight between 14.37% (H1) and 22.06% (H2), for kernel weight between 13.02% (H1) and 21.3% (C2), and for the pulp percentage it ranged between 3.33% (H1) and 6.56% (C2). Tables 3 and 4 show the distribution of fruit in cornelian cherry genotypes of Hartagani, Calaparu and Strimba-Jiu populations, in terms of fruit weight and pulp percentage. Thus it is noticed that 89 individuals (59%) of Hartagani population had a fruit weight with values between 1.7-2.6 g and only one was over 3.27 g.

As for the pulp percentage of fruits analyzed (70%) it had values over 71.6% (Table 3). A total number of 85 fruits from genotypes in Calaparu population had a fruit weight between 1.23-1.9 g, and only 5 individuals had value over 2.23 g, while in terms of pulp percentage it is noticed that over 79% of the individuals have the pulp percentage over 72%, and only 3 individuals over 83% (Table 4). It is also noted that 48 (84%) of the analyzed fruits belonging to the cornelian cherry genotype of Strimba-Jiu population had a fruit weight between 1.82 g and 2.97 g, while in terms of pulp percentage it is observed that over 87% of the individuals had the pulp percentage over 71%, and only 5 individuals over 81% (Table 4).

Biochemical characteristics of cornelian cherry fruits were recorded in Table 5. Total dry substance varied between 16.7% for S1 genotype and 36.84% for C2 genotype, whereas soluble dry substance values varied between 10% for S1 genotype and 25.5% for C2 genotype. Previous studies on cornelian cherry genotypes in Samsun area (Turkey) showed that the total dry substance ranged between 15.88% and 28.19%, while the soluble dry substance was between 12.50-21.00% (Tural and Koca, 2008). The values obtained are in accordance with the literature, and it is worth noting the high content of total dry substance in C2 genotype (36.84%). Ercisli *et al*. (2011) found total dry substance values ranging from 12.60 to 21.06%. Vitamin C content ranged from 220 ml/100 g in S1 genotype, and 325 ml/100 g for H3 genotype. Hassanpour *et al*. (2012), in analyzing the chemical composition of some cornelian cherry fruits in Iran, reported values between 240-360 mg/100 g fresh weight for ascorbic acid content, and the total soluble solids and total acidity were 5-12.5% and 0.43-1.86%, respectively.

Table 1. Fruit characteristics of six selected cornelian cherry (*Cornus mas* L.) genotypes

Genotypes	Descriptive analysis *	Fruit height (mm)	Large diameter (mm)	Small diameter (mm)	Size index (mm)	Shape index (mm)
	X ± SD	14.64±0.98	10.61 ±0.85	10.14±0.81	11.79±0.78	1.37±0.09
H1	Variation limits	12 - 16.7	8.3 - 12.4	8.1- 11.9	9.86- 13.43	1.18 - 1.57
	CV%	6.71	8.02	7.99	6.64	6.62
	X ± SD	17.85±2.61	12.25±2.74	11.92±2.70	14.00±2.63	1.48±0.18
H2	Variation limits	13.3-22.2	7.2-16.3	7-15.9	9.46-17.63	1.19-1.97
	CV%	14.65	22.41	22.71	18.8	12.39
	X ± SD	21.48±3.41	14.66±3.83	14.33±3.81	16.81±3.57	1.50±0.21
H3	Variation limits	15.5-31.8	9.1-25.9	8.8-25.8	11.86-27.87	1.05-2.14
	CV%	15.89	26.15	26.57	21.28	14.05
	X ± SD	15.23±2.17	10.60± 1.78	10.18±1.73	12.00±1.80	1.44±0.13
C1	Variation limits	12.2-21.3	8.7-16	8.5-15.6	10.06-17.33	1.25-1.99
	CV%	14.28	16.8	17.04	15.06	9.05
	X ± SD	13.74±1.15	8.85±0.71	8.36±0.73	10.31±0.66	1.55±0.16
C2	Variation limits	10.7-15.7	6.8-10.3	6.1-9.9	8.5-11.66	1.26-2.07
	CV%	8.4	8.08	8.73	6.43	10.78
	X ± SD	17.05±1.40	11.12±0.78	10.98±0.77	13.15±1.02	1.52±0.10
S1	Variation limits	14.15-20.78	9.45-13.16	9.37-13.1	11.24-16.41	1.33-1.75
	CV%	8.22	7.02	7.07	7.81	6.67

X ± SD –mean and standard deviation, CV% - coefficient of variation

Table 2. Quantitative values of fruits in the six genotypes under study

Genotype	Descriptive analysis *	Fruit weight (g)	Pulp weigh (g)	Kernel weight (g)	Pulp percentage (%)
	X±SD	2.01± 0.24	1.58±0.22	0.42±0.05	78.58±2.61
H1	Variation limits	1.6-2.5	1.2-2	0.3-0.6	72.22-83.33
	CV%	12.27	14.37	13.02	3.33
	X±SD	1.39±0.25	1.01± 0.22	0.38±0.06	72.08±4.52
H2	Variation limits	0.8-2	0.6-1.5	0.2-0.5	60-80
	CV%	18.54	22.06	16.63	6.27
	X±SD	2.31± 0.34	1.72±0.28	0.59±0.09	74.45±3.23
H3	Variation limits	1.7-3.5	1.2-2.8	0.4-0.8	66.66-80.95
	CV%	14.7	16.56	16.48	4.34
	X±SD	1.82±0.28	1.44±0.25	0.37±0.06	79.27±3.65
C1	Variation limits	1.3-2.6	1-2.1	0.2-0.5	71.42-86.66
	CV%	15.61	17.66	18.56	4.61
	X±SD	1.33±0.22	0.99±0.18	0.34±0.07	73.88±4.85
C2	Variation limits	0.9-1.9	0.7-1.4	0.2-0.5	61.53-81.81
	CV%	16.82	18.86	21.3	6.56
	X±SD	2.24+-0.33	1.75+-0.28	0.49+- 0.08	78.15+-3.16
S1	Variation limits	1.6-3.2	1.2-2.6	0.4-0.7	69.42-83.33
	CV%	14.96	16.37	18.07	4.04

X ± SD –mean and standard deviation, CV% - coefficient of variation

Table 3. Fruit distribution in selected genotypes depending on fruit weight

Fruit weight (g)					
Hartagani population		Calaparu population		Strimba-Jiu population	
Bin	Cumulative %	Bin	Cumulative %	Bin	Cumulative %
0.8	0.67	0.9	1.01	1.6	2.00
1.025	4.00	1.06	3.03	1.82	14.00
1.25	8.00	1.23	19.19	2.05	22.00
1.475	20.67	1.4	39.39	2.28	56.00
1.7	35.33	1.56	50.51	2.51	80.00
1.925	52.67	1.73	70.71	2.74	90.00
2.15	66.67	1.9	88.89	2.97	98.00
2.375	82.00	2.06	89.90	More	100.00
2.6	94.67	2.23	94.95		
2.825	98.67	More	100.00		
3.05	98.67				
3.275	99.33				
More	100.00				

Table 4. Fruit distribution in genotypes under study, depending on pulp percentage

Pulp percentage (%)					
Hartagani population		Calaparu population		Strimba-Jiu population	
Bin	Cumulative %	Bin	Cumulative %	Bin	Cumulative %
60	1.34	61.53	2.02	69.42	2.04
61.94	1.34	64.32	3.03	71.40	2.04
63.88	2.68	67.11	7.07	73.39	6.12
65.83	2.68	69.90	8.08	75.38	14.29
67.77	4.70	72.69	17.17	77.36	36.73
69.72	11.41	75.49	39.39	79.35	63.27
71.66	23.49	78.28	60.61	81.34	89.80
73.60	34.23	81.07	79.80	More	100.00
75.55	51.68	83.86	96.97		
77.49	67.79	More	100.00		
79.44	85.23				
81.38	93.96				
More	100.00				

Table 5. Characteristics on chemical composition in genotypes of the selected genotypes

Genotype	TDS %*	SDS %*	TA ml NaOH n10 $100g^{-1}$*
H_1	26.23	21	230
H_2	27.18	17	255
H_3	26.97	20.05	325
C_1	34.4	29	290
C_2	36.84	25.5	270
S_1	16.7	10	220

*TDS=total dry substance, SDS= soluble dry substance, TA= total titrable acidity

Conclusions

Studies conducted have shown that there is great diversity in cornelian cherry populations growing in different ecological areas. Differences are manifested themselves in terms of fruit size and biochemical characteristics. The results of the study are useful in attempting to select superior genotypes of cornelian cherry for culture.

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