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VARIABILITY OF PHYSICAL-CHEMICAL CHARACTERISTICS IN MEDLAR GENOTYPES (*MESPILUS GERMANICA* L.) DEPENDING ON CLIMATIC YEAR

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Abstract

This study was performed to determine some physical-chemical characteristics of 5 medlar genotypes, selected from the South-Western area of Romania, identified in both spontaneous and cultivated flora. During the 3 years of study the physical-chemical characteristics of fruits showed significant differences both between genotypes and between years (the average weight of fruits, the diameter of fruits and the volume of fruits varied between 3.08 g-36.68 g, 17.98 mm-44.15 mm, respectively, 3.92 cm³ - 37.18 cm³). The soluble dry matter has recorded values between 9.5% -26.6%, the total dry substance was between 24.96% - 44.97%, and titratable acidity was between 1.60 and 7.03 g malic acid/100 g fresh substance. This variability can be exploited to select valuable medlar genotypes (Mespilus germanica L.) for preservation and use in culture.

Key words*: genotype, Mespilus germanica L., morphological characteristics, variability.*

INTRODUCTION

The medlar (*Mespilus germanica* L.) is part of the *Rosaceae* family and is native to the eastern Mediterranean. It was cultivated about three thousand years ago in the Caspian Sea region of northern Iran (Velickovic et al., 2013).
The interest for it gradually disappeared, and later it was replaced by other, more productive cultures. Nowadays, medlar is cultivated quite rarely, mainly in botanical gardens or in private gardens (Cosmulescu et al., 2020).
The fruits are astringent and hard to harvest. They can be consumed fresh because they are high in potassium (Glew et al., 2003a) and amino acids (Glew et al., 2003b). Medlar fruits are used as a treatment for constipation, as a diuretic and for treating kidney stones and bladder (Baird and Thieret, 1989).
It is a healthy fruit, with phytochemicals including antioxidants (Ayaz at al., 2008; Selcuk and Erkan, 2015). Medlar is not resistant to temperature and has a much higher resistance against pests. Recently, more attention has been paid to morphological and biochemical properties of different medlar genotypes (Scrieciu and Cosmulescu, 2019; Cosmulescu et al., 2019; 2020). Some researchers have studied the spreading area of medlar (Yilmaz et al., Realcioglu, 2013), the phenological stages (Atay, 2013), but also the characteristics of pollen (Cavusoglu and Sulusoglu, 2013).
The fruit is medium in size (20-30 mm in diameter), hemispherical, flattened at the tip, chestnut-red colour, with a very large calyx cavity, the cup shape, on the side of which there are inserted large, lanceolated and persistent sepals. The fruit epidermis is thick, and the pulp is firstly whitish-yellowish, hard, sour and astringent; at maturity, as a result of fermentation, it becomes brown, soft (like a paste), acid-sweet, with a fine, specific, pleasant aroma. The seeds, in number of 5, have an irregular, woody coating (Dirr, 1990). Fruits are harvested at the end of October - beginning of November, after the fall of autumn hoarfrost. Being hard when they are harvested, the fruits are easily carried. In warehouse they should be placed on a layer of

straw. After 3-4 weeks of storage, their pulp becomes soft and edible (Baird and Thieret, 1989). There are not enough studies on chemical and nutritional composition of medlar fruits (Aydin and Kadioglu, 2001). The aim of this study was to determine genetic diversity, based on physical-chemical characteristics of fruits, in medlar (*Mespilus germanica* L.) from the South-Western area of Romania, found in both spontaneous and cultivated flora. This variability can be exploited to select valuable genotypes for conservation and use in culture.

MATERIALS AND METHODS

The study was carried out on five genotypes of medlar (*Mespilus germanica* L.) selected from different areas (Dolj, Gorj, Caraș-Severin, Teleorman), being identified in both spontaneous and cultivated flora. The fruits were harvested during autumn season (production of 2017, 2018, 2019) and carried to laboratory for biometric measurements and chemical analyses. Starting with the name of locality where they were identified, the biotypes were coded as follows: C1 (Craiova), N1 (Nanov), M1 (Mătăsari), T1 (Turnu Ruieni), E1 (Ezeriș). The determinations were performed on 50 fruits (randomly collected) from each identified genotype.

Physical characteristics

Biometric measurements were made, following: the weight of fruits was determined using the precision balance; the diameter and the height of fruits were used the electronic cube with ultrafast digital display and accuracy of 0.01 mm; volume (V; cm^3) and fruit density (ρ; g/cm^3) was determined using the liquid displacement method in a graduated cylinder, where 100 ml of water was added and then the fruit, thus determining the volume of fruits, and density was calculated using the formula $\rho = m/V$, where m = mass and V = volume. The shape index (If) was calculated according to the method presented by Ionică et al. (2018) and Cosmulescu (2013): If = H/D, where H = fruit height; D = fruit diameter.

Chemical characteristics

Total acidity was determined using the method described by Ionică (2014), by titrating a fruit extract, obtained by boiling and filtering and neutralization with NaOH, and the results obtained were expressed in ml of 0.1 N/100 g NaOH fresh substance. Total dry matter (SUT) was determined using the method based on water evaporation from the analytical average sample, using the oven, at temperatures of 85-105°C, the results being expressed as a percentage. The soluble dry matter (SUS) was determined with refractometer, the final result being expressed as a percentage. The data obtained were statistically processed using the Excel descriptive statistics program (StatPoint Technologies, Warrenton, VA, USA).

RESULTS AND DISCUSSIONS

The results regarding the variability of fruit characteristics for the studied genotypes are presented in Tables 1 and 2. Regarding the average weight of medlar fruits, there were big differences both between genotypes and within genotype from year to year. Thus, in 2017 the average fruit weight was between 3.15-36.68 g, in 2018 between 7.5-32.65 g, respectively, 3.08-27.20 g in 2019. The highest weight was observed in T1 genotype (36.68 g) in 2017, followed by C1 genotype (32.65-27.20 g), which recorded the highest average values for 2018 and 2019.

Medlar genotypes studied differ from each other in fruit weight. Aygun and Tasci (2013) reported that the average weight of medlar fruits in genotypes grown in Ordu region ranged from 6.32 g to 36.42 g. Similarly, Ozkan et al. (1997) and Bostan et al. (2002, 2007) reported that the average fruit weight was 16.51-32.98 g and 9.46-40.80 g, respectively. Previous studies by Ylmaz et al. (2016) showed that the average fruit weight was between 17.71-32.46 g in 2011 and 15.99-37.54 g in 2012 in genotypes grown in Tokat province.

Table 1 Morphologic characteristics of medlar fruits identified (2017-2019)

Genotype	Descriptive statistics	Fruit weight (g)	Fruit diameter (mm)	Fruit height (mm)	Fruit volume (cm^3)	Fruit density (g/cm^3)	Shape index (mm)
C1	Mean±SD Min./max CV%	27.13±5.55 21.55/32.65 20.45	38.67±2.78 36.54/41.82 7.19	34.96±1.40 33.62/36.43 4.03	27.63±4.74 22.48/31.82 17.16	0.98±0.04 0.95/1.03 4.23	0.90±0.08 0.83/0.99 8.94
N1	*Mean±SD* *Min./max* *CV%*	*21.16±1.45* *19.49/22.14* *6.87*	*36.22±0.68* *35.6/36.96* *1.89*	*33.94±0.26* *33.76/34.25* *0.79*	*20.50±1.30* *19.05/21.56* *6.34*	*1.03±0.01* *1.02/1.04* *1.11*	*0.93±0.01* *0.91/0.94* *1.86*
M1	Mean±SD Min./max CV%	4.57±2.53 3.08/7.5 55.32	20.24±3.53 17.98/24.31 17.45	20.06±0.81 19.13/20.66 4.07	5.04±1.55 3.92/6.82 30.92	0.89±0.18 0.76/1.1 20.31	1.00±0.19 0.78/1.14 19.60
T1	Mean±SD Min./max CV%	27.16±9.19 18.32/36.68 33.86	39.11±4.86 34.44/44.15 12.43	31.81±1.07 30.59/32.63 3.39	27.14±9.69 17.84/37.18 35.70	1.00±0.02 0.98/1.03 2.49	0.93±0.30 0.73/1.28 32.70
E1	Mean±SD Min./max CV%	20.21±1.46 18.68/21.61 7.27	32.8±1.42 31.47/34.31 4.35	35.50±1.08 34.36/36.52 3.05	20.61±1.64 19.08/22.35 7.97	0.98±0.01 0.96/0.99 1.76	1.07±0.04 1.03/1.11 3.86

*values include mean of the 3 years (2017, 2018, 2019) for each separate characteristic in selected genotypes

The fruit diameter is considered a very important quality element for medlar fruit, thus, the smallest value of fruit diameter over the three years of study was recorded in M1 genotype (18.43 mm, 24.31 mm, respectively 17.98 mm), and the highest value of fruit diameter was in T1 genotype (44.15 mm) in 2017 and in C1 genotype (41.82 mm, 40.24 mm) in 2018 and 2019. The values of variation coefficient, for this characteristic, were between 1.89% (N1) and 17.45% (M1) the variability being high. The results are in agreement with those obtained by Aygun and Tascı (2013) but also with Bostan (2002, 2007), studies that showed that fruit diameter was 23.10-42.65 mm, 31.52-42.44 mm, respectively 14.96-35.68 mm. Studies by Ylmaz et al. (2016) on physical characteristics of fruit showed that fruit diameter was significantly influenced by genotype and less by environmental conditions, recording values between 21.07-41.05 mm in 2011 and 17.49-43.63 mm. The average volume of medlar fruits has varied in very wide range, between 4.38 cm^3 (M1) and 37.18 cm^3 (T1), resulting in a difference of 8.48 times between the two genotypes in 2017, between 6.82 cm^3 (M1) and 31.82 cm^3 (C1), with a difference of 4.66 times between the two genotypes in 2018 and between 3.92 cm^3 (M1) and 28.60 cm^3 (C1), with a difference of 7.29 times between the two genotypes in 2019. Similar studies by Haciseferogullari et al. (2005) showed that fruit volume in genotypes from Eğirdir area, Turkey, was higher (13.7 cm^3) compared to the results obtained in M1 genotype in the present paper. For fruit density (ρ), the average value was between 0.76 (M1) - 1.04 g/cm^3 (N1) in 2017, between 0.96 (E1) - 1.10 g/cm^3 (M1) in 2018 and between 0.82 (M1) - 1.03 g/cm^3 (T1) in 2019. The variation coefficient recorded values between 1.11% in N1 genotype and 20.31% in M1 genotype. In order to determine the fruit shape, the shape index was calculated, ranging from 0.89 (C1) - 1.07 (M1, T1, E1) in 2017, between 0.78 (M1) - 0.99 (E1) in 2018, and in 2019 between 0.91 (C1) - 1.13 (M1 and T1). There is a high variability of all fruit characteristics both between genotypes and between climatic years. Thus, the average fruit height recorded the lowest value in M1 genotype in all three years of study (20.39 mm, 19.13 mm, 20.66 mm), and the highest value was obtained in E1 genotype (34.36 mm, 35.64 mm, 36.52 mm). The variation limits for the average fruit height were between 14.93 mm (M1) in 2018 and 41.43 mm (E1) in 2019. The highest value of variation coefficient for the average fruit height (4.07%) was calculated in M1 genotype. Šebek et al. (2019) have reported that the average height of medlar fruits, in 'Royal' medlar cultivar in the town of Bijelo Polje, had higher values (38.4 mm), compared to the results obtained in the present paper. Chemical characteristics of medlar fruits were recorded in Table 2.

Table 2 Chemical characteristics of medlar fruits (*Mespilus germanica* L.) mean of years 2017-2019

Statistical analysis/Genotype		SUT (%)	SUS (%)	TA (ml NaOH 0.1 u/100 g) g acid malic/100 g sp
Mean ± SD Minimum/Maximum CV%	M1	39.486 ± 4.79 36.11/44.97 12.13	16.83 ± 5.00 13/22.5 29.75	3.88 ± 2.74 2.01/7.03 70.71
	N1	29.770 ± 1.76 27.94/31.46 5.92	16.86 ± 8.09 11/26.1 47.98	4.01 ± 1.45 2.34/5.0 36.27
	C1	27.673 ± 3.51 24.96/31.64 12.69	16.26 ± 2.40 14.5/19 14.75	2.87 ± 1.21 1.6/4.02 42.25
	E1	27.676 ± 0.83 26.83/28.49 3.00	18.60 ± 8.16 9.5/25.3 43.91	3.45 ± 0.50 3.01/4.0 14.56
	T1	30.303 ± 2.80 27.08/32.18 9.25	21.20 ± 6.15 14.5/26.6 29.02	3.45 ± 1.27 2.0/4.35 36.80

*SUT = total dry substance; SUS = dry soluble substance; TA = titrable acidity; sp = fresh substance.

Total dry matter ranged from 27.08% (T1) to 36.11% (M1) in 2017, between 26.42% (C1) and 44.97% (M1) in 2018, and in 2019 values between 24.96% (C1) and 37.38% (M1) were registered. The variation coefficient was between 3.00% in E1 genotype and 12.69% (C1), representing a high variability.

The results of this research related to dry substance for the selected genotypes showed values close to medlar genotypes in Tokat province, where total dry substance was determined between 27.34-44.11%, in the paper done by Yilmaz et al. (2016). Regarding soluble dry matter, it ranged between 9.5% in E1 genotype, in 2017 and 26.6% in T1 genotype in 2019. Similar research by Durul et al. (2016) show that the soluble dry matter (SUS) values of medlar fruits grown in different agro-climatic regions of Turkey (Kocaeli province) were between 16.4 and 22.2%. The soluble dry matter content varies between 17.0 and 24.0%, for the selected medlar genotypes from Turkey (Tonya district of Trabzon province), by Ylmaz (2015).

The results of this study on soluble dry matter showed similar results with these studies. Titrable acidity recorded values between 2.01 (M1) and 4.69 g malic acid/100 g sp (N1) in 2017, between 2.34 (N1) and 7.03 g malic acid/100 g sp (M1) in 2018, and in in 2019 the titrable acidity was between 1.60 (C1) and 5.00 g malic acid/100 g sp (N1). According to studies by Ylmaz et al. (2016), showed that titrable acidity was between 4.25 and 8.94% in medlar genotypes in 2011-2012.

The values recorded for total dry matter, the titratable acidity and soluble dry matter of medlar fruits may be the result of different genetically based characteristics, but also the effect on agro-ecological conditions of culture.

CONCLUSIONS

The high variability of characteristics of medlar genotypes analyzed, offers the possibility of selecting the genotypes with superior characteristics, adapted to climatic conditions, which can be used for introduction into the culture and for development of new cultivars. This study shows that T1, C1 and N1 genotypes are promising in terms of characteristics evaluated in development of new cultivars.

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