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VARIATION IN MORPHOMETRIC TRAITS OF FRUITS OF *MESPILUS GERMANICA* L.

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ABSTRACT

According to the International Program for the Botanic Gardens Conservation, botanic gardens contribute to the conservation plant species, which are of great socio-economic importance, and develop and implement a policy to use herbal products derived from sustainably developing sources. The aim of this study was to determine morphometric parameters of fruits of seven genotypes of *Mespilus germanica* L., which are growing in the Forest-Steppe of Ukraine in M. M. Gryshko National Botanical Garden of NAS of Ukraine (Kyiv). Their morphometric parameters were following: fruit weight from 35.29 to 39.12 g, fruit length from 27.69 to 42.29 mm, fruit diameter from 24.98 to 44.75 mm, length of calyx basin from 17.55 to 32.46 mm. The shape index of the fruits was found in the range of 0.79 to 1.23. It was found that fruit diameter positively correlated with traits such as fruit weight and calyx basin length. Fruit weight was also highly correlated with calyx basin length and fruit length. Using the cluster analysis with Euclidian distances allowed to establish the relationships among the fruits *Mespilus germanica* germplasm and arranged the genotypes into five relatively homogenous clusters. Hence, the introduction population characterized by quite variability and contains plants with almost all types of fruits. Obtained data can be used for breeding programs and introducing of cultivars in *Mespilus germanica*.

Keywords: *Mespilus germanica*; fruits; genotypes; morphometric characteristics; variability; Forest-Steppe of Ukraine

INTRODUCTION

Recently, the increasing importance attached to the consumption of healthy food. Attention is attracted not by traditional fruit crops, but by wild plants with smaller fruits, which, however, contain natural vitamins and antioxidants: cornelian cherry, mountain ash, sea buckthorn, rose hip, service tree, elderberry, bilberry, mulberry, jujube. The *Mespilus germanica* L. (medlar) is also included in this group of popular fruit trees. This species belonging to the family Rosaceae Juss. was introduced to Greece around 700 BC, and to Rome about 200 BC **(Baird and Thieret, 1989)**. Until the seventeenth century, the medlar was the most important fruit crop. However, interest in it gradually faded away, and later it was replaced by other, more productive and undemanding crops. Currently, medlar is grown quite rarely and, mainly, in botanical gardens or in small farms. *Mespilus germanica* is indigenous to southwest Asia and possibly also southeastern Europe – from northern Turkey (some occurrence in Greece and on the Crimea) to the Caucasus and Transcaucasus and the north-eastern part of Iran **(Lim, 2012)**.

Studies found ripe *Mespilus germanica* fruit to be rich in potassium (740-841 mg.100 g^{-1}), calcium (67-80 mg.100 g^{-1}), phosphorus (30-48 mg.100 g^{-1}), magnesium (50-62 mg.100 g^{-1}) **(Ercisli et al., 2012)**. Medlar fruit was found to have dry matter content 27.0%, protein 11.4%, fibre 3.71%, energy 16.5 kcal.g^{-1}, and ash 1.96%, acidity 0.28%, pH 4.26 **(Haciseferogullari et al. 2005)**, fructose 2230 mg.g^{-1}, glucose 845.2 mg.g^{-1}, sucrose 228.4 mg.g^{-1} **(Glew et al., 2003b)**, high content of amino acids **(Glew et al., 2003a)**, fatty acids **(Ayaz et al., 2002a; Ayaz et al., 2002b)**, volatile components **(Pourmortazavia and Ghadirib, 2005)**, polyphenols and antioxidants **(Gruz et al., 2011; Gülçin et al., 2011; Nabavi et al., 2011; Rop et al., 2011)**. The *Mespilus germanica* fruit used as a treatment for constipation, as a diuretic, and to rid the kidney and bladder of stones **(Haciseferogullari et al., 2005; Glew et al., 2003a)**.

Morphological characterization continues to be the first step for germplasm description and classification **(Badenes et al., 2000; Nazari et al., 2012)**. The existence of a large variability in fruits has been demonstrated in different species such as *Prunus persica* (L.) Batsch **(Scorza, 1984)**, *Cornus mas* L. **(Brindza et al., 2007)**, *Prunus* spp. **(Zhang et al., 2008; Perez-Sanchez et al., 2008; Nazari et al., 2012)**, *Malus* sp. **(Mratinić and Akšić, 2012)**, *Diospyros* spp. **(Grygorieva et al., 2011)**, *Pseudocydonia sinensis* Schneid. **(Monka et al., 2014)**, *Vitis vinifera* L. **(Lamine et al., 2014)**, *Ziziphus*

jujuba Mill. (**Grygorieva et al., 2014; Ivanišová et al., 2017)**, *Castanea sativa* Mill. **(Poljak et al., 2016; Grygorieva et al., 2017b)**. For the *Mespilus germanica* breeders or plant biologists, the description of the fruit morphology is of significant importance for phenomics studies.

Scientific hypothesis

In our experiment, we have been supporting that fruit phenotyping variability of evaluated genotypes collection *Mespilus germanica* not predominate only cultivation conditions but also genetical features.

MATERIAL AND METHODOLOGY

Locating trees and data collection

The objects of the research were 10-year-old plants of *Mespilus germanica* from seed origin, which are growing in Forest-Steppe of Ukraine in M. M. Gryshko National Botanical Garden of NAS of Ukraine (NBG). The study was conducted 2018 year. We have described 7 genotypes of *Mespilus germanica*. Fruits were harvested at commercial maturity stage (skin brownish, pulp white, fruit hard).

Morphometric characteristics

30 fruits from each genotype were used immediately after harvest for phenotypic measurements such as fruit weight, (FW), in g, fruit length (FL), in mm, fruit diameter (FD), in mm, calyx basin length (CL), in mm. Fruit mass was measured by using a digital balance with a sensitivity of 0.01 g (PS6000/C/1). Linear dimensions of fruits as length and diameter were measured by using a digital calliper gauge with a sensitivity of 0.01 mm than shape index was calculated by using length/width ratio.

The measurements were made in each nut element as shown in Figure 1.

Statistical analyses

Basic statistical analyses were performed using PAST 2.17; hierarchical cluster analyses of similarity between phenotypes were computed on the basis of the Bray-Curtis similarity index; multi-dimensional scaling (MDS) analyses were performed in PRIMER **(Clarke and Gorley, 2006)**. Variability of all these parameters was evaluated using descriptive statistics. Level of variability determined by **Stehlíková (1998)**.

RESULTS AND DISCUSSION

In this study was selected certain fruit parameters, which can be interesting for commercial use.

The fruit weight, fruit length, fruit diameter, calyx basin length, and shape index of fruits in seven *Mespilus germanica* genotypes are shown in Tab. 1.

The data in the Table indicate the high variability of fruits, especially their mass. Thus, some genotypes can be used further in the selection process. The images of *Mespilus germanica* fruits of various genotypes are shown in Figure 2 and 3.

The highest fruit weight was обтаинед in genotype MG-05 as 35.29 g, and followed by MG-04 as 39.12 g (Figure 4).

The fruit weight was determined in the range from 2.59 g by **Nezhadghan and Hassanpou (2018)** to 40.80 g by **Bostan and Islam (2007)**. Our fruit weight results are in accordance within the range of the values reported literature (Tab. 2).

Table 1 The variability of some morphometric parameters of fruits for the collection of *Mespilus germanica* L. genotypes.

Characteristics	Unit	*n*	*min*	*max*	*mean*	*V%*
Fruit weight	**g**	210	5.70	54.20	24.14	47.56
Fruit length	**mm**	210	23.54	46.33	34.30	15.46
Fruit diameter	**mm**	210	20.26	51.17	35.11	21.02
Calyx basin length	**mm**	210	12.13	42.19	21.69	31.40
Shape Index		210	0.65	1.67	1.00	18.09

Note: n – number of measurements; min, max – minimal and maximal measured values; mean – arithmetic mean; V – coefficient of variation (%).

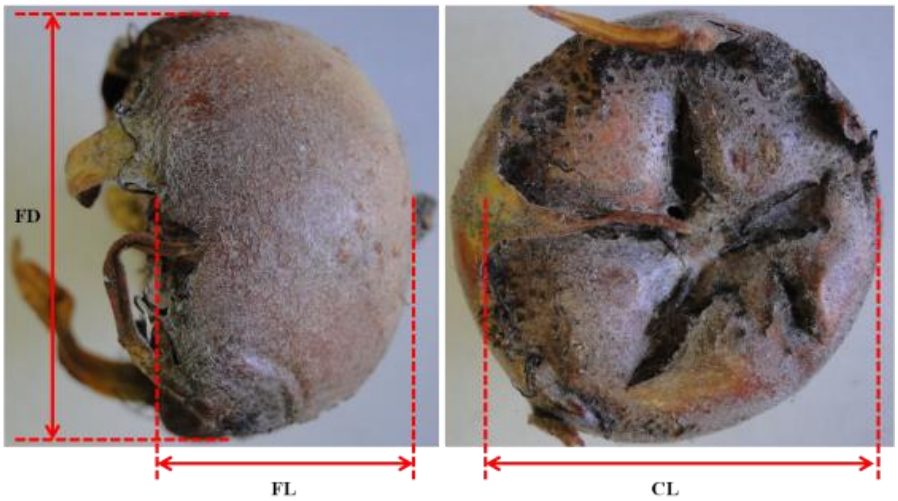

Figure 1 Variability in the shape of genotypes *Mespilus germanica* L. fruits.

Table 2 Variability of some morphometric characteristics on *Mespilus germanica* L. fruits according to the authors from different countries.

Authors	Weight (g)	Length (mm)	Diameter (mm)	Calyx basin length (mm)	Shape Index
Ozkan et al. (1997)	16.51 – 32.98	–*	–*	14.93 – 27.71	–*
Bostan and Islam (2007)	9.46 – 40.80	–*	–*	13.54 – 31.84	–*
Ercisli et al. (2012)	11.21 – 33.24	27.45 – 38.88	28.44 – 42.51	13.92 – 26.48	0.81 – 1.09
Aygun and Tasci (2013)	6.32 – 36.42	21.80 – 40.10	20.60 – 42.70	8.30 – 23.30	–*
Miko and Gažo (2014)	6.36 – 40.53	23.02 – 42.83	27.20 – 42.83	13.46 – 33.80	0.73 – 1.12
Akbulut et al. (2016)	12.30 – 23.60	–*	–*	13.80 – 22.10	0.87 – 1.04
Sulusoglu and Unver (2016)	9.69 – 24.45	21.00 – 33.30	21.20 – 33.60	13.20 – 17.60	–*
Nezhadghan and Hassanpou (2018)	2.59 – 10.95	18.50 – 29.00	16.00 – 28.20	–*	0.78 – 1.51
Yilmaz et al. (2016)	15.99 – 37.54	14.96 – 38.27	17.49 – 43.63	–*	–*

Figure 2 Variability in the shape of genotypes *Mespilus germanica* L. fruits.

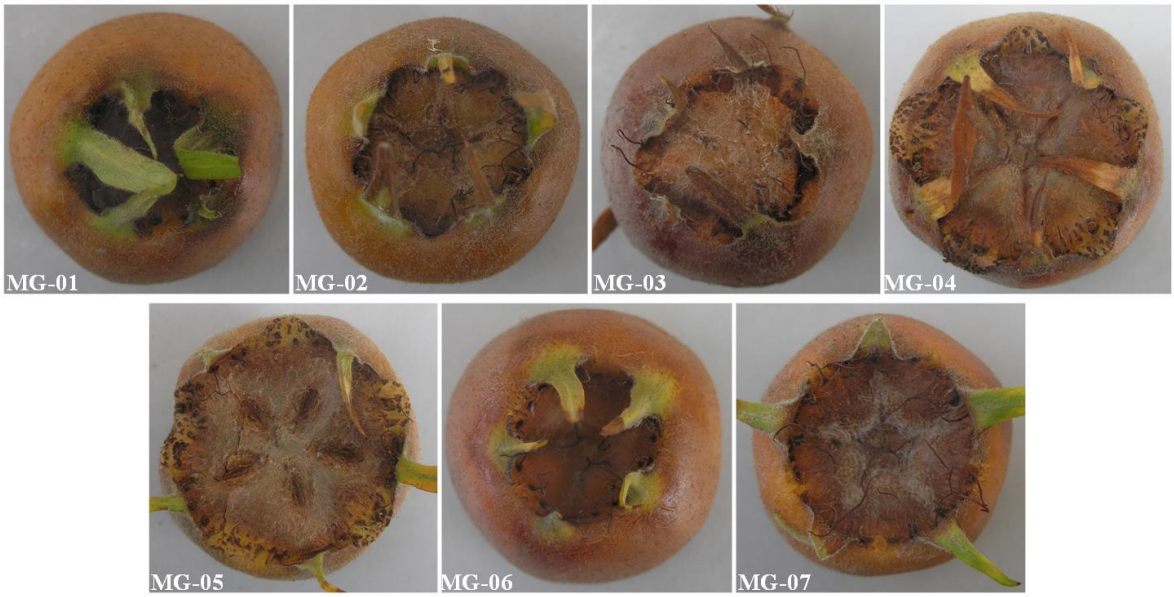

Figure 3 Variability in the shape of genotypes *Mespilus germanica* L. fruits.

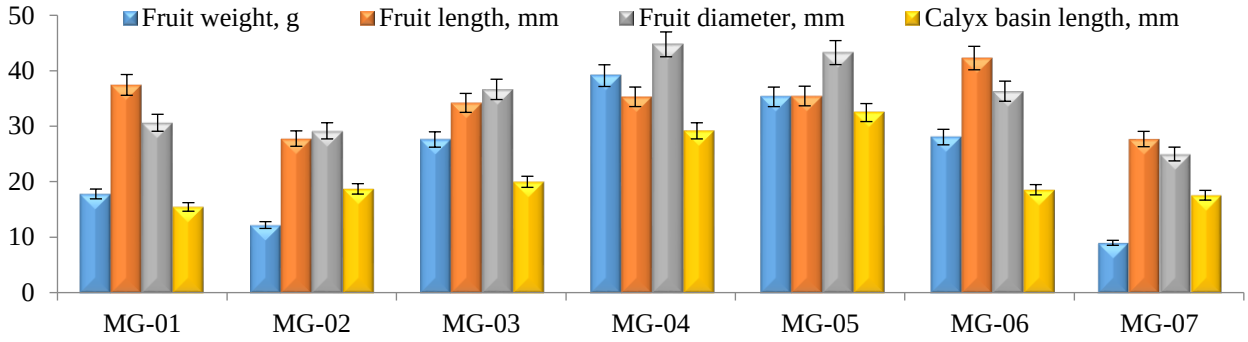

Figure 4 Mean values for various morphometric parameters of fruits and seeds of *Mespilus germanica* L. genotypes.

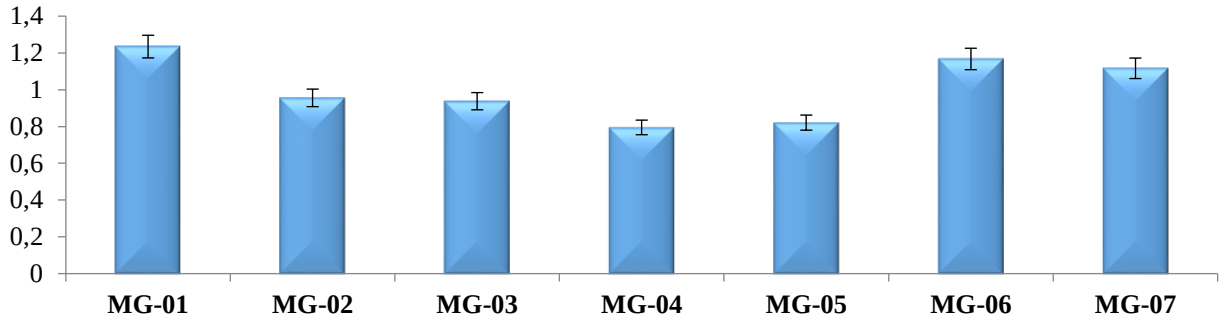

Figure 5 Comparison of the tested *Mespilus germanica* L. genotypes in the shape index of fruit.

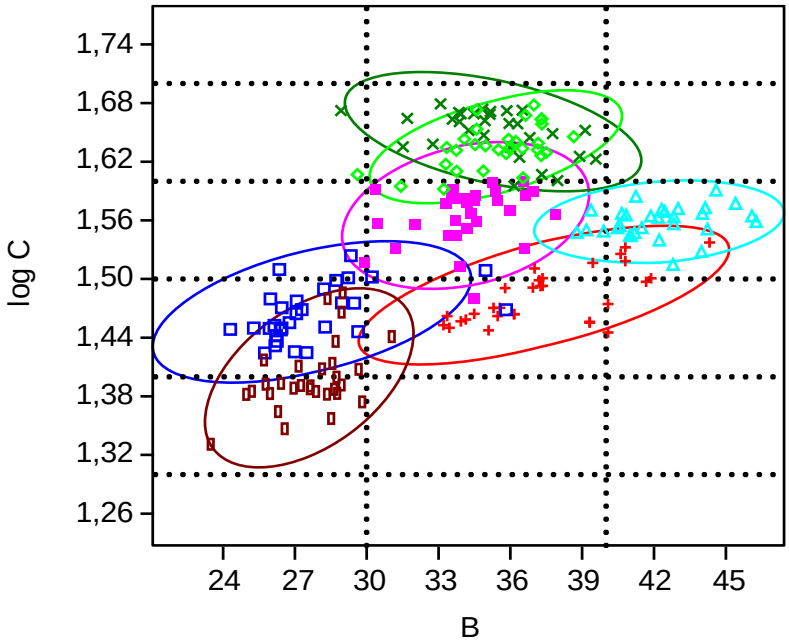

Figure 6 MDS plot of the similarity illustrating the length (C) and diameter (B) of fruits for studying genotypes of *Mespilus germanica* L.

The highest values in terms of fruit lengths were found in the genotype MG-06 (42.29 mm). The lowest values were determined in the genotype MG-07 (27.69 mm) and MG-02 (27.77 mm). In previous studies, it was indicated that the fruit lengths ranged from 14.96 to 40.10 mm in the genotypes selected **(Ercisli et al., 2012; Aygun and Tasci, 2013; Akbulut et al., 2016; Nezhadghan and Hassanpou, 2018; Sulusoglu and Unver, 2016; Yilmaz et al., 2016)**.

The fruit diameters of analyzed genotypes ranged from 24.98 (MG-07) to 44.75 (MG-04) mm. In the literature, it was stated that the fruit diameters of identified genotypes varied from 16.00 to 42.51 mm **(Ercisli et al., 2012; Aygun and Tasci, 2013; Sulusoglu and Unver, 2016; Yilmaz et al., 2016; Nezhadghan and Hassanpou, 2018).**

The length of calyx basin increased with the coarsening of fruit. For the length of the calyx, the basin was found between 17.55 (MG-07) and 32.46 (MG-05) mm. Studies in the literature carried showed that the values of length of

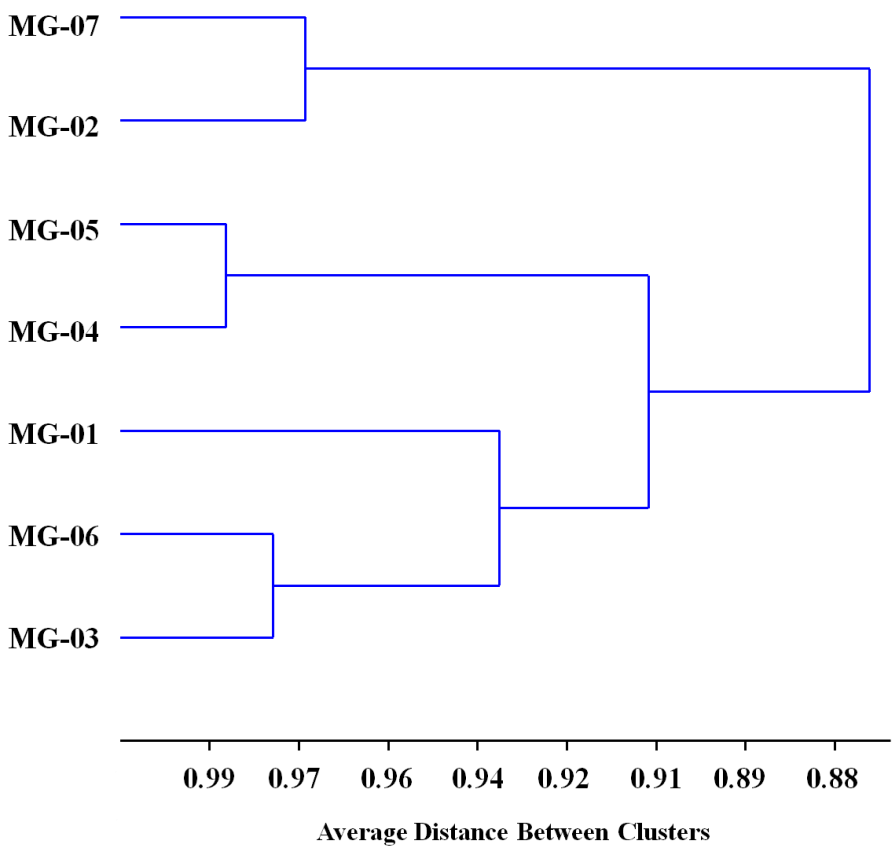

Figure 7 Dendrogram of 7 genotypes of *Mespilus germanica* L. based on morphometric characteristics of fruits.

calyx basin ranged from 8.30 g **(Aygun and Tasci, 2013)** to 33.80 g **(Miko and Gažo, 2014)**.

Shape index was found between 0.79 (MG-04) and 1.23 (MG-01) (Figure 5). According to shape index results, the genotypes MG-01, MG-06 and MG-07 have pearshaped and the others are apple-shaped fruit form. **Ercisli et al. (2012)** reported a shape index between 0.81 and 1.09. **Miko and Gažo (2014)** identified the shape index from 0.73 to 1.12. **Akbulut et al. (2016)** found a shape index between 0.87 and 1.04. In addition, **Nezhadghan and Hassanpou (2018)** identified the shape index between 0.78 and 1.51. Our result on shape index could be comparable with those studies.

The highest coefficient variability (Table 1) identified was for fruit weight (47.56%), followed by calyx basin length (31.40%).

It was found that fruit diameter positively correlated with traits such as fruit weight (r = 0.98) and calyx basin length (0.85). Fruit weight was also highly correlated with calyx basin length (0.79) and fruit length (0.60).

Multidimensional scaling (MDS) is to detect meaningful underlying dimensions that allow the researcher to explain observed similarities or dissimilarities (distances) between the investigated objects. Results of multidimensional scaling are shown in Figure 6.

In Figure, it is possible to see the visual distribution the size of the fruits of the studied genotypes. The genotypes MG-04 (green ellipse) and MG-05 (light green ellipse) with the largest fruit size and the genotypes MG-01 (red ellipse), MG-02 (blue ellipse) and MG-07 (brown ellipse) with the smallest fruit size differ each another with the probability of 95% (the ellipses in the figure do not overlap).

We applied cluster analysis to evaluate the differences in the morphological features of the *Mespilus germanica* fruits. This technique has been carried out earlier for studying the genetic variability of some other plant species **(Rakonjac et al., 2014; Blazakis et al., 2017; Grygorieva et al., 2017a; Metougui et al., 2017; Vinogradova et al., 2017)**.

Cluster analysis allowed the assessment of similarity or dissimilarity and clarified some of the relationships among wild cherry accessions.

Based on the cluster analysis of all 7 studied fruit's characteristics, a dendrogram for the genotypes of *Mespilus germanica* was made (Figure 7). On the dendrogram, you can see that the samples Mg-04 and MG-05 is really separated from the other samples. They differ from other genotypes in all studied parameters.

CONCLUSION

The introduction population of *Mespilus germanica* at M. M. Gryshko National Botanical Garden of NAS of Ukraine is quite variable and contains plants with almost all types of fruits. Evaluating of 7 genotypes of *Mespilus germanica* determined the weight of the fruits in the range from 39.12 to 35.29 g, fruit length from 27.69 to 42.29 mm, fruit diameter from 24.98 to 44.75 mm, length of calyx basin from 17.55 to 32.46 mm. The shape index of the fruits was found in the range of 0.79 to 1.23. This study carried revealed that the genotypes MG-04 and MG-05 was promising in terms of the characteristics evaluated

in variety development. The presence of a broadly variable population provides the conservation *Mespilus germanica*, which is of potentially great socio-economic importance, and will help in the future to use herbal products derived from sustainably developing sources.

REFERENCES

Akbulut, M., Ercisli, S., Jurikova, T., Mlcek, J., Gozlekci, S. 2016. Phenotypic and bioactive diversity on medlar fruits (*Mespilus germanica* L.). *Erwerbs-Obstbau*, vol. 3, p. 185-191. https://doi.org/10.1007/s10341-016-0272-z

Ayaz, F. A., Glew, R. H., Huang, H. S., Chuang, L. T., VanderJagt, D. J., Strnad, M. 2002a. Evolution of fatty acids in medlar (*Mespilus germanica* L.) mesocarp at different stages of ripening. *Grasas y Aceites*, vol 53, no. 3, p. 352-356. https://doi.org/10.3989/gya.2002.v53.i3.328

Ayaz, F. A., Huang, H. S., Chuang, L. T., Vanderjagt, D. J., Glew, R. H. 2002b. Fatty acid composition of medlar (*Mespilus germanica* L.) fruit at different stages of development. *Italian Journal of Food Science*, vol. 14, no. 4, p. 439-446.

Aygun, A., Tasci, A. R. 2013. Some fruit characteristics of medlar (*Mespilus germanica* L.) genotypes grown in Ordu, Turkey. *Sci. Pap. Ser. B. Hortic.*, vol. 57, p. 149-152.

Badenes, M. L., Martinez-Calvo, J., Llacer, G. 2000. Analysis of a germplasm collection of loquat (*Eriobotrya japonica* Lindl.). *Euphytica*, vol. 114, no. 3, p. 187-194. https://doi.org/10.1023/A:1003950215426

Baird, J., Thieret, J. 1989. The Medlar (*Mespilus germanica*, Rosaceae) from antiquity to obscurity. *Econ. Bot.*, vol. 43, no. 4, p. 328-372. https://doi.org/10.1007/BF02858732

Blazakis, K. N., Kosma, M., Kostelenos, G., Baldoni, L., Bufacchi, M., Kalaitzis, P. 2017. Description of olive morphological parameters by using open access software. *Plant Methods*, vol. 13, no. 111, p. 1-15. https://doi.org/10.1186/s13007-017-0261-8

Bostan, S. Z., Islam, A. 2007. A research on breeding by selection of medlar (*Mespilus germanica* L.) types in Eastern Black sea region of Turkey. *Proceedings of 5th National Horticultural Congress*, p. 330-337.

Brindza, P., Brindza, J., Tóth, D., Klimenko, S. V., Grigorieva, O. 2007. Slovakian cornelian cherry (*Cornus mas* L.) : potential for cultivation. *Acta Hortic.*, vol. 760, p. 433-437. https://doi.org/10.17660/ActaHortic.2007.760.59

Clarke, K., Gorley, R. 2006. PRIMER v6 : User Manual/Tutorial. Plymouth, UK : Primer-E, Ltd. 192 p.

Ercisli, S., Sengul, M., Yildiz, H., Sener, D., Duralija, B., Voca, S., Purgar, D. D. 2012. Phytochemical and antioxidant characteristics of medlar fruits (*Mespilus germanica* L.). *Journal of Applied Botany and Food Quality*, vol. 85, no. 1, p. 86-90.

Glew, R. H., Ayaz, F. A., Sanz, C., VanderJagt, D. J., Huang, H. S., Chuang, L. T., Strnad, M. 2003a. Effect of postharvest period on sugars, organic acids and fatty acids composition in commercially sold medlar (*Mespilus germanica* "Dutch") fruit. *Eur Food Res Technol.*, vol. 216, p. 390-394. https://doi.org/10.1007/s00217-002-0654-3

Glew, R. H., Ayaz, F. A., Sanz, C., VanderJagt, D. J., Huang, H. S., Chuang, L. T., Strnad, M. 2003b. Changes in sugars, organic acids and amino acids in medlar (*Mespilus germanica* L.) during fruit development and maturation. *Food Chemistry*, vol. 83, p. 363-369. https://doi.org/10.1016/S0308-8146(03)00097-9

Gruz, J., Ayaz, F. A., Torun, H., Strnad, M. 2011. Phenolic acid content and radical scavenging activity of extracts from medlar (*Mespilus germanica* L.) fruit at different stages of ripening. *Food Chem.*, vol. 124, no. 1, p. 271-277. https://doi.org/10.1016/j.foodchem.2010.06.030

Grygorieva, O., Abrahamová, V., Karnatovská, M., Bleha, R., Brindza, J. 2014. Morphological characteristic of fruit, drupes and seeds genotypes of *Ziziphus jujuba* Mill. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 8, no. 1, p. 306-314. https://doi.org/10.5219/414

Grygorieva, O., Brindza, J., Vietoris, V., Kucelová, L., Tóth, D., Abrahamova, V., Hricová, M. 2011. Morphological and organoleptic fruit properties of various persimmon species (*Diospyros* spp.). *Potravinarstvo Slovak Journal of Food Sciences*, vol. 5, no. 3, p. 11-19. https://doi.org/10.5219/150

Grygorieva, O., Klymenko, S., Brindza, J., Schubertová, Z., Nikolaieva, N., Šimková, J. 2017a. Morphometric characteristics of sweet chestnut (*Castanea sativa* Mill.) fruits. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 288-295. https://doi.org/10.5219/684

Grygorieva, O., Klymenko, S., Vergun, O., Hudz, N., Nikolaieva, N., Schubertová, Z., Palamarchuk, O., Brindza, J. 2017b. Morphological characteristics and determination of volatile organic compounds of *Diospyros virginiana* L. genotypes fruits. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 612-622. https://doi.org/10.5219/808

Gülçin, L., Topal, F., S. Sarıkaya, B. Ö., Bursal, E., Bilsel, G., Gören, A. C. 2011. Polyphenol contents and antioxidant properties of medlar (*Mespilus germanica* L.). *Rec. Nat. Prod.*, vol. 5, no. 3, p. 158-175.

Haciseferogullari, H., Ozcan, M., Sonmete, M. H., Ozbek, O. 2005. Some physical and chemical parameters of wild medlar (*Mespilus germanica* L.) fruit grown in Turkey. *Journal of Food Engineering*, vol. 69, p. 1-7. https://doi.org/10.1016/j.jfoodeng.2004.07.004

Ivanišová, E., Grygorieva, O., Abrahamová, V., Schubertova, Z., Terentjeva, M., Brindza, J. 2017. Characterization of morphological parameters and biological activity of jujube fruit (*Ziziphus jujuba* Mill.). *Journal of Berry Research*, vol. 7, no. 4, p. 249-260. https://doi.org/10.3233/JBR-170162

Lamine, M., Zemni, H., Ziadi, S., Chabaane, A., Melki, I., Mejri, S., Zoghlami, N. 2014. Multivariate analysis and clustering reveal high morphological diversity in Tunisian autochthonous grapes (*Vitis vinifera*) : insights into characterization, conservation and commercialization. *Journal international des sciences de la vigne et du vin Received*, vol 48, no. 2, p. 111-122. https://doi.org/10.20870/oeno-one.2014.48.2.1565

Lim, T. K. 2012. *Mespilus germanica*. *Edible Medicinal And Non-Medicinal Plants*. Dordrecht, Netherland, Springer. https://doi.org/10.1007/978-94-007-4053-2_50

Metougui, M. L., Mokhtari, M., Maughan, P. J., Jellen, E. N., Benlhabib, O. 2017. Morphological variability, heritability and correlation studies within an argan tree population (*Argania spinosa* (L.) Skeels) preserved in situ. International *Journal of Agriculture and Forestry*, vol. 7, no. 2, p. 42-51. https://doi.org/10.5923/j.ijaf.20170702.02

Miko, M., Gažo, J. 2014. *Biologické vlastnosti a hodnotenie genofondu mišpule obyčajnej (Mespilus germanica L.) Biological properties and evaluation of the genus of the moss (Mespilus germanica L.)*. 1st ed. Nitra, Slovakia : Slovak University of Agriculture, 97 p. ISBN 978-80-552-1261-6. (In Slovak)

Monka, A., Grygorieva, O., Chlebo, P., Brindza, J. 2014. Morphological and antioxidant characteristics of quince

(*Cydonia oblonga* Mill.) and chinese quince fruit (*Pseudocydonia sinensis* Schneid). *Potravinarstvo Slovak Journal of Food Sciences*, vol. 8, no. 1, p. 333-340. https://doi.org/10.5219/415

Mratinić, E., Akšić, M. F. 2012. Phenotypic diversity of apple (*Malus* sp.) germplasm in South Serbia. *Braz. Arch. Biol. Technol.*, vol. 55, no. 3, p. 49-358. https://doi.org/10.1590/S1516-89132012000300004

Nabavi, S. F., Nabavi, S. M., Ebrahimzadeh, M. A., Asgarirad, H. 2011. The antioxidant activity of wild medlar (*Mespilus germanica* L.) fruit, stem bark and leaf. *Afr. J. Biotechnol.*, vol. 10, no. 2, p. 283-289.

Nazari, S. A., Zamani, Z., Fatahi, M. R., Sofla, H. S. 2012. Morphological characterization of *Prunus incana* Pall. by multivariate analysis. *Plant Syst. Evol.*, vol. 298, p. 1805-1814. https://doi.org/10.1007/s00606-012-0681-x

Nezhadghan, B., Hassanpou, H. 2018. Investigation of physicochemical characterizations of some Medlar (*Mespilus germanica* L.) genotypes in East Azerbaijan province. *Iranian Journal of Horticultural Science*, vol. 49, no. 1, p. 157-169. https://doi.org/10.22059/ijhs.2017.214449.1069

Ozkan, Y., Gercekcioglu, R., Polat, M. 1997. A study on the determination of fruit properties of medlar types (*Mespilus germanica* L.) from Tokat region. *Proceedings of National Pome Fruit Symposium*, p. 123-129. (In Turkish)

Perez-Sanchez, R., Gomez-Sanchez, M. A., Morales-Corts, R. 2008. Agromorphological characterization of traditional Spanish sweet cherry (*Prunus avium* L.), sour cherry (*Prunus cerasus* L.) and duke cherry (*Prunus gondouinii* Rehd.) cultivars. *Span. J. Agric. Res.*, vol. 6, no. 1, p. 42-55. https://doi.org/10.5424/sjar/2008061-293

Poljak, I., Vahčić, N., Gačić, M., Idžojtić, M. 2016. Morphological characterization and chemical composition of fruits of the traditional croatian chestnut variety 'Lovran Marron'. *Food Technol Biotechnol.*, vol. 54, no. 2, p. 189-199. https://doi.org/10.17113/ftb.54.02.16.4319

Pourmortazavia, S. M., Ghadirib, M., Hajimirsadegh, S. S. 2005. Supercritical fluid extraction of volatile components from *Bunium persicum* Boiss. (Black cumin) and *Mespilus germanica* L. (medlar) seeds. *J. Food Comp. Anal.*, vol. 18, no. 5, p. 439-446. https://doi.org/10.1016/j.jfca.2004.01.003

Rakonjac, V., Mratinic, E., Jovkovic, R., Akšic, M. F. 2014. Analysis of morphological variability in wild cherry (*Prunus avium* L.) genetic resources from central Serbia. *J. Agr. Sci. Tech.*, vol. 16, p. 151-162.

Rop, O., Sochor, J., Jurikova, T., Zitka, O., Skutkova, H., Mlcek, J., Salas, P., Krska, B., Babula, P., Adam, V., Kramarova, D., Beklova, M., Provaznik, I., Kizek, R. 2011. Effect of Five Different stages of ripening on chemical compounds in medlar (*Mespilus germanica* L.). *Molecules*, vol. 16, no. 1, p. 74-91. https://doi.org/10.3390/molecules16010074

Scorza, R. 1984. Characterization of four distinct peach tree growth types. *J. Am. Soc. Hort. Sci.*, vol. 109, p. 455-457.

Stehlíková, B. 1998. *Basics of biostatiscics (Biodiversity protection 51)*. Nitra, Slovakia : Slovak University of Agriculture in Nitra, 79 p. ISBN 80-7137-539-X.

Sulusoglu, M., Unver, H. 2016. Morphological and chemical properties of medlar (*Mespilus germanica* L.) fruits and changes in quality during ripening. *AGROFOR International Journal*, vol. 1, no. 2, p. 133-140. https://doi.org/10.7251/AGRENG1602133S

Vinogradova, Yu., Grygorieva, O., Vergun, O., Brindza, J. 2017. Morphological characteristics for fruits of *Aronia mitschurinii* A. K. Skvortsov & Maitul. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 754-760. https://doi.org/10.5219/845

Yilmaz, A., Gerçekcioğlu, R., Özatasever, Ö. 2016. Determination of pomological and chemical properties of some medlar (*Mespilus germanica* L.) genotypes. *Journal of New Results in Science*, vol. 5, no. 11, p. 118-124.

Zhang, Q., Yan, G., Dai, H., Zhang, X., Li, C., Zhang, Z. 2008. Characterization of tomentosa cherry (*Prunus tomentosa* Thunb.) genotypes using SSR markers and morphological traits. *Sci Hortic.*, vol. 118, no. 1, p. 39-47. https://doi.org/10.1016/j.scienta.2008.05.022

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