https://doi.org/10.31298/sl.149.3-4.1

Izvorni znanstveni članci – Original scientific papers
Šumarski list, 3–4 (2025): 115–126

MEDLAR (*Mespilus germanica* L.) FRUIT MORPHOLOGY DEPENDING ON FRUIT SIZE

MORFOLOGIJA PLODA MUŠMULE (*Mespilus germanica* L.) U OVISNOSTI O VELIČINI PLODA

Damir DRVODELIĆ[1], Ela ŠPANJOL[1], Marko VUKOVIĆ[2], Tomislav JEMRIĆ[2]*

SUMMARY

The present study aims to investigate the effects of fruit size of medlar (*Mespilus germanica* L.) on fruit and seed morphology. Medlar fruits were harvested from the crowns of ten trees near Đulovac, Croatia, in autumn 2022 and 2023 at commercial maturity. Before morphological analysis, the fruits were divided into three groups according to their weight: small (< 14g), medium-sized (14 – 17g) and large (> 17g). Fruit size, year and the interaction between the fruit size and year had a significant influence ($P < 0.01$) on fruit weight, fruit length, fruit width, geometric mean diameter, sphericity and fruit shape index. Fruit length and width showed a significant correlation with fruit weight in almost all cases, with the only exception of the medium-sized fruit in 2022 for fruit length. Fruit sphericity was positively correlated with fruit width and negatively correlated with fruit length and fruit shape index. The number of filled seeds per fruit correlated only slightly or not at all with fruit weight, fruit length, fruit width, fruit shape index and the geometric mean diameter of the fruit. The results of the discriminant analysis show that large fruits harvested in 2022 and 2023 can be clearly separated from other fruit categories, which can be attributed to effect of crop load on fruit morphology. It can be concluded that there is a high variability of medlar fruits even at a single location and thus that they have high breeding potential. Therefore, future studies analysing the entire area of the Republic of Croatia are needed.

KEY WORDS: medlar, fruit, seed, morphology, biodiversity, multivariate analysis

INTRODUCTION
UVOD

Medlar (*Mespilus germanica* L.) is one of the two species within the genus *Mespilus* in the Rosaceae family. It is native to south-west Asia and south-east Europe and grows wild in the Caucasus and Transcaucasus, in the southern Crimea, in the north-eastern part of Iran, in Asia Minor, on the Balkan Peninsula and in Greece. The greatest diversity of forms has been found in Azerbaijan, with some wild forms also occurring in Turkmenistan (Grygorieva et al., 2018; Voaides et al., 2021).

Another member of the genus *Mespilus* is *M. canescens* J.B. Phipps (Stern's medlar) and this species was discovered in North America in 1990 (Popović-Djordjević et al., 2023), where *M. germanica* was mainly an unknown fruit (Baird and Thieret, 1989).

Medlar fruits were widely used as food and for medicinal purposes in the past (Baird and Thieret, 1989; Nistor et al., 2024; Popović-Djordjević et al., 2023; Schaefer et al., 2015; Voaides et al., 2021). Archaeobotanical evidence for the use of medlar in mediaeval Spain dates from the 8th to the 12th century AD (Peña-Chocarro and Pérez-Jordà, 2023), but there are also reports of its use from 30 centuries ago (Popović-Djordjević et al., 2023). However, despite the existence of commercial cultivars (Barbieri et al., 2011; Cristofori et al., 2019), today medlar is only used to a limited

[1] Assoc. prof. Damir Drvodelić, PhD, Ela Španjol, Bacc., University of Zagreb, Faculty of Forestry and Wood Technology, Zagreb, Croatia
[2] Marko Vuković, PhD, Prof. Tomislav Jemrić, PhD, University of Zagreb, Faculty of Agriculture, Zagreb, Croatia
*Corresponding author: email: tjemric@agr.hr

extent (Baird and Thieret, 1989; Grygorieva et al., 2018), even in areas where the use of wild fruits has a long tradition (Ghanbari et al., 2022).

In Croatia, the medlar tree is part of the natural flora and its fruits are consumed in some areas (Vitasović Kosić, 2020), which is why it is also occasionally found in gardens (Šilić and Šolić, 2002; Turalija et al., 2017).

Due to its recognised nutritional and medicinal properties (Nistor et al., 2024; Popović-Djordjević et al., 2023; Voaides et al., 2021), this tree species has recently gained the attention of researchers. Although research into the biodiversity and breeding potential of medlar has already begun in many countries (Akbulut et al, 2016; Çakır et al, 2019; Cosmulescu et al, 2019; Khadivi et al, 2019; Ognjanov and Cerović, 2004; Sadeghinejad et al, 2022; Schaefer et al, 2015), there has been no such initiative in Croatia.

This tree is currently not important in forestry. However, its fruits ripen later than those of other forest fruit trees and can serve as an important food source for wildlife. Therefore, the medlar tree could have considerable potential for the conservation of biodiversity in forest ecosystems.

The aim of this preliminary study is to investigate the fruit morphology of medlar trees and to assess their potential for breeding and utilisation.

MATERIALS AND METHODS
MATERIJALI I METODE

Medlar fruits were harvested in autumn 2022 and 2023 from the crowns of ten trees near Đulovac, Croatia (45°40'N 17°26'E). The fruits were hand-picked at commercial ripeness (brownish skin, white flesh, hard fruit) and then quickly brought to the laboratory for further analysis. A total of 50 fruits were harvested from each tree (500 fruits per harvest year). From each harvest, 150 fruits were randomly selected by hand, which were then divided into three categories: small fruits, medium fruits and large fruits. The small fruit category included fruit weighing less than 14 g, the medium fruit category included fruit weighing between 14 and 17 g and the large fruit category included fruit weighing 17 g or more.

All analyses were carried out in the Institute of Ecology and Silviculture of the Faculty of Forestry and Wood Technology (Figures 1 and 2).

The following morphological parameters were measured on the fruits: fruit weight (g), fruit length (mm), and fruit width (mm). Fruit weight was measured using a digital analytical balance (Kern PLS 4200 -2F, Germany) with an accuracy of 0.01 g. The width (mm) and length (mm) of the fruit were measured with a digital diameter measuring device (Sylvac pro) with an accuracy of 0.01 mm. Two transverse lengths and widths were measured on each fruit.

Sphericity and geometric mean diameter were calculated using the equations given by Mohsenin (1986).

After manual extraction of seeds from each fruit, they were counted and dried at room temperature for several days. Then the individual weight of the seeds of each fruit was measured according to the above categories using a digital analytical balance (Radwag AS R1 PLUS Analytical Balances, Poland) with an accuracy of 0.1 mg.

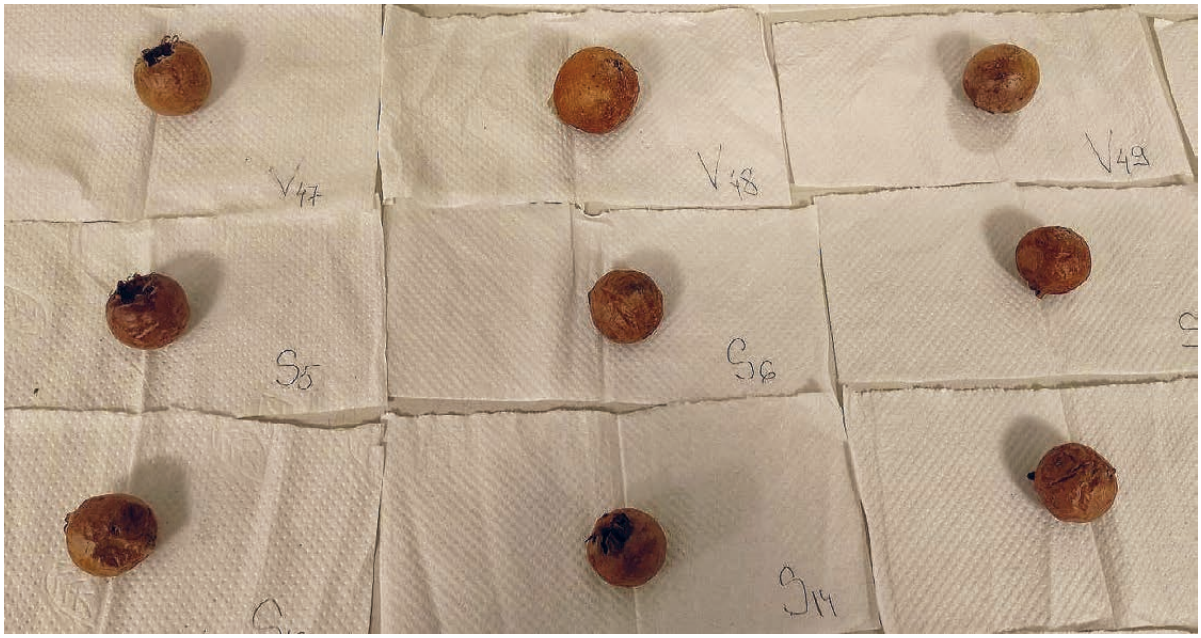

Figure 1. Medlar fruit used in the study
Slika 1. Plodovi mušmule korišteni u istraživanju

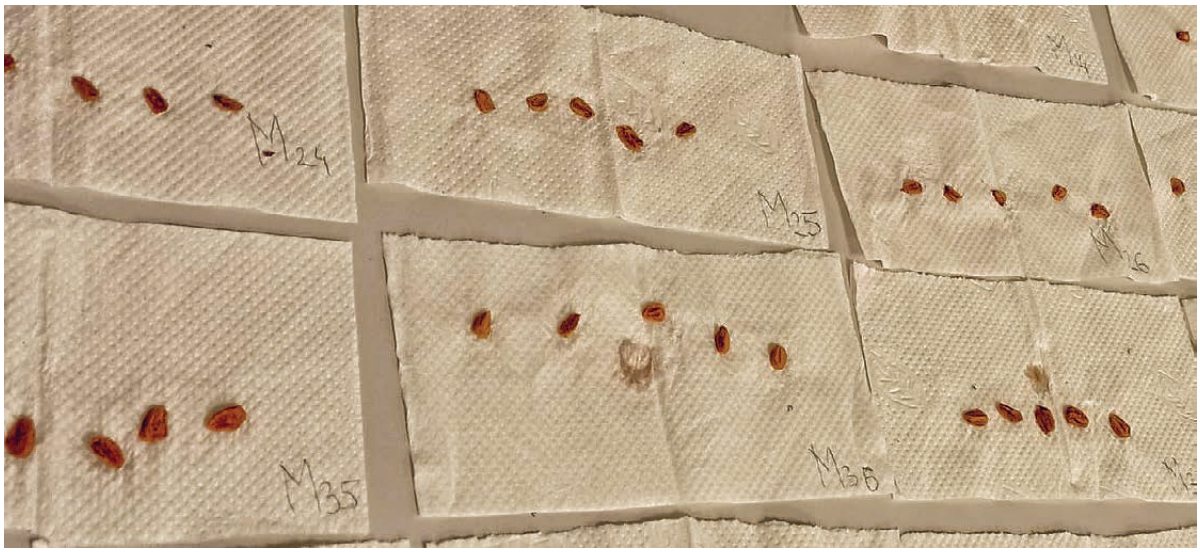

Figure 2. Medlar seeds extracted from individual fruit
Slika 2. Sjemenke mušmule izvađene iz pojedinačnih plodova

Data were statistically analysed with the XLSTAT add-on for Microsoft Office 2016 using ANOVA and Tukey's HSD test ($P < 0.05$). A Pearson's correlation analysis was also performed in the same software.

Canonical discriminant analysis (CDA) was performed using the XLSTAT add-on for Microsoft Office 2016. The quadratic method was used because the variances were not equal.

RESULTS
REZULTATI

The descriptive statistics (Table 1) showed that the fruits had different characteristics depending on the year. The crop load estimated on a scale of 1 to 5 was higher in 2022 (crop load score: 5) than in the harvest of 2023 (crop load score: 3) (data not shown). All traits, with the exception of the number of filled seeds per fruit, had a higher coefficient of variation in 2023. The minimum and maximum values were higher for all traits in 2023, with the exception of sphericity and the minimum values of one air-dried seed per fruit, which were higher in 2022 and the same in 2023. The minimum and maximum values for the number of filled seeds per fruit were the same in both years.

ANOVA showed that fruit size, year and the interaction between the fruit size and year had a significant effect ($P < 0.01$) on fruit weight, fruit length, fruit width, geometric mean diameter, sphericity and fruit shape index (data not shown). However, the interaction was not significant for the weight of air-dried seeds per fruit. No significant difference was found between fruit size, year and their interaction for the number of filled seeds per fruit. As the interaction was significant for most of the traits analysed, all subsequent ANOVA and Pearson's correlation analyses were performed separately for each year and fruit category (Tables 2-9).

In 2022, large fruits had significantly higher and small fruits had significantly lower values for fruit weight, fruit length, fruit width, geometric mean diameter, weight of air-dried seeds per fruit, the number of filled seeds per fruit, weight of air-dried seeds per fruit and weight of an air-dried seed per fruit (Table 2). The fruit shape index was significantly higher and sphericity significantly lower in small fruits than in medium and large fruits, between which there was no significant difference. In 2023, the same results were obtained (Table 3), except for sphericity, which was not significantly different between small and medium fruits, while there was no significant difference between large and medium fruits in 2022 (Table 2). There was also no significant difference in the number of filled seeds per fruit between the fruit categories in 2023, while a significant difference was found between the small and large fruit categories in 2022.

Pearson's correlation coefficients between the investigated traits showed a clear influence of the year and the fruit category (Tables 4-9). Some significant positive correlations between fruit size (fruit length, width and geometric mean diameter) and fruit weight, as well as between fruit length and width, are logical and expected, but this was not always the case. There was no significant correlation between fruit length and fruit width for medium sized fruits in 2022 and small and medium-sized fruits in 2023 (Tables 5, 7 and 8). Fruit shape index was positively correlated with fruit length and negatively correlated with fruit width, but there was no correlation with fruit weight. Fruit sphericity was positively

Table 1. Descriptive statistics of morphological and physiological characteristics of medlar fruits (*Mespilus germanica* L.) in 2022 and 2023
Tablica 1. Deskriptivna statistika morfoloških i fizioloških svojstava plodova mušmule (*Mespilus germanica* L.) u 2022. i 2023. godini

Characteristic *Svojstvo*	2022			2023		
	Min. *Min.*	Max. *Maks.*	Variation coeff. *Koef. varijac.*	Min. *Min.*	Max. *Maks.*	Variation coeff. *Koef. varijac.*
Fruit weight (g) / *Masa ploda (g)*	6.05	27.60	28.68	8.33	36.20	33.43
Fruit length (mm) / *Duljina ploda (mm)*	19.98	32.64	8.63	23.55	38.49	10.52
Fruit width (mm) / *Širina ploda (mm)*	22.26	36.69	10.02	23.21	41.26	12.58
Fruit shape index / *Indeks oblika ploda*	0.75	1.12	7.59	0.82	1.24	8.57
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*	21.74	34.66	8.98	24.93	40.22	11.26
Fruit sphericity / *Sferičnost ploda*	0.92	1.21	5.03	0.87	1.14	5.63
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*	3.00	6.00	8.34	3.00	6.00	7.47
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*	0.20	1.15	27.82	0.24	1.16	33.28
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*	0.06	0.23	25.94	0.05	0.23	32.10

correlated with fruit width and negatively correlated with fruit length and fruit shape index (Tables 4-9).

The number of filled seeds per fruit correlated only slightly or not at all with fruit weight, fruit length, fruit width, fruit shape index, geometric mean diameter and fruit sphericity. The correlation coefficient between the weight of air-dried seeds per fruit or the weight of a dried seed per fruit and fruit weight was not consistent. For small and large fruits in 2022 (Tables 4 and 6), the correlation was positive, but for medium-sized fruits this correlation was much lower or not significant (Table 5). In 2023, significant positive correlations were only found for large fruits (Table 9). Inconsistent correlations were found between seed weight and other traits, especially in small fruits in 2023 (Table 7), where no significant correlation was found with any of the analysed traits. For medium and large fruits, there were significant differences in the significance and values of the correlation coefficients (Tables 8 and 9).

CDA for selected fruit traits (fruit weight, fruit length, fruit width, fruit shape index, weight of air-dried seeds per fruit) showed that the first two canonical discriminant functions (F1 and F2) explained 96.84% of the total variability (Table 10, Figure 3). F1 explained 85.84% of the total variability and was strongly positively correlated with fruit weight,

Table 2. Morphological and physiological characteristics of small, medium and large fruits of the medlar tree (*Mespilus germanica* L.) (mean ± SD) in 2022
Tablica 2. Morfološka i fiziološka svojstva malih, srednje velikih i velikih plodova mušmule (*Mespilus germanica* L.) (srednja vrijednost ± SD) U 2022. godini

Characteristic *Svojstvo*	Small fruits *Mali plodovi*	Medium fruits *Srednji plodovi*	Large fruits *Veliki plodovi*	P
Fruit weight (g) / *Masa ploda (g)*	10.78 ± 2.05 c	15.52 ± 0.90 b	20.75 ± 2.39 a	<0.0001
Fruit length (mm) / *Duljina ploda (mm)*	25.97 ± 2.04 c	27.60 ± 1.45 b	29.93 ± 1.78 a	<0.0001
Fruit width (mm) / *Širina ploda (mm)*	27.30 ± 2.18 c	30.44 ± 1.23 b	33.53 ± 1.48 a	<0.0001
Fruit shape index / *Indeks oblika ploda*	0.95 ± 0.08 a	0.91 ± 0.08 b	0.89 ± 0.08 b	<0.0001
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*	26.81 ± 1.89 c	29.44 ± 0.89 b	32.27 ± 1.34 a	<0.0001
Fruit sphericity / *Sferičnost ploda*	1.03 ± 0.05 b	1.07 ± 0.05 a	1.08 ± 0.04 a	<0.0001
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*	4.78 ± 0.58 b	4.88 ± 0.33 ab	4.96 ± 0.20 a	<0.0001
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*	0.56 ± 0.18 c	0.74 ± 0.13 b	0.92 ± 0.13 a	<0.0001
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*	0.12 ± 0-03 c	0.15 ± 0.02 b	0.18 ± 0.02 a	<0.0001

Note: Values with the same letter are not significant according to the Tukey's HSD test at $P < 0.05$ level
Napomena: Vrijednosti označene istim slovom nisu statistički značajne prema Tukeyjevom HSD testu na razini $P < 0,05$

Table 3. Morphological and physiological characteristics of small, medium and large fruits of the medlar tree (*Mespilus germanica* L.) (mean ± SD) in 2023

Tablica 3. Morfološka i fiziološka svojstva malih, srednje velikih i velikih plodova mušmule (*Mespilus germanica* L.) (srednja vrijednost ± SD) u 2023. godini

Characteristic *Svojstvo*	Small fruits *Mali plodovi*	Medium fruits *Srednji plodovi*	Large fruits *Veliki plodovi*	P
Fruit weight (g) / *Masa ploda (g)*	12.05 ± 1.55 c	15.60 ± 0.94 b	24.55 ± 3.97 a	<0.0001
Fruit length (mm) / *Duljina ploda (mm)*	27.72 ± 2.05 c	30.87 ± 2.16 b	33.76 ± 2.10 a	<0.0001
Fruit width (mm) / *Širina ploda (mm)*	27.80 ± 1.45 c	30.68 ± 1.04 b	36.52 ± 2.18 a	<0.0001
Fruit shape index / *Indeks oblika ploda*	1.00 ± 0.08 a	1.01 ± 0.08 a	0.93 ± 0.06 b	<0.0001
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*	27.74 ± 1.30 c	30.72 ± 0.97 b	35.56 ± 1.88 a	<0.0001
Fruit sphericity / *Sferičnost ploda*	1.00 ± 0.06 b	1.00 ± 0.05 b	1.05 ± 0.04 a	<0.0001
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*	4.78 ± 0.84	4.96 ± 0.28	4.94 ± 0.31	0.531
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*	0.50 ± 0.17 c	0.68 ± 0.18 b	0.82 ± 0.19 a	<0.0001
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*	0.10 ± 0.03 c	0.14 ± 0.03 b	0.17 ± 0.04 a	<0.0001

Note: Values with the same letter are not significant according to the Tukey's HSD test at $P < 0.05$ level

Napomena: Vrijednosti označene istim slovom nisu statistički značajne prema Tukeyjevom HSD testu na razini $P < 0,05$

fruit length and fruit width and moderately correlated with air-dried seed weight per fruit. F2 explained 11.00% of the total variability and was moderately positively correlated with fruit shape index and slightly correlated with fruit length, while it was negatively correlated with air-dried seed weight. CDA clearly separated large fruit harvested in 2022 from large fruit harvested in 2023 (Figure 3) by both canonical functions. Large fruit harvested in 2022 generally had

Table 4. Correlation coefficients for the morphological and physiological characteristics of the small medlar fruits (*Mespilus germanica* L.) in 2022

Tablica 4. Korelacijski koeficijenti za morfološka i fiziološka svojstva malih plodova mušmule (*Mespilus germanica* L.) u 2022. godini

Variables *Varijable*	Fruit weight (g) *Masa ploda (g)*	Fruit length (mm) *Duljina ploda (mm)*	Fruit width (mm) *Širina ploda (mm)*	Fruit shape index *Indeks oblika ploda*	Geometric mean diameter of fruit (mm) *Geometrijski srednji promjer ploda (mm)*	Fruit sphericity *Sferičnost ploda*	Number of filled seeds (pcs) Broj punih sjemenki (kom)	Weight of air-dried seed per fruit (g) *Masa sjemena sušenog na zraku po plodu (g)*	Weight of 1 air-dried seed (g) *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	**0.570**	**0.827**	–0.276	**0.840**	0.263	**0.293**	**0.622**	**0.572**
Fruit length (mm) / *Duljina ploda (mm)*		1	**0.507**	**0.483**	**0.751**	**–0.486**	0.074	**0.285**	**0.298**
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.507**	**0.949**	**0.505**	0.227	**0.547**	**0.502**
Fruit shape index / *Indeks oblika ploda*				1	–0.213	**–0.997**	–0.150	–0.253	–0.197
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	0.209	0.205	**0.520**	**0.488**
Fruit sphericity / *Sferičnost ploda*						1	0.155	**0.255**	0.195
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	**0.417**	0.069
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.929**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$

Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 5. Correlation coefficients for the morphological and physiological characteristics of medium-sized medlar fruits (*Mespilus germanica* L.) in 2022
Tablica 5. Korelacijski koeficijenti za morfološka i fiziološka svojstva srednje velikih plodova mušmule (*Mespilus germanica* L.) u 2022. godini

Variables *Varijable*	**Fruit weight (g)** *Masa ploda (g)*	**Fruit length (mm)** *Duljina ploda (mm)*	**Fruit width (mm)** *Širina ploda (mm)*	**Fruit shape index** *Indeks oblika ploda*	**Geometric mean diameter of fruit (mm)** *Geometrijski srednji promjer ploda (mm)*	**Fruit sphericity** *Sferičnost ploda*	**Number of filled seeds (pcs)** Broj punih sjemenki (kom)	**Weight of air-dried seed per fruit (g)** *Masa sjemena sušenog na zraku po plodu (g)*	**Weight of 1 air-dried seed (g)** *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	0.185	**0.488**	–0.150	**0.551**	0.128	0.136	**0.298**	0.262
Fruit length (mm) / *Duljina ploda (mm)*		1	–0.140	**0.814**	**0.455**	**–0.824**	**–0.348**	–0.068	0.082
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.686**	**0.817**	**0.674**	0.049	**0.436**	**0.451**
Fruit shape index / *Indeks oblika ploda*				1	–0.145	**–0.997**	**–0.289**	**–0.309**	–0.206
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	0.126	–0.152	**0.357**	**0.454**
Fruit sphericity / *Sferičnost ploda*						1	0.278	**0.293**	0.194
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	**0.333**	–0.062
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.919**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$
Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 6. Correlation coefficients for the morphological and physiological characteristics of large medlar fruits (*Mespilus germanica* L.) in 2022
Tablica 6. Korelacijski koeficijenti za morfološka i fiziološka svojstva velikih plodova mušmule (*Mespilus germanica* L.) u 2022. godini

Variables *Varijable*	**Fruit weight (g)** *Masa ploda (g)*	**Fruit length (mm)** *Duljina ploda (mm)*	**Fruit width (mm)** *Širina ploda (mm)*	**Fruit shape index** *Indeks oblika ploda*	**Geometric mean diameter of fruit (mm)** *Geometrijski srednji promjer ploda (mm)*	**Fruit sphericity** *Sferičnost ploda*	**Number of filled seeds (pcs)** Broj punih sjemenki (kom)	Weight of air-dried seed per fruit (g) *Masa sjemena sušenog na zraku po plodu (g)*	**Weight of 1 air-dried seed (g)** *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	**0.527**	**0.792**	–0.066	**0.815**	0.047	0.064	**0.527**	**0.526**
Fruit length (mm) / *Duljina ploda (mm)*		1	**0.389**	**0.718**	**0.759**	**–0.733**	0.001	0.268	0.275
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.362**	**0.895**	**0.338**	–0.003	**0.568**	**0.590**
Fruit shape index / *Indeks oblika ploda*				1	0.091	**–0.997**	0.006	–0.162	–0.172
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	–0.116	–0.003	**0.532**	**0.552**
Fruit sphericity / *Sferičnost ploda*						1	–0.003	0.134	0.142
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	0.267	–0.022
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.957**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$
Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 7. Correlation coefficients for the morphological and physiological characteristics of the small medlar fruits (*Mespilus germanica* L.) in 2023
Tablica 7. Korelacijski koeficijenti za morfološka i fiziološka svojstva malih plodova mušmule (*Mespilus germanica* L.) u 2023. godini

Variables *Varijable*	**Fruit weight (g)** *Masa ploda (g)*	**Fruit length (mm)** *Duljina ploda (mm)*	**Fruit width (mm)** *Širina ploda (mm)*	**Fruit shape index** *Indeks oblika ploda*	**Geometric mean diameter of fruit (mm)** *Geometrijski srednji promjer ploda (mm)*	**Fruit sphericity** *Sferičnost ploda*	**Number of filled seeds (pcs)** Broj punih sjemenki (kom)	Weight of air-dried seed per fruit (g) *Masa sjemena sušenog na zraku po plodu (g)*	**Weight of 1 air-dried seed (g)** *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	**0.473**	**0.785**	–0.095	**0.840**	0.063	0.253	0.265	0.211
Fruit length (mm) / *Duljina ploda (mm)*		1	0.192	**0.757**	**0.675**	**–0.785**	0.051	0.197	0.179
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.493**	**0.854**	**0.454**	**0.413**	0.048	–0.058
Fruit shape index / *Indeks oblika ploda*				1	0.030	**–0.996**	–0.226	0.138	0.192
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	–0.075	**0.333**	0.136	0.049
Fruit sphericity / *Sferičnost ploda*						1	0.222	–0.126	–0.180
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	0.200	–0.099
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.953**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$
Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 8. Correlation coefficients for the morphological and physiological characteristics of medium-sized medlar fruits (*Mespilus germanica* L.) in 2023
Tablica 8. Korelacijski koeficijenti za morfološka i fiziološka svojstva srednje velikih plodova mušmule (*Mespilus germanica* L.) u 2023. godini

Variables *Varijable*	**Fruit weight (g)** *Masa ploda (g)*	**Fruit length (mm)** *Duljina ploda (mm)*	**Fruit width (mm)** *Širina ploda (mm)*	**Fruit shape index** *Indeks oblika ploda*	**Geometric mean diameter of fruit (mm)** *Geometrijski srednji promjer ploda (mm)*	**Fruit sphericity** *Sferičnost ploda*	**Number of filled seeds (pcs)** Broj punih sjemenki (kom)	Weight of air-dried seed per fruit (g) *Masa sjemena sušenog na zraku po plodu (g)*	**Weight of 1 air-dried seed (g)** *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	**0.341**	**0.720**	–0.014	**0.769**	0.000	0.254	**0.284**	0.252
Fruit length (mm) / *Duljina ploda (mm)*		1	–0.060	**0.900**	**0.700**	**–0.903**	0.079	**0.323**	**0.309**
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.487**	**0.671**	**0.476**	0.079	0.119	0.111
Fruit shape index / *Indeks oblika ploda*				1	**0.320**	**–0.996**	0.037	0.229	0.221
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	**–0.332**	0.118	**0.331**	**0.315**
Fruit sphericity / *Sferičnost ploda*						1	–0.045	–0.246	–0.238
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	**0.327**	0.180
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.988**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$
Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 9. Correlation coefficients for the morphological and physiological characteristics of large fruits of the medlar tree (*Mespilus germanica* L.) in 2023
Tablica 9. Korelacijski koeficijenti za morfološka i fiziološka svojstva velikih plodova mušmule (*Mespilus germanica* L.) u 2023. godini

Variables *Varijable*	**Fruit weight (g)** *Masa ploda (g)*	**Fruit length (mm)** *Duljina ploda (mm)*	**Fruit width (mm)** *Širina ploda (mm)*	**Fruit shape index** *Indeks oblika ploda*	**Geometric mean diameter of fruit (mm)** *Geometrijski srednji promjer ploda (mm)*	**Fruit sphericity** *Sferičnost ploda*	**Number of filled seeds (pcs)** Broj punih sjemenki (kom)	Weight of air-dried seed per fruit (g) *Masa sjemena sušenog na zraku po plodu (g)*	**Weight of 1 air-dried seed (g)** *Masa 1 sjemenke sušene na zraku*
Fruit weight (g) / *Masa ploda (g)*	1	**0.598**	**0.911**	–0.277	**0.925**	0.269	0.153	**0.677**	**0.654**
Fruit length (mm) / *Duljina ploda (mm)*		1	**0.458**	**0.542**	**0.739**	**–0.551**	0.218	**0.309**	0.259
Fruit width (mm) / *Širina ploda (mm)*			1	**–0.497**	**0.938**	**0.488**	0.156	**0.635**	**0.608**
Fruit shape index / *Indeks oblika ploda*				1	–0.165	**–0.999**	0.056	**–0.289**	**–0.308**
Geometric mean diameter of fruit (mm) / *Geometrijski srednji promjer ploda (mm)*					1	0.154	0.206	**0.602**	**0.561**
Fruit sphericity / *Sferičnost ploda*						1	–0.072	**0.286**	**0.310**
Number of filled seeds (pcs) / *Broj punih sjemenki (kom)*							1	0.269	–0.007
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*								1	**0.961**
Weight of 1 air-dried seed (g) / *Masa 1 sjemenke sušene na zraku (g)*									1

Note: All bold values present significant correlations at $P < 0.05$
Napomena: Sve podebljane vrijednosti su statistički značajne na razini $P < 0,05$

Table 10. CDA variables / factor correlations and standardised coefficients of the canonical discriminant function for the morphological and physiological traits of medlar fruit (*Mespilus germanica* L.) (2022-2023)
Tablica 10. CDA varijabla / faktor korelacije i standardizirani kanonički koeficijenti diskriminantne funkcije za morfološka i fiziološka svojstva plodova mušmule (*Mespilus germanica* L.) u 2022. i 2023. godini

	Variables / Factors correlations *Varijabla / faktor korelacija*		**Standardized canonical discriminant function coefficients** *Standardizirani kanonički koeficijenti diskriminantne funkcije*	
Variables *Varijable*	F1	F2	F1	F2
Fruit weight (g) / *Masa ploda (g)*	0.991	–0.115	0.739	–0.746
Fruit length (mm) / *Duljina ploda (mm)*	0.800	0.481	–0.201	0.588
Fruit width (mm) / *Širina ploda (mm)*	0.969	–0.066	0.603	0.755
Fruit shape index / *Indeks oblika ploda*	–0.281	0.698	0.386	0.430
Weight of air-dried seed per fruit (g) / *Masa sjemena sušenog na zraku po plodu (g)*	0.602	–0.484	–0.212	–0.573
Eigenvalue / *Svojstvena vrijednost*	5.199	0.663		
Variability (%) / *Varijabilnost (%)*	85.84	11.00		
Cumulative % / *Kumulativno (%)*	85.84	96.84		

lower values for F1 and F2, while large fruit harvested in 2023 generally had higher values for F1 and F2. The standardised coefficients for F1 were highly positive for fruit weight and moderately positive for fruit width, while they were slightly negative for fruit length and air-dried seed weight per fruit. The standardised coefficients for F2 were strongly negative for fruit weight and moderately negative for air-dried seed weight, while they were strongly positive for fruit width and moderately positive for fruit length and low for fruit shape index.

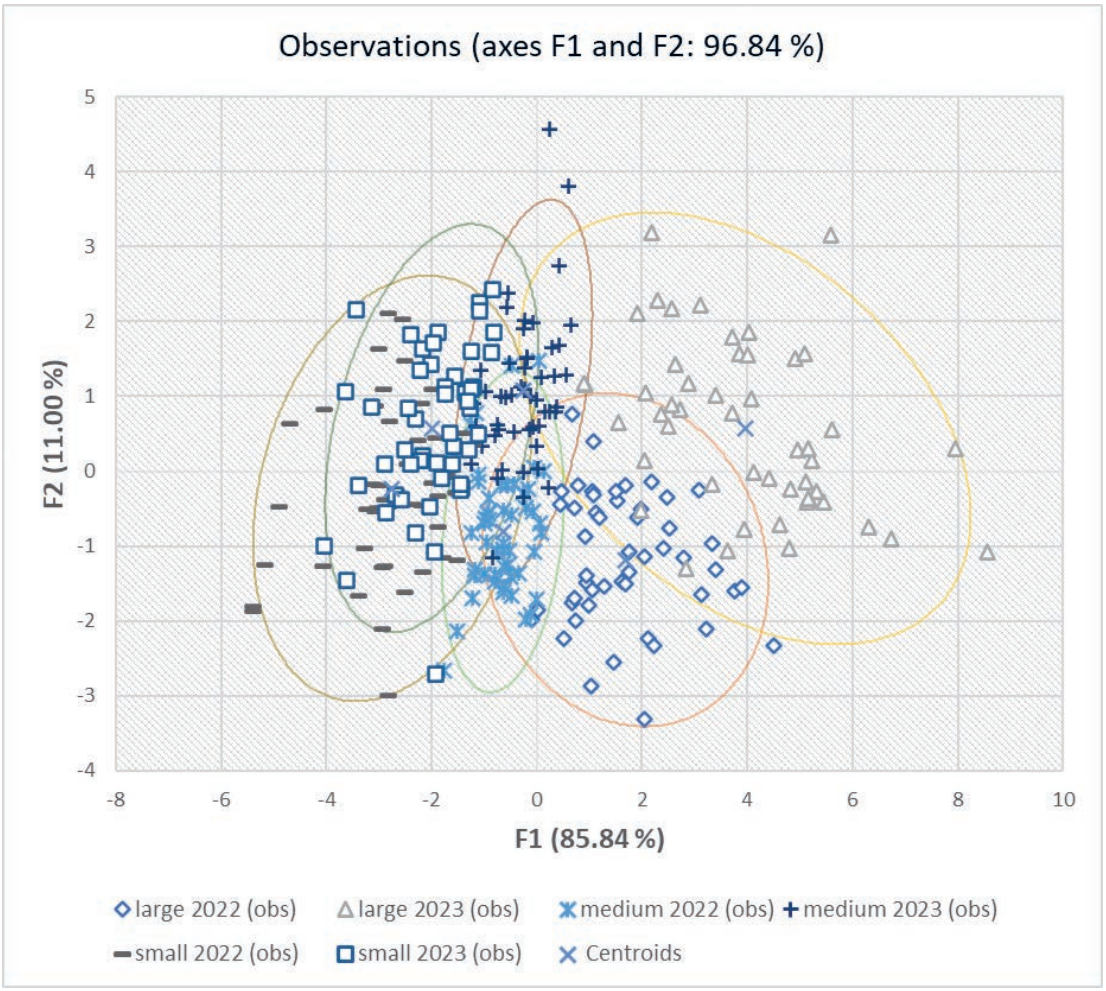

Figure 3. Discriminant analysis of medlar fruits (*Mespilus germanica* L.) in relation to fruit size (combined data 2022-2023)
Slika 3. Diskriminantna analiza plodova mušmule (*Mespilus germanica* L.) u odnosu na veličinu (kombinirani podaci za 2022. i 2023. godinu)
(Legenda: small 2022 – mali plodovi (2022. godina); medium 2022 – srednje veliki plodovi (2022. godina); large 2022 – veliki plodovi (2022. godina); small 2023 – mali plodovi (2023. godina); medium 2023 – srednje veliki plodovi (2023. godina); large 2023 – veliki plodovi (2023. godina))

DISCUSSION
RASPRAVA

Fruit weight in this study ranged from 6.05 g in 2022 to 36.20 g in 2023, with a coefficient of variation of 28.68 and 33.43% (Table 1). These values are within the range reported for wild medlar genotypes in Ukraine (Grygorieva et al., 2018), where fruit weight ranged from 5.70 to 52.4 g, but with a much higher coefficient of variation (47.56%). The mean fruit weight of medlar varieties in Italy ranged from 21.0 to 61.6 g (Barbieri et al., 2011) and from 21.40 to 25.50 g in Montenegro (Šebek et al., 2019), which is higher than the mean fruit weight for 2022 and 2023 in this study (16.55 g). The values in this study are also lower than the mean values for wild medlar genotypes (24.14 g) in Ukraine (Grygorieva et al., 2018). In Romania, even greater variability in fruit weight of wild medlar genotypes (3.15 to 36.68 g) was reported (Cosmulescu et al., 2019). In Iran, the fruit weight of 10 fruits was reported to range from 15.0 to 55.7 g (Khadivi et al., 2019), with a similar coefficient of variation as in this study (27.50%). In Türkiye, the fruit weight of wild genotypes ranged between 12.3 and 23.6 g (Akbulut et al., 2016), which is closer to the values of this study. The coefficients of variation as well as the minimum and maximum values of fruit weight (Table 1) show that the fruits differed between the studied years. This is in contrast to studies from Türkiye (Yilmaz et al., 2016), where a significant variation in fruit weight was found between medlar genotypes, but without a significant difference between years.

Fruit length in this study ranged from 19.98 mm in 2022 to 38.49 mm in 2023, with a coefficient of variation of 8.63% and 10.52%. These values are lower than those reported for wild medlar genotypes in Ukraine (Grygorieva et al., 2018), where fruit length ranged from 23.54 to 46.53 mm, with a coefficient of variation of 15.46%. The mean fruit length of medlar varieties in Italy ranged from 34.9 to 44.0 mm (Barbieri et al., 2011) and from 34.50 to 38.40 mm in Montenegro (Šebek et al., 2019), which is higher than the mean fruit length for 2022 and 2023 in this study (29.31 mm). The va-

lues in this study are also lower than the mean values for wild medlar genotypes (34.30 mm) in Ukraine (Grygorieva et al., 2018). The coefficients of variation and the minimum and maximum values of fruit width (Table 1) show that the fruits were similar between the years studied, which is consistent with studies from Türkiye (Yilmaz et al., 2016), where no significant differences were found between years. In Iran, lower values for fruit width (14.91 to 23.68 mm) were reported (Khadivi et al., 2019), but the coefficient of variation was similar to the values obtained in this study (10.55%).

Fruit width in this study ranged from 22.26 mm in 2022 to 41.26 mm in 2023, with a coefficient of variation of 10.02% and 12.58%, respectively. These values are within the values reported for wild medlar genotypes in Ukraine (Grygorieva et al., 2018), where fruit weight ranged from 20.26 to 51.17 mm, with a much higher coefficient of variability (21.02%). Similar values (18.43 and 44.15 mm) were reported for wild genotypes in Romania (Cosmulescu et al., 2019). The coefficients of variation and the minimum and maximum values of fruit width (Table 1) show that the fruits were similar in the years studied, which is consistent with studies from Türkiye (Yilmaz et al., 2016), which found no significant differences between the years. The mean fruit width of medlar varieties in Italy was between 35.3 and 52.7 mm (Barbieri et al., 2011) and between 31.50 and 36.20 mm in Montenegro (Šebek et al., 2019), which is higher or similar to the mean fruit length for 2022 and 2023 in this study (31.05 mm). The mean values determined in this study are also lower than those for wild medlar genotypes (35.11 mm) in Ukraine (Grygorieva et al., 2018). Lower values for fruit width (14.21 to 23.46 mm) were reported in Iran (Khadivi et al., 2019), but the coefficient of variation was similar to the values obtained in this study (11.18%).

The fruit shape index in this study ranged from 0.75 in 2022 to 1.24 in 2023, with a coefficient of variation of 7.59% and 8.57%, respectively. These values are within the values reported for wild medlar genotypes in Ukraine (Grygorieva et al., 2018), where the fruit shape index ranged from 0.65 to 1.67, with a much higher coefficient of variation (18.09%). The mean fruit shape index of medlar cultivars in Italy ranged from 0.70 to 1.10 (Barbieri et al., 2011), which is higher than the mean shape index for 2022 and 2023 in this study (0.95). In Türkiye, the fruit shape index of wild genotypes ranged from 0.87 to 1.02 (Akbulut et al., 2016), which is closer to the values in this study.

Shape is an important characteristic for consumer acceptance in many fruits, such as apples (Dan et al., 2015), and elongated fruits, such as those in this study (Figure 1, Table 2), are generally less accepted. Since the fruits were harvested from only one location, it is possible that a higher degree of variation is achieved when the fruits are from different locations, as has been found in other studies for fruit shape and other fruit characteristics (Grygorieva et al., 2018; Khadivi et al., 2019; Yilmaz et al., 2016).

The geometric mean diameter ranged from 21.74 mm in 2022 to 40.22 mm in 2023, with a coefficient of variation of 8.98% and 11.26%. No data on this trait were found in the available literature, but in some other wild fruits, such as dog rose, the geometric mean diameter differed significantly between years (Tomljenović et al., 2021), which is consistent with this study.

Fruit sphericity ranged from 0.87 in 2023 to 1.21 in 2022, with a coefficient of variation of 5.63% and 5.03%, respectively. This trait was the most stable of all traits analysed. No data on this trait was found in the available literature, but in some other wild fruits this trait did not differ between years (Tomljenović et al., 2021), which is not consistent with this study. This could be the result of genetic and climatic factors.

The range of the number of filled seeds per fruit was the same in both years studied (3 to 6 filled seeds per fruit), with a coefficient of variation of 8.34% in 2022 and 7.47% in 2023 (Table 1). In contrast, there were significant variations in the weight of air-dried seeds per fruit and in the weight of one air-dried seed per fruit (coefficients of variation of more than 20%).

The differences observed between fruit categories are logical and expected for fruit size traits. The effect of fruit category on fruit dimensions and shape index (Tables 2 and 3) is generally consistent with the results obtained in similar studies on service tree (Drvodelić et al., 2018) and wild apple (Drvodelić et al., 2015).

However, the number of filled seeds was not associated with the fruit category. Larger fruit of other wild fruits, such as wild apple, have more filled seeds per fruit (Drvodelić et al., 2015). In this study, however, this was only true for large fruits compared to the small ones in 2022, while in 2023 the differences between all three categories were not significant (Tables 2 and 3).

Regarding correlation analysis, it is interesting to observe lack of consistency between the studied years or fruit size categories. For example, in 2022 in small medlar fruit, weight of air-dried seed per fruit and weight of 1 air-dried seed was significantly correlated with fruit weight, length and width. However, no significant correlations regarding the aforementioned traits were reported in 2023. In 2023, weight of air-dried seed per fruit was significantly correlated with fruit weight, length and width of big medlar fruits, while no correlation was reported in small medlar fruits, and for medium medlar fruits the correlation was reported only with fruit weight and length. The same applies to the correlations between the number of filled seeds per fruit

and fruit size, which were inconsistent within fruit categories and years (Tables 4-9). Such differences between the studied years can possibly be explained by the effect of crop load, since it was much higher in the first year of the study, as well as to differences in ecological conditions. Drvodelić et al. (2015) reported significant correlation between the number of filled seeds per fruit and fruit weight in all three wild apple fruit size groups. Since such findings were not reported in this study for medlar fruit it can be concluded that effect of fruit size on the number of filled seeds is probably primarily genetically influenced. Since there is scarcity of available literature regarding the correlation between fruit and seed morphology within defined fruit size groups of medlar trees, these results can not be compared to other ones, which indicates the importance of this study.

Large fruit in 2022 and 2023 can be distinguished according to the DCA results (Figure 3), which is due to differences in crop load. Large fruits in 2022 were smaller than large fruits in 2023, although they had a similar number of seeds per fruit and a similar weight of air-dried seeds per fruit. The crop load in 2022 was higher than the crop load in 2023. The differences in crop load have a significant effect on the growth, size and weight of fruit trees (Ceccarelli et al, 2016; Crisosto et al, 1997; Radivojević et al, 2014; Salvador et al, 2006; Schupp, 1995; Wünsche et al, 2005) and this was the main reason for the differences in fruit size observed in this study.

CONCLUSIONS
ZAKLJUČCI

This is a preliminary study of the variability of medlar fruit in Croatia. It suggests that even at a single location there is a high variability of fruits and thus a high breeding potential. However, more detailed studies should be conducted to analyse the entire territory of the Republic of Croatia in order to fully evaluate the breeding potential of this species. In addition to morphological characteristics, the chemical composition of the fruit should also be analysed. Other uses (landscaping, increasing and maintaining biodiversity in forest habitats, etc.) should be investigated as well.

REFERENCES
LITERATURA

- Akbulut, M., S. Ercisli, T. Jurikova, J. Mlcek, S. Gozlekci, 2016: Phenotypic and Bioactive Diversity on Medlar Fruits (Mespilus germanica L.), Erwerbs-Obstbau, 58: 185–191. https://doi.org/10.1007/s10341-016-0272-z
- Baird, J.R., J.W. Thieret, 1989: The medlar (Mespilus germanica, Rosaceae) from antiquity to obscurity, Econ. Bot., 43: 328–372. https://doi.org/10.1007/BF02858732
- Barbieri, C., C. Bignami, V. Cristofori, M. Paolocci, G. Bertazza, 2011: Characterization and exploitation of minor pome fruits in Italy, Acta Hortic, 918: 953–959. https://doi.org/10.17660/ActaHortic.2011.918.125
- Çakır, E., A. Öztürk, B. Öztürk, 2019: Antioxidant Properties of Promising Medlar Genotypes Grown in Tekkeköy District of Samsun Province Ozturk Burhan Ordu Üniversitesi, In: A. Şekeroğlu, H. Eleroğlu, M. Duman (Eds.), 1st International Congress of the Turkish Journal of Agriculture - Food Science and Technology. Antalya, Turkey, pp. 39–44.
- Ceccarelli, A., G. Costa, D. Stefanelli, J. Lopresti, B. Tomkins, 2016: Influence of crop load and canopy position on fruit maturity and quality in nectarine, Acta Hortic, 1119: 235–242. https://doi.org/10.17660/ActaHortic.2016.1119.33
- Cosmulescu, S., F. Scrieciu, O. Iordanescu, M. Manda, 2019: Some pomological characteristics of medlar (Mespilus germanica L.) genotypes, Acta Hortic, 1259: 43–46. https://doi.org/10.17660/ActaHortic.2019.1259.8
- Crisosto, C.H., R.S. Johnson, T. DeJong, K.R. Day, 1997: Orchard factors affecting postharvest stone fruit quality, HortScience, 32(5): 820-823.
- Cristofori, V., C. Silvestri, A.L. Pica, G. Bertazza, C. Bignami, 2019: Evaluation of four medlar cultivars: agronomical, pomological and qualitative traits, Eur. J. Hortic. Sci., 84: 350–358. https://doi.org/10.17660/eJHS.2019/84.6.4
- Dan, C., C. Şerban, A.F. Sestras, M. Militaru, P. Morariu, R.E. Sestras, 2015: Consumer Perception Concerning Apple Fruit Quality, Depending on Cultivars and Hedonic Scale of Evaluation - a Case Study, Not. Sci. Biol., 7: 140–149. https://doi.org/10.15835/nsb.7.1.9553
- Drvodelić, D., T. Jemrić, M. Oršanić, V. Paulić, 2015: Fruits size of wild apple (Malus sylvestris (L.) Mill.): Impact on morphological and physiological properties of seeds, Sumar. List, 139: 145–153.
- Drvodelić, D., M. Oršanić, M. Vuković, M.A. Jatoi, T. Jemrić, 2018: Correlation of fruit size with morphophysiological properties and germination rate of the seeds of service tree (Sorbus domestica L .), South-east Eur. For., 9: 47–54. https://doi.org/10.15177/seefor.18-01
- Ghanbari, S., G. Weiss, J. Liu, I. Eastin, O. Fathizadeh, G. Moradi, 2022: Potentials and Opportunities of Wild Edible Forest Fruits for Rural Household's Economy in Arasbaran, Iran, Forests, 13: 453. https://doi.org/10.3390/f13030453
- Grygorieva, O., S. Klymenko, Y. Vinogradova, O. Vergun, J. Brindza, 2018: Variation in morphometric traits of fruits of Mespilus germanica L., Potravin. Slovak J. Food Sci., 12: 782–788. https://doi.org/10.5219/999
- Khadivi, A., M. Rezaei, P. Heidari, A. Safari-Khuzani, M. Sahebi, 2019: Morphological and fruit characterizations of common medlar (*Mespilus germanica* L.) germplasm, Sci. Hortic, 252: 38–47. https://doi.org/10.1016/j.scienta.2019.03.014
- Mohsenin, N.N., 1986: Physical Properties of Plant and Animal Materials, Second Rev. ed. Gordon and Breach, Science Publishers Inc., New York, London, Paris, Montreux, Tokyo.
- Nistor, D.I., R.A. Marc, C.C. Mureşan, 2024: Phytochemistry, nutritional composition, health benefits and future prospects of Mespilus germanica L. (Medlar): A review, Food Chem. X, 22: 101334. https://doi.org/10.1016/j.fochx.2024.101334
- Ognjanov, V., S. Cerović, 2004: Selection and utilization of minor fruit tree speciaes, Acta Hortic, 663: 569–574. https://doi.org/10.17660/ActaHortic.2004.663.99

- Peña-Chocarro, L., G. Pérez-Jordà, 2023: Plants from distant places: the 1st millennium ce archaeobotanical record from Iberia, Veg. Hist. Archaeobot. https://doi.org/10.1007/s00334-023-00971-9
- Popović-Djordjević, J., A. Kostić, S. Kamiloglu, M. Tomas, N. Mićanović, E. Capanoglu, 2023: Chemical composition, nutritional and health related properties of the medlar (Mespilus germanica L.): from medieval glory to underutilized fruit, Phytochem. Rev., 22: 1663–1690. https://doi.org/10.1007/s11101-023-09883-y
- Radivojević, D.D., J.M. Milivojević, Č.D.J. Oparnica, T.B. Vulić, B.S. Djordjević, S. Ercişli, 2014: Impact of early cropping on vegetative development, Productivity, and fruit quality of gala and braeburn apple trees, Turkish J. Agric. For., 38: 773–780. https://doi.org/10.3906/tar-1403-83
- Sadeghinejad, Z., J. Erfani-Moghadam, A. Khadivi, 2022: Bioactive content and phenolic compounds of common medlar (Mespilus germanica L.) and Stern's medlar (M. canescens Phipps), Food Sci. Nutr., 10: 1988–1993. https://doi.org/10.1002/fsn3.2814
- Salvador, F.R. De, M. Fisichella, M. Fontanari, 2006: Correlations between fruit size and fruit quality in apple trees with high and standard crop load levels, J. Fruit Ornam. Plant Res., 14: 113–122.
- Schaefer, K., A. Nyberg, J. Postman, N. Bassil, 2015: Genetic Diversity of Medlar (Mespilus germanica) Germplasm Using Microsatellite Markers,Acta Hortic., 1094: 47–56. https://doi.org/10.17660/ActaHortic.2015.1094.3
- Schupp, J.R., 1995: Growth and performance of four apple cultivars on M.26 and Mark rootstocks, with or without pre-plant mineral nutrients, Fruit Var. J., 49: 198–204.
- Šebek, G., V. Pavlova, T. Popović, 2019: Biochemical and pomological characteristics of fruit of some commercial medlar cultivars (Mespilus germanica L) grown in Bijelo Polje, Food Environ. Saf. Journal, 18: 97–104.
- Šilić, Č., M.E. Šolić, 2002: Addition to the vascular flora in the region of Biokovo (Dalmatia, Croatia), Nat. Croat, 11: 341–363.
- Tomljenović, N., T. Jemrić, M. Vuković, 2021: Variability in pomological traits of dog rose (Rosa canina L .) under the ecological conditions of the Republic of Croatia, Acta Agric. Serbica, 26: 41–47. https://doi.org/10.5937/AASer2151041T
- Turalija, A., A. Perkovic, J. Vizentaner, J. Avdic, V. Jukic, D. Horvat, 2017: A Fruit Tree as an Identification Element of Ornamental Gardens Shaping in Croatia- Istria Ornamental Gardens Case, Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca. Hortic., 74(1): 50-60. https://doi.org/10.15835/buasvmcn-hort:12369
- Vitasović Kosić, I., 2020: Samonikle tradicionalno korištene voćne svojte u mediteranskom dijelu Hrvatske, In: T. Jemrić (Ed.), Proceedings of the Academy of Agricultural Sciencies Vol. 2. Academy of Agricultural Sciencies, pp. 3–12.
- Voaides, C., N. Radu, E. Birza, N. Babeanu, 2021: Medlar—A Comprehensive and Integrative Review, Plants, 10, 2344. https://doi.org/10.3390/plants10112344
- Wünsche, J.N., D.H. Greer, W.A. Laing, J.W. Palmer, 2005: Physiological and biochemical leaf and tree responses to crop load in apple, Tree Physiol, 25: 1253–1263. https://doi.org/10.1093/treephys/25.10.1253
- Yilmaz, A., R. Gerçekcioglu, Ö.Ö. Atasever, 2016: Determination of pomological and chemical properties of some Medlar (Mespilus germanica L.) genotypes, J. New Res. Sci., 11: 118–124.

SAŽETAK

Cilj istraživanja jest utvrditi utjecaj veličine ploda mušmule (*Mespilus germanica* L.) na morfološka svojstva ploda i sjemena. Plodovi mušmule ručno su ubrani u jesen 2022. i 2023. godine u komercijalnoj zrelosti s krošnja deset stabala u području pokraj Đulovca, Hrvatska. Navedeni plodovi podijeljeni su u tri grupe prema njihovoj masi (mali (< 14 g), srednji (14 – 17 g) i veliki (> 17 g)). Zabilježen je značajan utjecaj ($P < 0,01$) veličine ploda, godine te interakcije veličine ploda i godine na masu ploda, duljinu ploda, širinu ploda, geometrijski promjer ploda, sferičnost i indeks oblika ploda. Duljina i širina ploda imala je značajnu korelaciju s masom ploda u skoro svim slučajevima, s jedinom iznimkom kod srednje velikih plodova u 2022. godini za duljinu ploda. Sferičnost ploda bila je pozi-tivno korelirana sa širinom ploda i negativno s duljinom ploda i indeksom oblika ploda. Broj punih sjemenki po plodu bio je samo blago koreliran ili nekoreliran s masom ploda, duljinom ploda, širinom ploda, indeksom oblika ploda i geometrijskim promjerom ploda. Veliki plodovi se u 2022. i 2023. godini mogu jasno razdvojiti od ostalih kategorija plodova pomoću diskriminantne analize, što je posljedica utjecaja prirode na morfologiju ploda. Može se zaključiti da je čak i na istoj lokaciji prisutna velika varijabilnost ploda mušmule te sukladno navedenome postoji veliki oplemenjivački potencijal. Stoga su potrebna daljnja istraživanja koja će obuhvatiti cijeli teritorije Republike Hrvatske.

KLJUČNE RIJEČI: mušmula, plod, sjeme, morfologija, bioraznolikost, multivarijatna analiza