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MORPHOLOGICAL AND CHEMICAL PROPERTIES OF MEDLAR (*MESPILUS GERMANICA* L.) FRUITS AND CHANGES IN QUALITY DURING RIPENING

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ABSTRACT

Medlar has acquired increasing popularity in recent years for its edible fruits and some healing properties in modern medicine. Medlar fruits are often stored under non-cold conditions in straw. This study was conducted to determine morphological and biochemical characteristics of medlar fruits and changes in fruit quality occurring under ordinary storage conditions. For this purpose, eight types of medlar trees were evaluated. The trees were at a mature stage and productive. Morphological properties such as the fruit and seed weight (g), length, and width (mm) were measured after the harvest. Fruit soluble solid content (%) and pH values were determined at physiological maturity after harvesting, and the fruit soluble solid content was measured again at ripening (edible stage), after 25 days of storage under ordinary storage conditions (mean temperature of 10 °C and mean humidity of 65–70%). Leaf characteristics were also determined. The tree productivity was very different between the types, and it was determined to range from 5.9 and 17.8 kg. The fruit weight varied from 9.69 to 24.45 g, while the water content decreased nearly to the half of the harvest values in some genotypes. The soluble solid content changed depending on the water losses and increased during the ripening period. The seed numbers ranged from 1.7 to 4.7 among the types, and the seed weight varied from 0.12 to 0.45 g. The fruits were able to reach ripening maturity in three weeks under the ordinary storage conditions depending on the type. Thus, this method of storage is practical for the medlar producer, but the results clearly showed that the storage period was too short and that the fruit quality was negatively affected. Cold storage conditions are needed to ensure quality and a long selling time.

Keywords: *medlar, fruit characteristics, storage, ripening.*

INTRODUCTION

The medlar (*Mespilus germanica* L.) is a deciduous species belonging to the family Rosaceae and native to Southeastern Europe, Anatolia, and Caucasia. Medlar trees produce brown, sometimes reddish-tinged, pear- and apple-shaped fruits (Selcuk and Erkan, 2015). The fruits are astringent and hard at harvesting time but become sweet and reasonably pleasant when fully ripe, with a white flesh surrounding a few small stones inside. The fruits are eaten fresh, and rich in potassium (Glew *et al.*, 2003a) and amino acids (Glew *et al.*, 2003b). The fruits of medlar are used as a nutritional material by local customers and are consumed as marmalade and jellies (Baytop, 1999). It is a very healthy fruit, with phytochemicals including antioxidants (Ayaz *et al.*, 2008; Selcuk and Erkan, 2015). Medlar fruits are used as a treatment for constipation, as a diuretic, and for kidney and bladder stones (Baird and Thieret, 1989). The medlar shows better pest and climate resistance than most other fruit species of landscaping importance.

Recently, more attention has been paid to morphological and biochemical properties of different types of medlar. Some researchers have investigated the distribution of medlar (Yılmaz and Gerçekcioğlu, 2013), phenological stages (Atay, 2013), and pollen characteristics (Cavusoglu and Sulusoglu, 2013). The fruit is a typical climacteric fruit, which becomes brown, soft, sweet, and edible after and during storage (Dirr, 1990). The fruits are harvested during October and November, and ripening occurs later under storage conditions. The fruits are stored in a dry cool place until they are over-ripe. The green and hard flesh of the fruit softens and changes its color to light brown. This process is called overripening, and after that, the fruit becomes suitable for consumption. The pulp then has a distinctive, slightly sour flavor and can be consumed directly (Baird and Thieret, 1989).

Changes in sugars, organic acids, and fatty acids of consumed medlar have been reported during the post-harvest period (Glew *et al.*, 2003). In previous studies, mechanical properties and the chemical composition of medlar were described during maturation and ripening (Rodriguez *et al.*, 2000; Rop *et al.*, 2011; Veličković *et al.*, 2013). Changes in fruit quality are important for marketing of medlar fruits. Therefore, in this study, in addition to physical properties, mechanical and chemical properties of medlar fruits were investigated at physiological maturity and during the ripening period.

MATERIALS AND METHODS

This study was carried out in Kocaeli province (Turkey) for two growing seasons, between 2013 and 2014. The province of Kocaeli is located in the northwestern part of Turkey, at the latitude of 40°42′ N, longitude of 30°01′ E, and at 76 m above the sea level. The research area has a hybrid climate with a humid subtropical climate on the south Marmara Sea coast, an oceanic climate on the Black Sea coast, and a humid continental climate in the interior. Summers are warm to hot, humid, and moderately dry, whereas winters are cold, wet, and

sometimes snowy. The material for the study consisted of eight types of medlar trees cultivated in the research garden of the Kocaeli University Arslanbey campus. Each tree was considered a type. All trees were at the same age (10 years old) and productivity period and represented healthy mature plants.

Fruit characteristics: Fruit characteristics of the types, such as the fruit weight, width, and length, were determined for 10 fruit samples picked up randomly from each type. The weight of the fruit was determined using a 0.01-g sensitive balance. The measurements of the length and width (diameter) of the fruits, the length of the fruit stalk, and the width, and length of the calyx basin were carried out using a 0.01-mm sensitive digital compass caliper.

Leaf characteristics: The leaf width and length and the length of the leaf stalk were measured for 10 leaves with a 0.01-mm sensitive digital compass caliper.

Seed characteristics: The seed weight, length, width, and thickness were determined for 10 seeds. The weight of the seed was determined using a 0.01-g sensitive balance. The measurements of the length and width of the seeds were carried out using a 0.01-mm sensitive digital compass caliper.

Biochemical characteristics: Medlar fruits are picked at a hard and green stage, but they are not edible until they become half-rotten or 'overripe', i.e., turn brown and soft. Soluble solid content and pH values of the fruits were measured at the harvest time. The harvested medlars were stored in a cool, dark place until they were suitably overripe and developed an aromatic flavor. At this stage, the soluble solid content was determined again. The weight was recorded again for the same sample fruits that were selected at the green stage to determine the water losses during ripening.

Experimental design and statistical analysis: All measurements (fruit, stone, and leaf) were done for randomly selected samples, and three replicates were used ten samples each. Data were subjected to analysis of variance using the Minitab software (Minitab, Inc.). The data were transformed by arcsine square for percentage means. The means were separated by the Duncan's multiple range test ($P< 0.05$).

RESULTS AND DISCUSSION

Table 1. The characteristics of Fruit and Productivity of Medlar Types

Type	Tree Productivity (kg/tree)*	Fruit weight (g)	Fruit diameter (mm)	Fruit length (mm)	Fruit stalk length (mm)	Calyx leaf length (mm)	Calyx leaf width (mm)	Calyx basin length (mm)
1	5.9	6.6 c	22.2de	25.7c	4.9a	12.1ab	0.86	15.4
2	14.5	10.7 c	27.0c	28.3b	2.0c	14.9a	0.81	16.4
3	10.1	10.0cd	26.0c	27.6b	2.3c	12.4ab	0.96	15.9
4	17.8	20.1 a	33.3a	33.6a	3.3bc	11.4ab	0.86	17.6
5	10.6	7.6 de	23.8d	24.1d	2.4c	11.4ab	0.88	16.0
6	10.9	5.2e	21.2e	21.0e	4.4ab	9.61	0.92	13.2
7	11.5	15.1b	29.7b	28.9b	2.9c	13.0ab	1.00	14.7
8	12.5	12.4bc	27.8c	29.4b	3.3bc	11.7ab	0.84	16.7
Mean	11.7	11.0	26.4	27.3	3.2	12.1	0.89	15.7

Only one tree for each type was considered and no statistical analysis was conducted.

The tree productivity and fruit characteristics are given in Table 1. The tree productivity ranged between 5.9 and 17.8 kg. The most productive type in the orchard was type 4. Comparisons were made for all collected and weighed fruits (Table 1; Figures 1 and 2). The highest fruit weight was observed in type 4. Statistically significant differences were obtained for the means of the fruit weight, fruit length, fruit diameter, fruit stalk length, and calyx leaf length.

Figure 1. Medlar fruits at the harvest time.

Figure 2. Ripened medlar fruits.

The fruit diameter and length ranged among the types from 21.2 to 33.3 mm and from 21.0 to 33.6 mm, respectively. The calyx basin diameter and structure directly affected the quality of the fruit (Figure 1). A crack on the fruit lowers its marketable quality. Types 1 and 6 showed more cracks and abnormalities on the calyx side (Figure 3). In previous studies, the fruit weight, length, and diameter were found to range between 9.46 and 40.80 g, 26.53 and 48.73 mm, and 23.67 and 42.51 mm, respectively (Bostan and İslam, 2007), which is comparable with our results. The highest fruit pH value was found in type 6 (4.02), while pH values were between 2.89 and 3.22 in another study (Özkan *et al.*, 1997).

Figure 3. Deformations on the calyx basin side.

The fruit soluble solid contents were measured between 16.4 and 22.2% at the time of harvest. The soluble solid contents varied between 17.0 and 24.0% in earlier studies (Özkan *et al*., 1997; Yılmaz, 2015). The soluble solid content increased in the ripening period for all of the medlar types (Table 2). The fruits lost water during the ripening period (Figure 4), which caused a decrease in quality. The highest water loss occurred in Type 5. Some fresh fruits are susceptible to enzymatic browning during the ripening period, with flesh browning, which generally results in the loss of weight, as well as nutritional and organoleptic qualities (Altunkaya *et al*., 2009). The same results were obtained in this study.

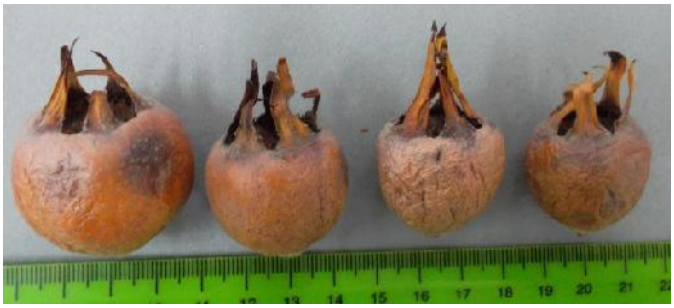

Figure 4. Water losses and deformation of fruits.

Table 2.Changes in biochemical characteristics of medlar fruits during the ripening period

Type	pH at harvest time*	Soluble solid contents at harvest time (%)	Soluble solid contents after ripening (%)	Humidity loses during the ripening period (%)
1	3.68	18.4	22.9	17.16
2	3.97	16.4	22.2	16.75
3	3.75	17.8	23.9	15.45
4	3.88	21.5	27.5	13.57
5	3.78	21.8	26.2	14.41
6	4.02	18.6	22.6	15.52
7	3.80	22.2	25.8	16.44
8	3.85	21.8	25.5	15.28
Mean	3.84	19.8	24.6	15.23

The leaf and leaf stalk lengths showed small and unimportantdifferences among the types; however, there were statistically significant differences in all measured stone characteristics among the types. The average stone number varied from 1.7 to 4.8 per fruit (Table 3).

Table 3. The characteristics of leaf and stone of medlar types

Type	Leaf length (cm)	Leaf width (cm)	Leaf stalk length (mm)	Stone number per fruit	Stone weight (mm)	Stone width (mm)	Stone length (mm)	Seed thickness (mm)
1	7.4bc	3.2	0.57c	1.7b	0.16e	6.4d	10.4d	3.8b
2	7.8bc	3.0	0.57c	4.3a	0.24d	7.5bc	11.5abc	4.2b

3	8.3b	3.4	0.59bc	4.6a	0.23d	7.80bc	11.1bcd	4.1b
4	10.0a	3.5	0.81a	4.7a	0.45a	9.0a	12.5a	5.4a
5	7.9bc	2.9	0.62bc	4.7a	0.45a	7.6bc	11.2bcd	5.4a
6	6.5c	2.9	0.44d	4.7a	0.22d	7.1cd	10.5cd	4.0b
7	7.2bc	3.0	0.58bc	4.8a	0.34b	8.1b	12.5a	5.2a
8	8.1bc	2.9	0.69b	4.7a	0.29c	7.9bc	12.1ab	5.02a
Mean	7.9	3.1	0.61	4.3	0.30	7.7	11.5	4.63

CONCLUSION

After 25 days, darkening, softening, water loss, and flavor development were observed in the fruits. During the ripening period, some fruits lost their marketable value. Ripe medlar fruits are an important source of nutrition, and they become edible only after natural softening and browning. Studies must continue to prevent quality losses and improve quality during overripening.

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