

## Some Fruit Traits of Hawthorn (*Crataegus spp.*) Genetic Resources from Malatya, Turkey

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**Abstract:** Hawthorns (*Crataegus spp.*) are native to Turkey. It is possible to see wild hawthorn bushes or trees in every regions of Turkey. This study deals with evaluating fruit characteristics of 42 genotypes belonging to five different hawthorn species collected from Malatya (eastern Turkey). The mean values of fruit height, fruit diameter, fruit weight, seed height and seed diameter differed statistically by the hawthorn species. The highest fruit diameter belonged to *C. tanacetifolia* with 23.9 mm, followed by *C. orientalis* (21.5 mm), *C. pontica* (19.4 mm), *C. aronia* (18.7 mm) and *C. meyeri* (15.2 mm), respectively. *C. tanacetifolia* had the highest fruit weight (4.99 g), followed by *C. orientalis* (3.48 g), *C. pontica* (3.31 g), *C. aronia* (2.63 g) and *C. meyeri* (1.36 g). Data of seed weight, seed number, fruit flesh percentage, SSC, pH and acidity also differed statistically by the species. The seed numbers were recorded as 4.3 in *C. orientalis* and *C. tanacetifolia*, 3.3 in *C. pontica*, 3.2 in *C. aronia* and 2.0 in *C. meyeri*. Fruits of *C. tanacetifolia* and *C. orientalis* had the highest fruit flesh percentages with 81.5% and 81.0%, respectively. The content of soluble solids (SSC) in five hawthorn species ranged from 14.0 % (*C. tanacetifolia*) to 19.0 % (*C. meyeri*).

**Key words:** *Crataegus spp.*, hawthorn, fruit, genetic resources, Malatya

### INTRODUCTION

Hawthorn belongs to the family *Rosaceae*, and the genus *Crataegus*. Approximately its 200 species have been recorded in the world<sup>[7,9]</sup>. It is not easy to separate into species due to individual variations of hawthorn plants. The long, straight or slightly curved, branches with long, sharp thorns are distinctive characteristics. The leaves can vary in shape, some are slightly or deeply lobed, and others have not any sign of lobes. The ripe fruits are small, and their colors can be yellowish, orange, reddish, black and dark blue. Most hawthorn species are described based on different sized fruits. Hawthorns are deciduous plants, and they usually prefer alkaline soils. Sparks and Martin<sup>[19]</sup> examined hawthorn (*C. monogyna*) fruit yields under different hedgerow management treatments in experimental hedgerows at Cambridgeshire (UK) and found statistically significant differences between the management treatments with yields per unit area, and he determined 50 fruit weight between 10.6 g and 17.0 g, and dry matter percentage between 44.8 % and 50.7 %.

Hawthorn fruits contain vitamin C, flavonoids, glycosides, anthocyanidins, saponins, tannins,

antioxidants<sup>[12]</sup> and phenolics<sup>[8,18]</sup>. Their flowers and fruits are also used for medicinal purposes<sup>[2-5,8,16,17]</sup>.

Knowledges regarding hawthorn genetic resources in Turkey and in the world is limited<sup>[1,20]</sup>. Hawthorns (*Crataegus spp.*) are native to Turkey. It is possible to see wild hawthorn bushes or trees in every regions of Turkey. Hawthorn species such as *C. monogyna*, *C. pentagyna*, *C. azarolus*, *C. orientalis*, *C. prunitifolia*, *C. curvisephala*, and *C. oxycantha* are wild grown in Turkey<sup>[1,20]</sup>. Therefore, Turkey is rich in genetic resources of hawthorn. Donmez<sup>[10]</sup> reported as a new species *C. yaltirikii* that has widely cuneate leaf bases, wide basal leaf lobes, slightly oblong fruit, dark red fruit colour and the distinct neck of the calyx base. Hawthorn plants known with the many synonymes such as aliç, yemşen, guhuşk and haziran in different regions of Turkey are usually utilized for scattered hedgerow planting in the orchards and along the road borders<sup>[20]</sup>. Hawthorns are wild grown in Darende district (Malatya) located in eastern Turkey. In the district, hawthorn genetic resources have not been previously studied. This study aims to identify some fruit attributes of hawthorn species grown in the district for further breeding efforts.

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## MATERIALS AND METHODS

The study was performed in native hawthorn population of Darende (district Malatya) located in eastern Turkey. Fresh wild hawthorn fruits were collected from hawthorn bushes growing in Darende in middle and late September. The fruits were transported in polypropylene bags and held at room temperature. Fruits were cleaned by manual. Based on different plant characteristics, large fruited genotypes of hawthorn were marked in the scattered population. At the harvest time, fruit samples were collected from the marked genotypes. Genotypes that belong to different hawthorn species were morphologically separated<sup>[7]</sup>. In the study, 42 hawthorn genotypes represented by five different species were investigated. In the genotypes, fruit properties such as fruit height (mm), fruit diameter (mm), the ratio of fruit height (mm) and fruit diameter, fruit weight (g), seed height (mm), seed diameter (mm), seed weight (g), seed number, fruit flesh percentage (%), soluble solids content (SSC %), pH and titratable acidity (mg/100 g) were determined<sup>[20]</sup>. A completely randomized design with three replications was used for statistical analysis of fruit data. For fruit analyses, 10 fruits randomly chosen per replicate were based. The means were separated by Duncan's multiple range test. Significant differences were found at  $p < 0.01$ . Statistical package program Minitab release 10.2 for Windows was used for the analysis of variance (ANOVA).

## RESULTS AND DISCUSSIONS

The mean values of fruit height, fruit diameter, fruit weight, seed height and seed diameter differed statistically by the hawthorn species. The mean fruit heights measured for the species *C. orientalis*, *C. aronia*, *C. meyeri*, *C. tanacetifolia* and *C. pontica* were 17.3 mm, 15.2 mm, 12.5 mm, 20.2 mm and 16.6 mm, respectively. The highest mean fruit diameter belonged to *C. tanacetifolia* with 23.9 mm, followed by *C. orientalis* (21.5 mm), *C. pontica* (19.4 mm), *C. aronia* (18.7 mm) and *C. meyeri* (15.2 mm), respectively. The ratio of fruit height and fruit diameter ranged from 0.81 (*C. orientalis*) to 0.86 (*C. pontica*), and it did not differ statistically. *C. tanacetifolia* had the highest mean fruit weight (4.99 g), followed by *C. orientalis* (3.48 g), *C. pontica* (3.31 g), *C. aronia* (2.63 g) and *C. meyeri* (1.36 g). The mean seed height was determined between 0.74 mm (*C. meyeri*) and 0.94 (*C. tanacetifolia*). The mean seed diameter ranged from 0.57 mm (*C. meyeri*) to 0.69 (*C. aronia*) (Table 1).

On the other hand, data of seed weight, seed number, fruit flesh percentage, SSC, pH and acidity also differed statistically by the species. *C. tanacetifolia* had the highest seed weight (0.92 g), this was followed by *C. pontica* (0.81 g), *C. aronia* (0.77 g), *C. orientalis* (0.65 g) and *C. meyeri* (0.32 g), respectively. The mean seed numbers were recorded as 4.3 in *C. orientalis* and *C. tanacetifolia*, 3.3 in *C. pontica*, 3.2 in *C. aronia* and 2.0 in *C. meyeri*. Fruits of *C. tanacetifolia* aronia and

**Table 1:** Values of fruit height, fruit diameter, fruit height/fruit diameter, fruit weight, seed height and seed diameter in hawthorn genotypes belonging to five hawthorn species from Darende (Malatya, Turkey).

Genotypes		Fruit height (mm)	Fruit diameter (mm)	Fruit height/diameter	Fruit weight (g)	Seed height (mm)	Seed diameter (mm)
<i>Crataegus orientalis</i> Palas ex. M. Bieb. var. <i>orientalis</i>	D-1	17.1	21.2	0.84	2.87	0.83	0.57
	D-33	16.5	20.5	0.80	2.89	0.77	0.54
	D-38	17.2	20.1	0.85	3.27	0.78	0.61
	D-43	18.4	24.1	0.76	4.90	0.92	0.61
	Mean	17.3 b	21.5 b	0.81	3.48 b	0.81 b	0.58 b
<i>Crataegus aronia</i> (L.) Bosc. ex. DC. var. <i>aronia</i>	D-2	16.1	19.3	0.83	2.47	0.86	0.63
	D-6	17.0	19.3	0.88	2.68	0.92	0.64
	D-7	14.9	17.1	0.87	2.35	0.88	0.82
	D-8	15.1	18.4	0.82	2.09	0.88	0.62
	D-15	14.9	16.7	0.90	2.13	0.89	0.62
	D-16	15.6	18.2	0.86	2.70	0.88	0.71
	D-22	10.0	18.8	0.53	2.75	0.96	0.76
	D-34	17.3	20.9	0.83	3.15	0.94	0.71
D-36	16.4	19.8	0.83	3.15	0.91	0.76	

Table 1: Continued.

	D-40	15.2	18.9	0.80	3.02	0.84	0.73
	D-42	15.2	18.1	0.84	2.45	0.90	0.62
	Mean	15.2 c	18.7 c	0.82	2.63 c	0.89 a	0.69 a
<i>Crataegus meyeri</i> Pojark	D-3	11.4	13.2	0.86	0.98	0.68	0.52
	D-4	12.4	15.4	0.81	1.26	0.75	0.61
	D-5	11.2	14.0	0.80	1.08	0.65	0.56
	D-9	12.2	14.7	0.83	1.27	0.73	0.54
	D-11	12.8	15.7	0.81	1.68	0.78	0.59
	D-13	13.0	15.9	0.82	1.51	0.78	0.61
	D-14	14.7	17.2	0.85	1.73	0.83	0.61
	Mean	12.5 d	15.2 d	0.82	1.36 d	0.74 c	0.57 b
<i>Crataegus tanacetifolia</i> (Lam.) Pers	D-10	20.8	24.0	0.87	4.91	1.02	0.61
	D-12	19.4	24.2	0.80	5.15	0.94	0.53
	D-18	21.7	25.8	0.84	5.01	0.95	0.64
	D-20	20.0	23.7	0.84	4.93	1.04	0.66
	D-23	19.6	22.8	0.86	4.52	0.98	0.62
	D-24	21.0	23.8	0.88	5.02	0.98	0.69
	D-25	20.7	25.3	0.82	5.25	0.98	0.64
	D-26	21.1	25.3	0.83	5.86	0.91	0.62
	D-27	18.2	22.9	0.80	4.63	0.97	0.63
	D-28	21.0	28.1	0.75	5.28	1.05	0.78
	D-29	20.1	21.4	0.94	5.11	0.99	0.59
	D-30	20.1	24.5	0.82	5.07	0.92	0.68
	D-31	18.6	22.1	0.84	4.81	0.55	0.64
	D-32	20.7	22.4	0.92	4.69	1.04	0.68
	D-35	19.8	21.3	0.93	4.41	0.92	0.63
	D-37	20.0	24.4	0.82	5.25	1.03	0.63
	Mean	20.2 a	23.9 a	0.85	4.99 a	0.94 a	0.64 a
<i>Crataegus pontiaca</i> C. Koch	D-17	17.4	21.1	0.83	4.16	0.98	0.63
	D-21	16.0	18.3	0.87	2.69	0.87	0.71
	D-39	15.8	18.5	0.86	3.04	0.85	0.63
	D-41	17.1	19.8	0.86	3.36	0.93	0.60
	Mean	16.6 b	19.4 c	0.86	3.31 b	0.90 a	0.64 a
Significance		***	***	NS	***	***	***

NS: non-significant.

**Table 2:** Values of seed weight, seed number, fruit flesh percentage, soluble solids content (SSC), fruit pH and acidity in hawthorn genotypes belonging to five hawthorn species from Darende (Malatya, Turkey).

Genotypes	Seed weight (g)	Seed number	Fruit fleshper. (%)	SSC (%)	Fruit Ph	Fruit acidity (mg/100g)	
<i>Crataegus orientalis</i> Palasex. M. Bieb. var. <i>orientalis</i>	D-1	0.74	4.8	74.2	11.8	4.15	0.13
	D-33	0.48	4.0	83.4	13.6	3.66	0.11
	D-38	0.52	3.6	84.1	16.9	3.65	0.13
	D-43	0.86	4.9	82.5	14.0	4.11	0.13
	Mean	0.65 c	4.3 a	81.0 a	14.1 c	3.89 b	0.12 a
<i>Crataegus aronia</i> (L.) Bosc.ex. DC. var. <i>aronia</i>	D-2	0.76	3.8	69.2	10.2	4.31	0.12
	D-6	0.84	3.2	68.7	14.2	4.10	0.15
	D-7	0.70	2.6	70.3	20.5	4.21	0.13
	D-8	0.78	3.8	62.8	19.8	4.23	0.12
	D-15	0.68	2.6	68.1	23.6	4.46	0.13
	D-16	0.62	2.6	77.1	15.3	4.36	0.12
	D-22	0.84	3.0	69.5	16.5	4.28	0.15
	D-34	1.04	3.8	67.1	18.5	4.17	0.13
	D-36	0.78	3.0	75.3	17.0	4.18	0.14
	D-40	0.74	2.9	76.9	19.7	4.25	0.17
	D-42	0.72	3.4	70.7	22.4	3.25	0.09
	Mean	0.77	3.2 b	75.4 b	17.8	4.16 a	0.13 a
<i>Crataegus meyeri</i> Pojark	D-3	0.28	2.0	71.6	21.3	3.60	0.10
	D-4	0.36	2.0	71.5	23.7	3.96	0.12
	D-5	0.24	2.0	77.9	21.1	4.39	0.10
	D-9	0.32	2.0	74.8	20.8	4.25	0.09
	D-11	0.38	2.0	77.4	15.8	4.35	0.08
	D-13	0.36	2.0	76.2	13.2	4.54	0.11
	D-14	0.34	2.1	80.4	16.8	4.51	0.09
	Mean	0.32 d	2.0 c	75.7 b	19.0 a	4.37 a	0.10 b
<i>Crataegus tanacetifolia</i> (Lam.) Pers	D-10	0.86	4.2	82.5	11.5	4.08	0.12
	D-12	0.92	4.2	82.2	13.8	3.59	0.10
	D-18	0.96	4.3	80.9	14.0	4.05	0.13
	D-20	1.08	4.7	78.1	15.5	3.92	0.16
	D-23	0.88	4.4	80.6	12.8	4.06	0.17
	D-24	0.94	4.8	81.3	14.8	4.09	0.12
	D-25	0.88	5.0	83.3	17.8	3.47	0.15

Table 2: Continued.

	D-26	0.94	4.4	83.6	12.6	3.75	0.12
	D-27	0.90	4.6	80.6	13.0	4.12	0.16
	D-28	0.98	4.9	81.5	14.2	4.09	0.11
	D-29	0.90	4.4	82.4	13.2	3.69	0.13
	D-30	0.78	4.5	84.7	12.8	3.40	0.12
	D-31	0.97	4.7	79.7	15.1	4.10	0.11
	D-32	0.94	4.7	80.0	14.0	4.01	0.09
	D-35	0.90	4.8	79.6	14.1	4.05	0.13
	D-37	0.88	4.9	83.3	14.3	4.26	0.16
	Mean	0.92 a	4.3 a	81.5 a	14.0 c	3.92 b	0.13 a
<i>Crataegus pontiaca</i> C. Koch	D-17	1.12	2.6	73.1	12.1	4.38	0.14
	D-21	0.64	3.0	76.2	18.3	3.72	0.13
	D-39	0.80	4.0	73.7	18.0	3.78	0.15
	D-41	0.68	3.4	79.8	15.9	4.16	0.12
	Mean	0.81 a	3.3 b	75.7 b	16.1	4.01	0.13 a
Significance	***	***	***	***	***	***	

*C. orientalis* had the highest fruit flesh percentages with 81.5% and 81.0%, respectively. The content of soluble solids (SSC) in five hawthorn species ranged from 14.0 % (*C. tanacetifolia*) to 19.0 % (*C. meyeri*). The value of fruit pH was between 3.89 (*C. orientalis*) and 4.37 (*C. meyeri*). The titratable acidity was determined between 0.10 (*C. meyeri*) and 0.13 (*C. aronia*, *C. pontica* and *C. tanacetifolia*) (Table 2).

In hawthorns, fruit size varies to species. For example, while fruit diameter of *C. marshalli* is 4.9 mm, fruit diameter of *C. pedicellata* is about four times higher with 19.5 mm<sup>[1,7]</sup>. Piper<sup>[15]</sup> reported 11.1 mm fruit diameter, 0.634 g fruit weight and 4.7 seed number per fruit for *C. flava* called yellow hawthorn. Fruit diameter for *C. monogyna* was reported as 7-10 mm by Obeso and Herrera<sup>[13]</sup> and 10 mm by Hampe<sup>[11]</sup>. Bignami *et al*<sup>[6]</sup> recorded 2.9-7.9 g fruit weight, 13.6-18.9 SSC%, 3.2-3.5 pH and 0.56-1.98% acidity for *C. azarolus* from five different accessions of Italy. Ozcan *et al*<sup>[14]</sup> measured 19.34 mm fruit diameter, 3.03 g fruit weight, 0.87 g seed weight, 14.39 mm fruit length, 19.34 mm fruit diameter, 3.03 g fruit weight, 3.38 pH, 1.98% acidity and 32.31% soluble solids content for fresh wild hawthorn fruits collected from Konya (Derbent) in Turkey. Turkoglu *et al*<sup>[20]</sup> averagely recorded fruit diameter between 15.15-18.60 mm and fruit weight between 2.24-2.44 g fruit weight for different genotypes

of *C. orientalis* collected from Van. Sparks and Martin<sup>[19]</sup> determined between 0.21 g and 0.34 g fruit weight for *C. monogyna*. In this study, while fruit diameters were 23.9 mm for *C. tanacetifolia*, 21.5 mm for *C. orientalis*, 19.4 mm for *C. pontica*, 18.7 mm for *C. aronia* and 15.2 mm for *C. meyeri*, fruit weights were determined as 4.99 g in *C. tanacetifolia*, 3.48 g in *C. orientalis*, 3.31 g in *C. pontica*, 2.63 g in *C. aronia* and 1.36 g in *C. meyeri*. In addition, fruits belonging to *C. orinetalis* were larger than those of reported for *C. orientalis* by Turkoglu *et al*<sup>[20]</sup>. Determining many fruit characteristics in ninety eight hawthorn genotypes belonging to the species *C. orientalis*, *C. curvisephala*, *C. pentagyna*, *C. monogyna subsp. azarella* and *C. monogyna subsp. monogyna*, Turkoglu *et al*<sup>[20]</sup> averagely recorded 2.24-2.44 g fruit weight, 0.078-0.082 g seed weight, 4.23-4.90 seed number, 77.8-83.0 % fruit flesh percentage, 15.23-15.28 % SSC and 0.54-0.86 mg/100g acidity for fruits of *C. orientalis* grown in Van. In this study, the majority of fruit data recorded for *C. orientalis* was similar to those of *C. orientalis* grown in Van.

According to fruit data of the study, *C. tanacetifolia* had the largest fruits, the highest seed number and fruit flesh percentage, and the lowest SSC, while *C. meyeri* had the smallest fruits, the lowest seed number and the highest SSC.

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