RESEARCH ARTICLE

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Morphological and pomological characterization of some genotypes Sumac (Rhus coriaria L.) obtained by selection breeding

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Abstract
Sumac (*R. coriaria* L.) is a subtropic and temperate climate plant with medicinal and aromatic properties which has a natural distribution in many regions of Anatolia. Sumac which is used as a food additive in the food industry due to the flavoring substances has been in high demand in recent years. Besides the beneficial secondary metabolites, it is used in the field of medicine and pharmacy. Sumac (*R. coriaria*) which grows spontaneously in the natural environment without any agricultural practices is collected by the local people in the region and supplied to the local market. Since this situation, the ideas of creating modern orchards for sumac have begun to emerge. For this reason, selection breeding studies have been planned in sumac (*R. coriaria* L.). This study was carried out at the East Mediterranean Transition Zone Agricultural Research Institute during 2019-2021 years. Approximately 300 different sumac genotypes were observed and botanically 92 genotypes were found positive in this study. It was determined that the wet weight values of the clusters in the examined sumac genotypes varied between 5.63-87.74 g as a result of the statistical analysis. The highest cluster weight varied between 87.74, 78.92, and 70.81 g in GN26, GN86, and GN90 genotypes respectively. The lowest cluster wet weight was found in GN28 (5.63 g) and GN41 (6.00 g) genotypes in the study. It was found in the study that the cluster powder efficiency values varied between 30.62% and 72.49% and the average cluster powder efficiency was 49.15%. It was determined that the results obtained from about 20 sumac genotypes were found to be positive in the statistical analyzes made on the characteristics examined in this study. It is aimed to use this sumac (*R. coriaria* L.) genotypes in the modern sumac cultivation planned for the future.
Keywords: Characteristic, Fruit, Medicinal and aromatic, *Rhus coriaria*, Spice

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INTRODUCTION

Sumac (*Rhus coriaria* L.) belongs to the *Rhus* genus of the *Anacardiaceae* family and contains approximately 250 species. The name sumac is derived from the Syriac word "sumaga" meaning "red" (Wetherill and Pala, 1994). *R. coriaria* has a natural distribution in all subtropical and temperate climate zones especially in Iran, Southern Europe, North Africa, Western Asia, and the Middle East. These plants which are studied as a non-forest wood products in botanical form grow naturally in almost every region, especially in western and southern Anatolia (Basoglu and Cemeroglu 1984; Kurucu et al., 1993). It is reported that Turkey has a natural distribution area of primarily *R. coriaria* L. *Cotinus coggyria* and *Rhus chinensis* species (Eminagaoglu and Ozcan 2018; Sutyemez et al., 2019). Among these, *R. coriaria* L. is the species with the most widely growing area and medicinal aromatic usage area (Yucedag et al., 2010). In the survey studies conducted that this species naturally spreads in arid and semi-arid regions calcareous soils non-agricultural lands and forests in the Kahramanmaraş region (Guvenc et al., 2017). In addition, it can be said that this plant can grow from sea level up to altitudes of 2000 m (Yucedag et al., 2010). Sumac (*R. coriaria* L.) is traditionally used as a food additive due to its acid content and intense sour taste (Fereidoonfar et al., 2018). On the other hand, due to the biochemicals it contains it is used in medicine and pharmacy (Elagbar et al., 2020; Alsamri et al., 2021), the leather industry (Davis, 1885; Tiryaki 2010; Pipinis et al., 2017), veterinary (Langroodi et al., 2018), landscaping (Corbaci et al., 2011) and erosion control studies (Gokturk et al., 2006). It has been reported to have antioxidant, anticancer, analgesic, antidiabetic, antihistamine, antiviral, antibacterial and antifungal effects (Bloshenko and Letchamo, 1996; Kizil and Turk, 2010; Kurt et al., 2014; Yuksel, 2018; Under and Saltan, 2019). Sumac (*R. coriaria L.*) can be propagated by seed generatively. Due to the secretion of a resin-like substance in the base of the cutting vegetative propagation is difficult (Muhamed and Dawodet, 2017; Karakuzulu, 2018). However, these problems are less common in micropropagation applications (Edwards and Thomas, 1980; Amiri and Mohammadi, 2021). The endocarp structure of the sumac seed which is extremely hard makes it difficult to germinate the physical and physiological dormancy state of the embryo in propagation with seeds (Uzun, 2016).

Due to the commercial importance of sumac (*R. coriaria* L.) establishment of a modern orchards have started. Therefore, it was necessary to carry out selection breeding studies in order to establish more homogeneous and productive modern orchards. Various articles on the phytochemical contents of Turkish sumac have been published (Gezici 2019; Ozcan et al., 2021; Caliskan et al., 2022). But studies on morphological and pomological data have been very limited (Yilmaz, 2021). This study was carried out to determine the morphological and pomological characteristics of some sumac (*R. coriaria* L.) genotypes naturally distributed in the Kahramanmaraş region. It is aimed to obtain 20 different sumac (*R. coriaria* L.) genotypes with different characteristics and commercial importance in the following stages of the study.

MATERIALS AND METHOTS

Materials

The material of this study consisted of 92 different sumac (*R. coriaria* L.) genotypes in terms of botanical characteristics obtained by selection breeding from the Eastern Mediterranean Region of Turkey. The pomological analysis of the study was carried out in the Eastern Mediterranean Transition Zone Agricultural Research Institute laboratories.

Methods

Fruit samples were taken and labeled at the appropriate ripening time in order to perform morphological and pomological analyzes of plants in different locations. The measurement of each fruit characteristic was made over 3 replications and the average values were used (Fereidoonfar et al., 2018). Qualitative features such as yield, fruit density in the cluster, and presence of waxy layer on the fruit were evaluated according to coding and scoring (Fereidoonfar et al., 2018). Selected 92 sumac (*R.coriaria*) genotypes were examined in terms of 15 different morphological and pomological features.

Pomologic and Morphologic Observations

The selected 92 sumac genotypes were evaluated in terms of 15 different characteristics both qualitative and quantitative (Table 2).

Yield

The yield calculations were taken into account the number of clusters per tree (Yilmaz, 2021; Fereidoonfar et al., 2018). Yield values were calculated in accordance with the 1-4 criteria (1: Low yield, 4: High yield)

Bunch width, length, bunch diameter and wet-dry bunch weight

The width, length and diameter of the bunch stem were measured with the help of a 0.01 mm sensitive digital caliper (0.01 mm Gomax GMX1017020), and the weight of the bunch was measured with the help of an electronic balance with 0.01 g precision (Fereidoonfar et al., 2018). The fresh weight of the bunch was measured immediately after the harvest and the dry weight of the bunch was measured after the bunches were dried in an oven at 60°C for 24 hours.

Color of fruit

Sumac fruits are small, tightly packed spheres that form dense clusters of reddish seeds called sumac bobs (Sakhr and Khatib 2020). The fruit color of sumac fruits was presented to the observers during the harvest period and determined by the survey methods. Observers were asked to choose one of 4 color alternatives: red, reddish brown, brown, and burgundy (Fereidoonfar et al., 2018).

Average fruit weight, fruit width, fruit length and fruit thickness, 100 fruit fresh and dry weights

100 pieces fresh fruit pieces weight was measured with the help of sensitive electronic scales. After the fruit pieces were dried in an oven at 60°C for 24 hours and measured. The width, length and thickness of the fruit pieces were measured randomly in millimeters with the help of a digital caliper (0.01 mm Gomax GMX1017020) (Ozcan and Haciseferogullari, 2004).

Fruit pieces density in bunch

The bunches were presented to the observers and determined by the questionnaire method and they were asked to give points from 1 to 5. (1: very sparsely, 2: sparsely, 3: moderately dense, 4: dense, 5: very dense) (Fereidoonfar et al., 2018).

Waxy cuticle on fruits

Sumac fruits leave color and sticky feeling on the hands when touched. Fruits were offered to the observers and determined by the questionnaire method and they were asked to give points from 1 to 5 (Sezgin et al., 2015). (1: nonstick, 2: slightly sticky, 3: medium sticky, 4: sticky, 5: very sticky).

Fruit flesh powder weight per bunch

Harvested fruits were dried and separated from their flesh and the flesh of the fruit was ground into fresh powder then the weight of sumac fresh powder coming out of a bunch was measured with the help of a precision scale (0,01 g precision).

Evaluation of data

After the fruit and bunch samples were analyzed in three parallels and the weighted grading method modified by Ugur and Kargı (2018), was applied to the results [Table 1 (a), Table 1 (b), Table 1 (c)]. Weighing grading is a method frequently used in fruit breeding studies. After adding the scores of selected sumac genotypes for each trait total scores were obtained.

Findings and Discussion

15 different characteristics were investigated in selected sumac (*R. coriaria*) genotypes in the study. It is seen in Table (3a-b-c) that there are quite different distributions among genotypes in terms of these characteristics. The wet weight values of the bunch showed a very different distribution between 5.63 - 87.74 g. It is seen that about 36% of the genotypes are above the average value (31.80 g) and the majority of the genotypes (64%) are below. It was determined that the highest wet bunch weight varied between 87.74-71.79, and 70.81 g in GN-26, GN-90, and GN-3 genotypes, respectively. The lowest values were measured in GN28 (5.63g), GN41 (6.00 g) and GN70 (9.28 g) genotypes. Fereidoonfar et al., (2018) determined that the cluster weight of sumac plants was between 0.55-6.67 in their study on 136 sumac plants. Yilmaz (2021) reported that the bunch weights of 394 sumac genotypes he investigated in the Kahramanmaraş province Dulkadiroğlu region ranged from 7.22 g to 37.48 g. It is seen that the bunch weights obtained from our study are quite high considering these values. It is thought that this situation is caused by the cultivation of some genotypes in their environment. However, bunch weight values were found to be high in our study. It is known that bunch characteristics are among the most important quality criteria in sumac breeding studies. It was determined in the study that the average dry weight of the cluster was 24.15 g. The highest dry weight of the bunch was recorded as GN-3 with 67.82 g and the lowest dry weight of the cluster was recorded as GN-46 with 3.15 g. Fereeidonfar et al. (2018) reported that bunch weight stands out as the feature with the highest coefficient of variation (CV=69.00%) among the examined features. Similarly, it was concluded that the fresh and dry weights of clusters showed a wide variation in our study. It was observed that some genotypes with high wet weight of the bunch lost more water when dried and their weight decreased. GN-27 lost 64.72% of its weightand, GN-42, 61.12%, and GN46 68.18% after drying. The high dry weight of the cluster is very important in the yield criteria of sumac plants. The yield values varied between 1.80 and 3.60 according to the 1-4 criteria. It was observed that the average yield value was 2.71 in our study. The highest yield was determined in GN-34 (3.60), GN-

Table 1 (a). Value ranges based on the scores (Ugur and Kargı, 2017)

Yield (1/10)			Bunch wet weight (g)			Bunch dried weight (g)			Fruit fleshpowder (FPP) (g)			(FPP) efficiency (%)		
Min.	Max.	Mean	Min.	Max.	Mean	Min	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1,8	3,6	0,18	5,63	87,74	8,21	3,15	67,82	6,47	2,05	28,98	2,69	30,63	72,49	4,19
Points			Points			Points			Points			Points		
1	1,8	1,98	1	5,63	13,84	1	3,15	9,62	1	2,05	4,74	1	30,63	34,82
2	1,99	2,17	2	13,85	22,06	2	9,63	16,09	2	4,75	7,45	2	34,83	39,01
3	2,18	2,36	3	22,07	30,28	3	16,10	22,57	3	7,46	10,15	3	39,02	43,21
4	2,37	2,55	4	30,29	38,50	4	22,58	29,05	4	10,16	12,85	4	43,22	47,40
5	2,56	2,74	5	38,51	46,73	5	29,06	35,53	5	12,86	15,56	5	47,41	51,60
6	2,75	2,93	6	46,74	54,95	6	35,54	42,00	6	15,57	18,26	6	51,61	55,80
7	2,94	3,12	7	54,96	63,17	7	42,01	48,48	7	18,27	20,96	7	55,81	59,99
8	3,13	3,31	8	63,18	71,39	8	48,49	54,96	8	20,97	23,66	8	60,00	64,19
9	3,32	3,50	9	71,40	79,61	9	54,97	61,43	9	23,67	26,37	9	64,20	68,38
10	3,51	<	10	79,62	<	10	61,44	<	10	26,38	<	10	68,39	<

Table 1 (b). Value ranges based on the scores (Ugur and Kargı,2017)

Bunch width (mm)			Bunch size (mm)			Bunch stem diameter (mm)			Density of fruit pieces (1/5)			Weight of fruit piece (g)		
Min.	Max.	Mean	Min.	Max.	Mean	Min	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
26,93	96,77	6,98	9,5	29,2	1,97	2,67	10,59	0,79	1,5	5	0,35	0,87	6,18	0,53
Points			Points			Points			Points			Points		
1	26,93	33,91	1	9,5	11,47	1	2,67	3,46	1	1,5	1,85	1	0,87	1,40
2	33,92	40,91	2	11,48	13,45	2	3,47	4,26	2	1,86	2,21	2	1,41	1,94
3	40,92	47,90	3	13,46	15,43	3	4,27	5,07	3	2,22	2,57	3	1,95	2,48
4	47,91	54,90	4	15,44	17,41	4	5,08	5,87	4	2,58	2,93	4	2,49	3,02
5	54,91	61,89	5	17,42	19,39	5	5,88	6,67	5	2,94	3,29	5	3,03	3,57
6	61,90	68,88	6	19,40	21,37	6	6,68	7,47	6	3,30	3,65	6	3,58	4,11
7	68,89	75,88	7	21,38	23,35	7	7,48	8,27	7	3,66	4,01	7	4,12	4,65
8	75,89	82,87	8	23,36	25,33	8	8,28	9,08	8	4,02	4,37	8	4,66	5,19
9	82,88	89,87	9	25,34	27,31	9	9,09	9,88	9	4,38	4,73	9	5,20	5,73
10	89,88	<	10	27,32	<	10	9,89	<	10	4,74	<	10	5,74	<

Table 1 (c). Value ranges based on the scores (Uğur and Kargı,2017)

Weight of fruit piece (g)			Fruit width (mm)			Fruit size (mm)			Thickness of pericarp (mm)			Waxy cuticle on fruit (1/5)		
Min.	Max.	Mean	Min.	Max.	Mean	Min	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
0,3	5,18	0,49	3,56	7,14	0,36	3,53	7,71	0,42	0,97	5,4	0,44	2,33	4,85	0,25
Points			Points			Points			Points			Points		
1	0,3	0,79	1	3,56	3,92	1	3,53	3,95	1	0,97	1,41	1	2,33	2,58
2	0,80	7,78	2	3,93	4,29	2	3,96	4,38	2	1,42	1,87	2	2,59	2,84
3	7,79	14,78	3	4,30	4,65	3	4,39	4,80	3	1,88	2,32	3	2,85	3,11
4	14,79	21,77	4	4,66	5,02	4	4,81	5,23	4	2,33	2,77	4	3,12	3,37
5	21,78	28,76	5	5,03	5,39	5	5,24	5,66	5	2,78	3,23	5	3,38	3,63
6	28,77	35,76	6	5,40	5,76	6	5,67	6,09	6	3,24	3,68	6	3,64	3,89
7	35,77	42,75	7	5,77	6,13	7	6,10	6,52	7	3,69	4,13	7	3,90	4,15
8	42,76	49,75	8	6,14	6,49	8	6,53	6,94	8	4,14	4,58	8	4,16	4,42
9	49,76	56,74	9	6,50	6,86	9	6,95	7,37	9	4,59	5,04	9	4,43	4,68
10	56,75	<	10	6,87	<	10	7,38	<	10	5,05	<	10	4,69	<

105(3.50) and GN-33(3.40) genotypes, the lowest yield value was found in GN-59 (1.80), and GN-8 (1.80) sumac genotypes in the study. It was determined that about 37% of sumac (*R. coriaria*) genotypes had yield values below the average. However, it was determined that the yield in 63% of the genotypes could be considered high. On the other hands yield values were found to be high in sumac (*R. coriaria*) genotypes. . Fereidoonfar et al. (2018) grouped the yields of 136 sumac plants as low (27.90%), medium (45.60%) and high (26.50%). It was observed that the diameter of the bunch stem varied between 2.67 and 10.59 mm and the mean diameter of the bunch stem was measured as 5.57 mm in our study. Fereidoonfar et al. (2018), measured that the diameter of the bunch stem diameter of the sumacs in the Iran region as the highest at 5.27 mm and lowest at 1.43 mm. Yilmaz (2021) observed that the cluster stem diameter values between 3.03 mm and 7.02 mm in 25 promising sumac genotypes in the Kahramanmaraş Dulkadiroğlu district. The density of fruit on the bunch was presented to the observers by the questionnaire method and they were asked to give a score between 1 and 5. According to the results, the average density of fruit in the bunch was calculated as 3.88. Fereidoonfar et al. (2018) calculated the average density of fruit on the bunch of 136 sumac genotypes as 3.29. Fereidoonfar et al. (2018) stated that 136 sumac genotypes had low density (22.10%), medium density (41.20%) and high density (36.80%) fruit densities in the

Table 2. Relative scores used in weighted grading applied to selected sumac genotypes

Pomological Feature	Relative point (Total 100)
Bunch wet weight (g)	7
Yield	15
Bunch dried weight (g)	8
Fruit fleshpowder (FPP) (g)	11
FPP efficiency (%)	16
Bunch width (mm)	5
Bunch size (mm)	4
Diameter of bunch stem (mm)	2
Density of fruit on the bunch	8
Weight of 100 wet fruit pieces (g)	6
Weight of 100 dried fruit pieces (g)	9
Fruit width (mm)	2
Fruit size (mm)	3
Thickness of pericarp (mm)	1
Waxy cuticle on fruit (1/5)	3

cluster. Yilmaz (2021) grouped the 25 promising sumac genotypes he observed 202 genotype as rare (8%), moderate (36%), dense (40%) and very dense (16%) in the Kahramanmaras region. The results of our study seem to be compatible with the literature. Fruit flesh powder yield is an important quality criterion in sumac (*R. coriaria*). Because in the food industry where sumac is widely used in many parts of the world the fruits of flesh powder are generally used as a spice and an additive in foods. For this purpose the efficiency of the fruit flesh powder of the bunch was calculated for the first time in this study. The fruit flesh powder yield in sumac (*R. coriaria*) genotypes varied between 72.49% and 30.63% and the average sumac fruit flesh powder yield was 49.15%. It was determined that the powder yield was below the average in approximately 51% of the 92 sumac (*R. coriaria*) genotypes and more promising results were obtained in 49% of them. The highest fruit flesh powder yield were in GN-113 (69.88%), GN-43 (68.80%) and GN-42 (67.33%) genotypes and the lowest was in GN-62 (30.63%) and GN-114 (33.73%) genotypes. This situation may have occurred due to genetic differences or soil conditions where the plant is located. Therefore, this feature should be reviewed under equal soil conditions. It was conducted that the average bunch length was 186.2 mm in sumac (*R. coriaria*) genotypes with bunch lengths ranging from 95 to 292 mm. The highest cluster lengths were found in GN103 (292 mm), GN54 (290 mm), and GN83 (284 mm) genotypes. The lowest bunch lengths were found in GN46 (95 mm), GN80 (116 mm), and GN25 (135 mm) genotypes.

Fereidoonfar et al. (2018) observed that the sumac bunch lengths in the Iran region ranged from 54.71 mm to 142.42 mm. Yilmaz (2021), in his study with sumacs in Kahramanmaraş Dulkadiroğlu district reported that the length of the bunch was between 91.80 mm and 302.50 mm. Accordingly, it can be said that the bunch of sumacs in Turkey is much longer. The bunch widths ranged from 26.93 mm to 96.77 mm with an average of 50.24 mm in our study. Feredidoonfar et al. (2018), stated that the bunch widths of Iranian sumacs vary between 13.65 and 35.55 mm. It can be said that the reason why the

Figure 1. Tree, leaf, flower and fruit of the studied edible *Rhus coriaria* genotypes

Table 3(a). Pomological analyzes of selected sumac (*R. coriaria* L.) genotypes

NO	GNTP	BWW	Y	BDW	FPP	FPPE	BW	BS	DBS	DFB	WWFP	WDFP	FW	FS	TP	WCF	TOTAL
1	GN105	53,26	3,50	46,64	24,68	52,91	96,77	159,00	6,82	4,50	3,50	2,68	6,00	5,11	2,95	3,75	760
2	GN111	50,23	3,20	45,11	20,46	45,36	95,36	262,5	8,12	4,60	3,84	2,90	6,78	6,88	3,22	4,00	738
3	GN58	69,84	3,20	52,24	23,82	45,60	76,82	178,0	6,30	4,50	4,54	3,54	6,10	5,31	2,15	3,00	646
4	GN33	49,45	3,40	43,67	19,18	43,91	60,96	236,0	5,23	4,50	4,96	3,02	5,51	5,64	2,51	4,75	638
5	GN26	87,74	2,50	58,96	25,75	43,68	61,01	201,0	6,74	4,70	4,58	2,94	5,95	6,06	2,07	3,00	602
6	GN109	61,48	3,20	38,11	19,37	50,83	47,94	228,0	6,28	3,80	4,44	2,63	5,41	5,72	2,55	3,00	591
7	GN94	60,03	2,80	57,01	21,37	37,48	68,74	238,0	7,98	4,60	3,40	3,63	6,35	4,69	2,97	4,80	587
8	GN34	38,94	3,60	36,40	14,25	39,15	64,14	257,0	6,36	4,30	2,70	2,76	6,16	5,72	2,48	4,20	580
9	GN90	71,79	2,90	43,84	23,92	54,57	61,45	130,0	4,88	5,00	4,20	3,42	6,84	6,62	2,45	3,74	579
10	GN61	46,66	2,50	42,31	20,27	47,91	74,00	238,0	6,06	4,50	3,72	3,48	6,14	5,36	2,40	3,75	564
11	GN3	70,81	2,50	67,82	28,98	42,73	75,57	245,0	5,87	4,85	3,66	2,76	6,33	5,89	2,71	4,50	562
12	GN85	59,35	2,80	52,03	25,42	48,86	54,26	258,0	6,68	4,85	3,38	3,24	5,13	5,40	2,25	3,74	556
13	GN87	54,22	2,50	31,10	15,87	51,03	52,19	215,0	7,04	4,50	5,10	3,00	5,91	7,03	2,66	3,74	549
14	GN106	29,64	3,60	27,44	12,74	46,43	80,00	157,0	5,85	3,80	3,90	3,60	6,54	5,69	3,45	4,00	548
15	GN60	28,35	3,20	26,13	14,89	56,98	40,29	174,0	5,40	4,50	3,46	3,32	5,42	5,26	2,44	3,74	543
16	GN89	53,91	2,70	36,56	18,88	51,64	57,93	245,0	9,42	4,85	3,97	2,56	5,74	5,96	2,16	3,74	530
17	GN54	66,92	2,50	41,47	14,80	35,68	60,06	290,0	8,02	4,60	5,06	3,45	6,07	6,49	2,56	3,74	523
18	GN76	24,93	3,20	24,81	11,88	47,88	49,78	157,0	5,01	4,60	3,07	2,90	5,33	6,19	2,90	3,74	513
19	GN51	30,76	3,00	28,98	13,49	46,55	55,60	168,0	4,95	4,00	4,91	4,76	6,22	6,70	2,75	3,40	512
20	GN115	35,52	3,30	22,78	9,84	43,20	60,67	247,0	6,36	3,75	4,82	1,50	5,79	6,69	3,34	3,74	512
21	GN17	58,25	3,00	38,85	13,76	35,42	61,64	192,0	4,65	4,20	3,91	2,64	5,76	6,02	2,15	3,74	509
22	GN101	26,07	3,00	22,63	12,78	56,47	47,95	160,0	4,67	4,00	2,86	3,26	4,74	5,96	2,47	4,10	505
23	GN62	67,22	3,00	35,52	10,88	30,63	68,18	248,0	7,02	4,30	3,88	2,46	5,17	6,00	2,26	3,74	502
24	GN31	45,00	2,50	41,19	19,66	47,73	39,71	142,5	4,77	4,60	3,54	3,14	5,26	5,30	2,87	4,00	499
25	GN110	29,68	3,00	28,79	14,23	49,42	61,33	222,0	6,70	3,75	2,56	2,42	6,49	5,68	3,54	2,50	499
26	GN108	44,39	3,00	37,12	18,08	48,71	55,38	164,0	6,10	5,00	3,16	3,19	5,22	5,24	2,22	4,00	497
27	GN25	29,78	3,00	13,60	8,95	65,81	36,39	135,0	4,74	4,00	3,53	2,78	5,31	4,92	2,14	3,74	494
28	GN27	38,44	2,40	13,56	9,83	72,49	56,81	210,0	6,42	4,60	2,18	0,87	3,56	4,13	2,57	3,74	494
29	GN18	35,14	2,70	15,02	9,90	65,91	48,71	151,0	5,92	4,20	3,56	2,76	4,91	5,12	2,46	3,74	492
30	GN113	15,27	2,50	13,18	9,21	69,88	40,40	189,0	3,53	3,50	4,24	4,04	7,14	6,84	2,89	3,70	492
31	GN83	40,94	1,80	27,00	15,31	56,70	69,89	284,0	5,95	4,00	3,70	2,74	5,27	5,78	2,19	3,74	491
32	GN116	29,85	2,80	24,65	12,54	50,86	47,61	209,0	5,39	4,20	3,54	3,49	5,41	5,76	2,78	4,85	490
33	GN91	22,73	2,80	17,96	9,44	52,56	49,06	260,0	6,02	3,50	3,94	3,38	5,50	6,28	2,49	3,74	487
34	GN40	36,55	3,10	20,00	10,81	54,05	50,38	210,0	5,79	3,70	5,82	3,64	6,23	6,23	2,29	3,74	486
35	GN20	37,71	2,80	22,18	11,16	50,31	47,61	175,0	6,96	3,80	4,30	3,10	5,68	5,84	2,61	3,74	481

GNTP= Genotype code; BWW=Bunch wet weight (g); Y= Yield (1/4); BDW=Bunch dried weight (g); FPP=Fruit flesh powder (g); FPPE= Fruit flesh powder efficiency (%); BW=Bunch width (mm); BS=Bunch size (mm); DBS=Diameter of bunch stem (mm); DFB=Density of fruit on the bunch (1/3); WWFP=Weight of 100 wet fruit pieces (g); WDFP=Weight of 100 dried fruit pieces (g); FW=Fruit width (mm); FS=Fruit Size (mm); TP=Thickness of pericarp (mm); WCF=Waxy cuticle on fruit (1/5)

length and width of the bunch is higher than the Iranian sumacs are the climatic factors, soil structure, altitude between the two countries. Yilmaz (2021) reported that the width of the bunch varied between 27.95 mm and 73.91 mm in his study. The average fruit width was 5.57 mm and it varied between the lowest 3.56 mm (GN-27) and the highest 7.14 mm (GN-113). The average value of fruit length was measured as 5.55 and it was calculated between the lowest 3.53 mm (GN-41) and the highest 7.71 mm (GN-98). Fereidonfaar et al. (2018) measured that the fruit lengths of 136 sumac genotypes between 2.98 -4.54 mm and fruit width between 3.20-4.49 mm. Yilmaz (2021), fruit lengths in the range of 7.24-5.45 mm in 25 promising sumac genotypes. Fruit thicknesses were measured between 0.97 mm (GN-28) - 5.40 mm (GN-2). Mazaheri et al. (2017) recorded that the sizes of sumac fruits from Iran's Gonabad, Ferdows and Zohk regions were 3.84 mm, 3.58 mm, and 3.6 mm respectively. The diameter of the sumac fruit sample taken from Turkey was measured as 3.64 mm. Özcan and Hacıseferogullari (2004) reported that average fruit length and fruit width as 4.72 mm and 3.90 mm in Turkey. In addition, the fruit sizes are relatively larger and compatible with the literature in our study. It is thought that the reason for the larger fruit sizes may be related to the geographical, climate and soil structure of Kahramanmaraş. 100 fruits weight the highest GN-50 (6.18 g) and the lowest GN-28 (0.87 g) average was 2.76 g. Fereidoonfar et al. (2018) observed that the weight of 10 fruits in Iranian sumac ranged between 0.06 g and 0.21 g with an average of 0.14 grams. Yilmaz (2021) stated that the weight of 100 fruits varied between 2.40 g and 4.14 g in 25 promising sumac genotypes. It is understood that the sumac (*R. coriaria*) genotypes differ from each other in terms of all characteristics and show a wide distribution.

Table 3(b). Pomological analyzes of selected sumac (*R. coriaria* L.) genotypes

NO	GNTP	BWW	Y	BDW	FPP	FPPE	BW	BS	DBS	DFB	WWFP	WDFP	FW	FS	TP	WCF	TOTAL
36	GN53	42,87	2,75	27,53	11,23	40,79	65,07	208,0	5,53	4,70	3,68	2,96	5,18	4,77	2,76	4,00	481
37	GN30	52,63	2,50	41,12	15,26	37,11	46,38	200,0	7,13	4,70	4,86	3,40	5,83	6,44	2,85	3,20	478
38	GN37	39,17	2,90	23,41	9,74	41,61	70,19	197,0	4,48	4,00	4,92	1,38	6,32	5,39	2,22	3,74	477
39	GN84	37,95	2,50	21,56	12,22	56,68	48,24	143,0	4,96	4,70	3,34	1,92	5,75	5,62	2,27	3,74	474
40	GN75	27,78	3,00	27,67	12,34	44,60	59,42	153,0	4,00	4,00	3,20	3,16	6,07	5,32	3,06	4,30	469
41	GN39	21,76	3,40	15,20	7,76	51,05	37,82	150,0	4,56	4,10	3,50	2,84	4,99	5,05	2,37	3,74	460
42	GN42	29,91	2,00	11,63	7,83	67,33	79,12	262,0	5,78	3,50	2,70	1,18	4,47	5,53	1,97	3,74	460
43	GN24	22,85	3,00	17,62	8,40	47,68	45,56	165,0	4,47	4,30	3,54	3,02	5,17	5,64	2,10	3,74	458
44	GN86	78,92	2,00	37,55	17,54	46,71	70,61	122,0	6,43	5,00	4,64	2,64	6,70	6,20	2,54	3,74	457
45	GN59	45,27	1,80	31,96	16,27	50,91	59,92	218,0	5,67	4,00	4,06	2,76	4,90	5,68	2,35	3,75	455
46	GN48	37,47	2,00	18,25	9,81	53,75	46,07	155,0	5,47	4,50	4,88	2,90	6,69	5,87	2,35	3,74	446
47	GN56	20,03	3,00	16,55	8,02	48,46	33,09	190,0	4,12	4,10	2,98	2,57	5,23	5,22	2,40	4,60	444
48	GN50	22,41	2,70	16,49	10,09	61,19	45,62	150,0	5,50	3,60	6,18	3,54	6,59	5,39	2,53	3,74	442
49	GN2	26,93	2,71	13,99	7,27	51,97	64,50	146,0	5,34	4,30	3,64	1,98	6,04	5,52	5,40	2,33	440
50	GN23	23,85	2,80	18,09	8,88	49,09	41,13	230,0	4,78	3,50	3,12	2,14	5,19	5,19	2,23	3,74	436
51	GN98	19,45	3,00	15,14	8,71	57,53	33,29	130,0	5,12	3,50	5,78	5,18	6,23	7,71	2,75	3,20	434
52	GN43	15,52	2,50	7,34	5,05	68,80	42,75	132,0	5,18	3,90	2,33	1,25	4,84	5,76	1,99	3,74	434
53	GN104	37,55	2,50	25,75	11,15	43,31	55,45	200,0	6,74	4,40	3,32	2,42	5,09	4,37	1,87	2,80	434
54	GN92	22,00	2,90	15,77	7,81	49,52	37,79	189,0	8,22	3,40	3,14	2,16	5,97	5,82	2,00	3,74	426
55	GN57	26,77	2,50	24,71	12,19	49,32	40,41	202,0	7,13	3,30	3,00	2,74	5,92	5,33	2,89	3,74	425
56	GN47	14,45	2,80	11,50	5,85	50,87	36,97	122,5	4,54	3,90	4,28	3,48	5,68	6,28	2,38	3,74	417
57	GN88	36,96	2,25	33,46	16,78	50,15	52,61	107,0	4,78	4,80	4,64	3,82	6,67	5,34	2,49	3,74	416
58	GN99	28,88	2,70	26,90	12,78	47,51	45,36	214,0	5,64	2,80	3,18	3,06	5,70	5,21	2,07	2,80	416
59	GN22	23,08	2,80	19,07	8,92	46,78	38,63	200,0	4,57	3,60	3,06	2,44	5,37	5,65	2,22	3,74	414
60	GN72	27,82	2,50	27,09	11,10	40,97	51,03	167,0	5,35	4,30	3,47	3,39	6,21	5,60	2,77	3,74	414
61	GN81	15,00	3,30	14,38	7,53	52,36	48,10	139,0	5,31	2,40	1,50	1,44	4,96	5,04	1,86	3,74	413
62	GN35	23,23	2,90	21,75	8,55	39,31	46,58	227,0	4,33	2,80	3,62	3,92	6,19	6,04	2,84	4,00	411
63	GN77	20,50	2,70	20,26	9,45	46,64	39,03	176,0	4,39	4,00	4,06	3,92	6,13	5,48	3,20	4,00	411
64	GN100	30,68	2,50	27,71	12,88	46,48	53,75	147,0	5,23	4,00	2,36	1,95	4,70	5,91	2,64	3,00	410
65	GN112	13,04	3,00	11,59	5,47	47,16	37,02	173,0	5,92	3,50	4,78	4,49	4,96	5,32	2,59	3,74	409
66	GN21	10,00	2,80	9,33	4,97	53,30	26,93	165,0	4,51	4,50	2,14	1,56	5,71	5,02	2,98	4,00	408
67	GN36	23,10	2,80	22,18	9,20	41,48	36,98	186,0	4,47	3,70	3,22	3,10	5,85	5,52	2,51	3,80	407
68	GN95	15,78	2,50	15,28	8,03	52,55	42,04	180,0	4,34	4,00	3,10	2,30	4,85	4,15	2,48	4,20	406
69	GN29	13,78	3,00	8,76	4,26	48,63	36,56	170,0	5,10	4,00	2,60	2,40	5,17	5,54	2,00	4,50	398
70	GN67	12,84	2,50	11,52	6,54	56,77	34,06	18,10	5,12	3,00	3,30	3,10	6,29	5,92	2,48	3,30	393
71	GN49	19,31	2,50	17,98	8,52	47,39	44,22	14,30	4,95	3,80	4,06	3,90	5,36	6,46	2,58	3,74	391

GNTP= Genotype code; BWW=Bunch wet weight (g); Y= Yield (1/4); BDW=Bunch dried weight (g); FPP=Fruit flesh powder (g); FPPE= Fruit flesh powder efficiency (%); BW=Bunch width (mm); BS=Bunch size (mm); DBS=Diameter of bunch stem (mm); DFB=Density of fruit on the bunch (1/3); WWFP=Weight of 100 wet fruit pieces (g); WDFP=Weight of 100 dried fruit pieces (g); FW=Fruit width (mm); FS=Fruit Size (mm); TP=Thickness of pericarp (mm); WCF=Waxy cuticle on fruit (1/5)

CONCLUSION

It has been revealed that there are sumac genotypes with different botanical characteristics (*R. coriaria*) which have a natural distribution in the Eastern Mediterranean Transition Region and these genotypes might be used in modern fruit growing. It was understood that these genotypes showed wide variations in terms of pomological characteristics and it is concluded that 20 genotypes showed more promising characteristics and it is important to use them in future studies. In addition, the molecular identification of 20 botanically defined genotypes will be used for future hybridizations.

Table 3(c). Pomological analyzes of selected Sumac (*R.coriaria* L) genotypes

NO	GNTP	BWW	Y	BDW	FPP	FPPE	BW	BS	DBS	DFB	WWFP	WDFP	FW	FS	TP	WCF	TOTAL
72	GN114	32,79	2,50	25,38	8,56	33,73	50,67	243,0	6,56	4,00	3,30	2,76	5,67	5,22	2,92	4,50	391
73	GN80	17,58	2,50	17,51	8,20	46,83	45,77	116,0	4,53	3,80	3,06	1,17	6,59	5,76	2,69	3,74	386
74	GN8	41,58	1,80	26,44	11,14	42,13	53,80	225,0	10,59	4,00	4,08	3,44	5,58	5,93	2,50	3,00	380
75	GN66	15,13	2,75	14,13	6,67	47,20	33,88	160,0	4,45	3,80	2,20	1,95	6,14	5,04	2,71	3,74	375
76	GN74	12,15	2,75	12,09	6,01	49,71	32,01	135,0	3,44	4,00	2,90	2,78	5,05	5,27	3,17	3,20	374
77	GN44	16,03	2,75	13,50	5,96	44,15	46,13	203,0	4,31	3,00	2,38	2,07	4,59	5,11	2,40	3,74	367
78	GN97	17,34	2,00	14,77	7,52	50,90	65,67	186,0	4,56	3,50	3,44	3,12	5,47	5,25	2,45	3,00	365
79	GN55	16,11	2,40	15,25	7,39	48,46	39,54	153,0	5,90	4,00	2,84	2,90	4,73	5,10	2,08	3,74	363
80	GN71	11,23	2,00	10,67	5,35	50,14	42,31	151,0	2,67	3,80	4,12	3,76	5,12	6,16	3,01	4,50	363
81	GN69	18,72	3,00	18,49	7,21	38,99	32,86	175,0	5,63	3,70	2,47	2,35	4,34	5,06	2,23	3,74	361
82	GN78	13,37	3,00	12,33	5,75	46,63	32,09	184,0	5,15	2,50	1,80	1,74	5,62	6,16	2,09	3,74	355
83	GN38	22,89	2,50	16,29	7,25	44,51	43,52	183,0	5,01	3,80	1,85	1,43	4,31	3,69	1,99	3,74	348
84	GN52	21,15	2,00	19,61	7,55	38,50	45,64	186,0	7,07	3,80	4,02	4,00	6,66	5,43	2,74	3,74	345
85	GN82	10,01	2,25	24,15	11,42	49,15	32,51	162,0	6,47	2,30	2,35	2,76	4,63	5,28	2,41	3,74	342
86	GN46	9,90	2,75	3,15	2,05	65,08	28,94	95,0	3,38	1,50	0,92	0,82	4,92	4,25	2,52	3,74	339
87	GN103	26,92	2,00	16,83	7,25	43,08	66,62	292,0	5,12	2,70	1,83	1,48	5,66	5,65	2,34	4,00	335
88	GN41	6,00	3,20	5,93	3,44	58,01	29,02	153,0	5,26	1,70	1,04	0,30	3,65	3,53	1,73	3,74	331
89	GN73	10,63	2,50	10,14	4,86	47,93	32,91	200,0	5,48	2,20	2,49	4,86	5,75	5,11	2,63	3,74	326
90	GN70	9,28	3,00	8,91	4,39	49,27	28,41	150,0	3,21	2,30	1,68	1,47	4,76	4,65	1,97	3,74	322
91	GN79	10,83	2,00	10,30	4,77	46,31	34,01	168,0	5,15	3,10	2,04	1,98	4,54	4,80	2,40	3,74	286
92	GN28	5,63	2,40	4,98	2,80	56,22	38,53	134,0	5,01	2,00	0,87	0,71	4,35	4,28	0,97	3,74	284
Minimum		**5,63**	**1,80**	**3,15**	**2,05**	**30,63**	**26,93**	**95,0**	**2,67**	**1,50**	**0,87**	**0,30**	**3,56**	**3,53**	**0,97**	**2,33**	**284**
Maximum		**87,74**	**3,60**	**67,82**	**28,98**	**72,49**	**96,77**	**292,0**	**10,59**	**5,00**	**6,18**	**5,18**	**7,14**	**7,71**	**5,40**	**4,85**	**760**
Mean		**31,80**	**2,71**	**24,15**	**11,42**	**49,15**	**50,24**	**186,2**	**5,57**	**3,88**	**3,45**	**2,76**	**5,57**	**5,55**	**2,52**	**3,74**	**456**
Stand. deviation		±18,14	±0,40	±13,07	±5,69	±7,83	±14,60	±4,34	±1,27	±0,74	±1,05	±0,92	±0,71	±0,69	±0,49	±0,43	±89

GNTP= Genotype code; BWW=Bunch wet weight (g); Y= Yield (1/4); BDW=Bunch dried weight (g); FPP=Fruit flesh powder (g);FPPE= Fruit flesh powder efficiency (%);BW=Bunch width (mm);BS=Bunch size (mm);DBS=Diameter of bunch stem (mm);DFB=Density of fruit on the bunch (1/3);WWFP=Weight of 100 wet fruit pieces (g);WDFP=Weight of 100 dried fruit pieces (g);FW=Fruit width (mm);FS=Fruit Size (mm); TP=Thickness of pericarp (mm); WCF=Waxy cuticle on fruit (1/5)

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

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