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Araştırma Makalesi (Research Article)

**Fruit Properties of Rose Hip (*Rosa spp.*) Genotypes Selected from Akkuş,
Ordu Province****

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Abstract: In this study, fruit properties of 19 rose hip (*Rosa spp.*) genotypes selected from a large number of genotypes in the natural rose hip population in Akkuş district (Ordu province) in 2014-2015 were determined. The genotypes belonged to *Rosa dumalis* Bechst., *Rosa gallica* L. and *Rosa canina* species. They had a range of 1.22-3.47 g in fruit weight, 10.2-16.9 mm in fruit width, 13.2-25.2 mm in fruit length, 1.25-2.09 in fruit shape index, 62-72% in fruit flesh ratio, 16-35 in seed number, 13.6-24.4% in total soluble solids, 560-1025 mg 100g⁻¹ in C vitamin content, and 1.06-2.48 Brix° in titratable acidity. The five genotypes were less thorny plants. The two genotypes (AK-75 and AK-20) were evaluated as promising in terms of fruit weight and fruit flesh ratio. In addition, AK-63 for TSS content and AK-16 for vitamin C content were found remarkable. Findings revealed that some genotypes could be valuable as genetic material for future breeding efforts.

**Ordu ili Akkuş Yöresinden Seçilen Kuşburnu (*Rosa spp.*) Genotiplerinin
Meyve Özellikleri**

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Anahtar kelimeler

Meyve,
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Öz: 2014-2015 yıllarında yürütülen bu çalışmada, Ordu ili Akkuş yöresi doğal kuşburnu popülasyonunda çok sayıda genotip arasından seçilen 19 kuşburnu (*Rosa spp.*) genotipinin meyve özellikleri belirlenmiştir. *Rosa dumalis* Bechst., *Rosa gallica* L. ve *Rosa canina* türlerine ait olan genotiplerde meyve ağırlığı 1.22-3.47 g, meyve genişliği 10.2-16.9 mm, meyve uzunluğu 13.2-25.2 mm, meyve şekil endeksi 1.25-2.09, meyve eti oranı %62-72, tohum sayısı 16-35, suda çözünebilir kuru madde miktarı 13.6-24.4 °briks, C vitamini içeriği 560-1025 mg 100g⁻¹ ve titre edilebilir asitlik %1.06-2.48 aralığında değişim göstermiştir. Beş genotip az dikenli bulunurken, iki genotip (AK-75 ve AK-20) meyve ağırlığı ve meyve eti oranı açısından ümitvar olarak değerlendirilmiştir. Bunun yanında, suda çözünebilir kuru madde miktarı bakımından AK-63 ve C vitamini içeriği bakımından AK-16 dikkat çekici bulunmuştur. Bulgular, bazı genotiplerin gelecekteki ıslah çabaları için genetik materyal olarak değerli olabileceğini ortaya çıkarmıştır.

** This study was obtained from M. Sc. thesis data.

1. Introduction

Anatolia, where 25 *Rosa* species are grown, is among the natural spreading areas of *Rosa* species (Ercişli, 2005). Wild rose hip populations are distributed in all regions of Turkey, and they have a wide genetic diversity due to seed propagation and open pollination conditions since ancient times. These populations can contribute as valuable genetic resources to breeding programs aiming high yields, good fruit properties and resistance to diseases and pests (Çelik, 2007).

Rose hip, whose value is recognized in terms of human health, is in high demand today. Rose hip fruit contains natural antioxidants, minerals, carotenoids, bioflavonoids, tocopherol, fruit acids, vitamin C, pectin, tannin and amino acids (Ercişli, 2007). The chemical content of its fruit can vary to species, variety, genotype, growing ecology, altitude, harvest season and stage of fruit maturation. Rose hip is widely used in food, pharmacy and cosmetics industry (Yıldız and Çelik, 2011). It is valued as a valuable raw material in the food and pharmaceutical industry in many European countries such as Russia, Germany, Switzerland and Finland. In these countries, rose hip fruit is used in fruit gel, baby food, fruit juice, marmalade and tea form, as an additive in pastry and confectionery industry, and also in vitamin-enrichment of other fruit and vegetable juices (Kızılcı, 2005; Dölek, 2008). In Turkey, rose hip is processed as fruit juice, marmalade, pulp and tea in factories and establishments in Gümüşhane, Erzincan and Tokat (Kızılcı, 2005).

Rose hip breeding programs are carried out in countries such as Bulgaria, Czechoslovakia, Germany, Russia and Sweden to develop commercial varieties. Our country is rich in rose hip genetic resources (Ercişli, 2005). In this respect, it is important to investigate the natural rose hip populations spreading to all regions and to select valuable genotypes with high yield and fruit quality. The first works on the selection of rose hip germplasm in Turkey started in 1990s, as a result of researches carried out up to the present many promising selections have been identified for yield and fruit characteristics. Although some studies on the registration of promising genotypes are still going on, there is yet no registered rose hip cultivar found in Turkey. On the other hand, rose hips grown in almost every region of our country are used as firewood in many places and this leads to the destruction of rose hip genetic resources.

The aim of this study was to select promising genotypes from the natural rose hip population in Akkuş district of Ordu province and to describe their fruit characteristics for future breeding efforts.

2. Materials and Methods

2.1. Materials

The material of the research consisted of wild rose hip plants growing in Akkuş district of Ordu Province. Fruit samples were collected from wild plants during the harvest season. Akkuş district is surrounded by Kumru in the east, Erbaa and Çarşamba in the west, Terme and Ünye in the north and Niksar in the south. The mountains are covered with forests up to the peaks. The town center is located on a small plateau between the mountains at an altitude of 1 300 meters. The district has no major rivers and lakes, but it has small creeks and streams. The most important of these is Tifi stream. The forest area corresponds to 65% of the overall surface area and is 412 451 km². Beech trees constitute 90% of the forest. A small amount of yellow pine and oak species are also available. Akkuş district has different climate structures. Inner Black Sea climate prevails in the northern part, continental (Central Anatolia) climate in the southern part and gate climate in the central part. Winters are hard and long, summers are short and cool. The average annual rainfall is 1000 mm. The average cultivable land depth in the district is 50 cm. Soil pH reaction is about 6-7.5. In general, soil structure is loamy (58%) and clayey-loamy (42%), barren, stony and weak features (Anonymous, 2017).

2.2. Methods

In order to determine the promising genotypes in the naturally grown rose hip population in the district, a large of of plants were investigated by observation before harvest season, and the plants marked according to the selection criteria such as fruit size, fruitfulness and thorn density were numbered. Each labeled plant was evaluated as a genotype. Fruit samples were taken from these plants

during the harvest season. Care was taken not to collect fruit samples from plants with very small fruits, over-thorny, low fruitful, and disease and pest infestation. In the study, 106 wild rose hip plants were assessed within native population. At least 100 fruit samples were randomly taken from each of these plants during the harvest season. According to the fruit analyses of the first year, 30 genotypes with the lowest fruit weight and vitamin C contents were eliminated. Thus, the number of genotypes was reduced to 76 in the second year. All genotypes were compared to the Weighted Ranked Method (WRM) that based on 6 criteria such as fruit weight, fruit flesh ratio, vitamin C content, total soluble solids content, thorn density and fruitfulness (Akkuş, 2016; Ersoy and Özen, 2016). The 19 genotypes with the highest WRM scores were selected and their fruit characteristics were described. Fruit samples randomly collected from the genotypes were measured and analyzed in Ordu University Faculty of Agriculture Department of Horticulture. For genotypes, values of fruit weight, fruit width, fruit length, fruit flesh ratio, fruit shape, fruit shape index, seed weight, seed number, vitamin C content, titratable acidity (TA), total soluble solids (TSS) and pH were determined. The content of Vitamin C was quantified with the reflectometer set of Merck Co (Merck RQflex). In addition, fruit color, fruit shape, thorn density, fruitfulness, and fruit exterior pubescence were identified.

3. Results

Within the natural rose hip population at 1100-1300 m altitude in the district, 71 *Rosa canina*, 15 *Rosa gallica* L. and 20 *Rosa dumalis* Bechst. genotypes were examined for two years (in 2014-2015). Having the highest WRM scores, 19 genotypes were selected promising, and their fruit characteristics were identified in this study.

Table 1. Values of fruit weight, seed weight, seed number, fruit flesh weight, fruit flesh ratio, fruit length, fruit width, fruit shape index for 19 rose hip (*Rosa* spp.) genotypes selected from Akkuş, Ordu Province (2014-2015).

Genotype	Species	Fruit Weight (g)	Seed Weight (g)	Seed Number	Fruit Flesh Weight (g)	Fruit Flesh Ratio (%)	Fruit Length (mm)	Fruit Width (mm)	Fruit Shape Index
AK-75	<i>Rosa dumalis</i> Bechst.	3.47	0.99	28	2.48	71	25.2	16.9	1.48
AK-65	<i>Rosa dumalis</i> Bechst.	2.08	0.66	27	1.42	68	23.3	12.8	1.83
AK-36	<i>Rosa dumalis</i> Bechst.	1.73	0.47	21	1.26	71	20.6	12.5	1.63
AK-100	<i>Rosa dumalis</i> Bechst.	1.70	0.63	27	1.07	62	21.7	12.1	1.80
AK-82	<i>Rosa dumalis</i> Bechst.	1.58	0.54	25	1.04	65	17.8	12.7	1.41
AK-37	<i>Rosa dumalis</i> Bechst.	1.49	0.52	22	0.97	68	21.4	10.4	2.09
AK-86	<i>Rosa gallica</i> L.	2.17	0.75	35	1.42	65	19.8	14.5	1.37
AK-87	<i>Rosa gallica</i> L.	2.06	0.67	31	1.39	67	13.2	10.5	1.25
AK-16	<i>Rosa gallica</i> L.	1.71	0.57	27	1.14	65	18.5	12.9	1.42
AK-20	<i>Rosa canina</i>	2.04	0.58	24	1.46	71	20.7	13.4	1.55
AK-3	<i>Rosa canina</i>	2.22	0.83	32	1.39	63	19.8	14.7	1.34
AK-44	<i>Rosa canina</i>	1.78	0.53	21	1.25	71	19.2	13.0	1.48
AK-63	<i>Rosa canina</i>	1.72	0.49	22	1.23	71	20.2	13.0	1.56
AK-70	<i>Rosa canina</i>	1.62	0.43	16	1.19	72	20.8	11.6	1.79
AK-61	<i>Rosa canina</i>	1.68	0.55	23	1.13	68	22.2	12.0	1.83
AK-83	<i>Rosa canina</i>	1.66	0.55	24	1.11	66	20.2	12.4	1.61
AK-54	<i>Rosa canina</i>	1.54	0.44	17	1.10	71	18.6	12.5	1.47
AK-56	<i>Rosa canina</i>	1.45	0.46	20	0.99	68	18.9	12.1	1.56
AK-98	<i>Rosa canina</i>	1.22	0.40	19	0.82	68	17.4	10.2	1.70

Values of fruit weight, seed weight, seed number, fruit flesh weight, fruit flesh ratio, fruit length, fruit width, fruit shape index recorded for promising genotypes were presented in Table 1. Fruit weight was recorded between 1.22 g and 3.47 g. The six genotypes (AK-75, AK-20, AK-65, AK-86, AK-3 and AK-87) had fruits over 2 g. Seed weight changed between from 0.40 g to 0.99 g. Genotypes produced 16-35 seeds per fruit. Fruit flesh weight varied between 0.82 to 2.48 g. Fruit flesh ratio ranged from 62% to 71%, and it was determined over 70% for seven genotypes. In addition, genotypes had a range of 13.2-25.2 mm for fruit length, 10.2-16.9 mm for fruit width and 1.25-2.09 for fruit shape index (Table 1).

Table 2. The total soluble solids (TSS), vitamin C and titratable acidity (TA) values for 19 rose hip (*Rosa* spp.) genotypes selected from Akkuş district, Ordu Province (2014-2015).

Genotype	Species	TSS (Brix°)	TA (%)	Vitamin C (mg 100g ⁻¹)
AK-75	<i>Rosa dumalis</i> Bechst.	15.4	2.48	795
AK-65	<i>Rosa dumalis</i> Bechst.	21.2	1.73	750
AK-36	<i>Rosa dumalis</i> Bechst.	16.4	1.53	670
AK-100	<i>Rosa dumalis</i> Bechst.	17.8	1.17	710
AK-82	<i>Rosa dumalis</i> Bechst.	15.8	1.20	815
AK-37	<i>Rosa dumalis</i> Bechst.	18.0	1.81	745
AK-86	<i>Rosa gallica</i> L.	18.4	2.13	750
AK-87	<i>Rosa gallica</i> L.	13.6	1.06	770
AK-16	<i>Rosa gallica</i> L.	14.2	1.22	1025
AK-20	<i>Rosa canina</i>	17.8	1.32	725
AK-3	<i>Rosa canina</i>	15.4	1.79	945
AK-44	<i>Rosa canina</i>	15.4	2.07	885
AK-63	<i>Rosa canina</i>	24.4	2.05	560
AK-70	<i>Rosa canina</i>	21.2	1.91	905
AK-61	<i>Rosa canina</i>	14.2	1.18	815
AK-83	<i>Rosa canina</i>	14.8	1.11	860
AK-54	<i>Rosa canina</i>	16.6	1.61	845
AK-56	<i>Rosa canina</i>	14.0	1.08	765
AK-98	<i>Rosa canina</i>	22.3	1.88	760

Table 3. Descriptions regarding fruitfulness, thorn density, fruit color, fruit shape and fruit exterior pubescence based on species for 19 rose hip (*Rosa* spp.) genotypes selected from Akkuş district, Ordu Province.

Genotype	Species	Fruitfulness	Thorn Density	Fruit Color	Fruit Shape	Fruit Exterior Pubescence
AK-75	<i>Rosa dumalis</i> Bechst.	Medium	High	Orange	Oval	Absent
AK-65	<i>Rosa dumalis</i> Bechst.	Medium	High	Red	Conical	Absent
AK-36	<i>Rosa dumalis</i> Bechst.	Medium	High	Orange	Conical	Absent
AK-100	<i>Rosa dumalis</i> Bechst.	High	Medium	Orange	Conical	Absent
AK-82	<i>Rosa dumalis</i> Bechst.	Medium	Low	Orange	Oval	Absent
AK-37	<i>Rosa dumalis</i> Bechst.	High	High	Red	Cylindrical	Absent
AK-86	<i>Rosa gallica</i> L.	High	Low	Red	Round	Absent
AK-87	<i>Rosa gallica</i> L.	Low	Medium	Red	Round	Absent
AK-16	<i>Rosa gallica</i> L.	High	Medium	Orange	Oval	Absent
AK-20	<i>Rosa canina</i>	Medium	High	Orange	Oval	Absent
AK-3	<i>Rosa canina</i>	Medium	High	Orange	Round	Absent
AK-44	<i>Rosa canina</i>	Medium	High	Red	Oval	Absent
AK-63	<i>Rosa canina</i>	Medium	Medium	Red	Oval	Absent
AK-70	<i>Rosa canina</i>	Medium	High	Orange	Conical	Absent
AK-61	<i>Rosa canina</i>	High	Low	Orange	Conical	Absent
AK-83	<i>Rosa canina</i>	Low	Low	Orange	Conical	Absent
AK-54	<i>Rosa canina</i>	Medium	Medium	Red	Oval	Absent
AK-56	<i>Rosa canina</i>	High	Low	Orange	Oval	Absent
AK-98	<i>Rosa canina</i>	High	Medium	Red	Conical	Absent

The fruits of 19 rose hip selections contained TTS between 13.6 and 24. brix°. The content of total soluble solids was higher than %20 in four genotypes (AK-63, AK-65, AK-70 and AK-98). The TA was determined between 1.06% and 2.08%. pH value changed between 3.53-4.95. The content of vitamin C was found from 560 mg 100 g⁻¹ to 1025 mg 100 g⁻¹ (Table 2).

On the other hand, the species of rose hip selections were *Rosa canina*, *Rosa dumalis* Bechst. and *Rosa gallica* L. All selections had red and orange colored, and round, oval, conical and cylindrical shaped fruits. The pubescence of fruit exterior was absent for all selections. While the density of thorn was observed as low, medium and high, it was low for five genotypes (AK-56, AK-61, AK-82, AK-83 and AK-86). Plant fruitfulness was evaluated as high for seven genotypes (AK-16, AK-37, AK-56, AK-61, AK-86, AK-98 and AK-100), medium for ten genotypes and low for two genotypes (Table 3).

4. Discussion

As it is known, fruit size, high fruit flesh ratio, high contents of dry matter and vitamin C, fruitfulness and thornless plant, suitability for mechanical harvest, easy propagation, resistance to disease and damages are emphasized as important characters for rose hip cultivar breeding efforts (Çelik, 2007).

In Turkey, many studies were conducted on native rose hip genetic resources in different areas, several fruit and plant characteristics were identified for many genotypes (Ercişli and Eşitken, 2004; Türkben et al., 2005; Doğan and Kazankaya, 2006; Çelik et al., 2009; Sağır, 2010; Güneş, 2011; Yıldız and Çelik, 2011; Ekincialp and Kazankaya, 2012; Çelik et al., 2015; Akkuş, 2016; Ersoy and Özen, 2016). In this study carried out in the wild rose hip population of Akkuş (Ordu province), fruit and some plant characteristics of 19 promising genotypes selected according to the selection criteria were identified.

In developing rose hip cultivar suitable for the industry, cultivars with large-sized fruits and high fruit flesh ratio are desired (Çelik et al., 2009). In this study, the promising genotypes exhibited a range of 1.22-3.47 g for fruit weight and 62-72% for fruit flesh ratio. For some rose hip (*Rosa* spp.) genotypes from different areas in Turkey, the range of fruit weight and fruit flesh ratio were reported as 3.14-4.80 g and 63.1-71.1% from Erzurum (Ercişli and Eşitken, 2004), 2.04-6.10 g and 46.8-79.9% from Bitlis, Hakkâri and Van regions (Kazankaya et al., 2005), 2.21-6.16 g and 61.3-80.4% from Gumushane and Erzincan (Kızılcı, 2005), 1.37-3.04 g and 45.8-79.4% from Amasya (Dölek, 2008), 1.79-4.95 g and 66.4-100% from Lake Van Basin (Çelik et al., 2009), 1.65-2.78 g and 63.8-75.0% from Akıncılar, Sivas (Sağır, 2010), 1.82-4.09 g and 55.2-85.0% from Muradiye (Yıldız and Çelik, 2011), 1.52-3.92 g and 59.3-76.6% from Hakkari (Ekincialp and Kazankaya, 2012), 1.44-4.69 g and 60-79% from Hamur, Ağrı (Akkuş, 2016), 1.40-2.77 g and 64-9-82.8% (Ersoy and Özen, 2016), respectively. In addition, Cheikh-Affene et al. (2013) reported that rose hip genotypes (*Rosa* spp.) from Tunisia had a range of 0.9-1.9 g for fruit weight and 63.6-73.7% for fruit flesh ratio. Soare et al. (2015) recorded 1.17-2.86 g fruit weight for rose hip genotypes (*Rosa* spp.) from Romania. It is possible to establish various similarities between the promising genotypes of this study and some rosehip genotypes and selections mentioned in the above studies. The values of fruit weight and fruit flesh ratio determined in some studies seem higher than those of this research. In this study, AK-75 was remarkable in terms of fruit weight (3.47 g) and fruit flesh ratio (71%). Promising genotypes had smaller fruits than those of most research above.

It has been reported that the chemical composition of rose hip fruit could be affected by many factors such as species, cultivar, genotype, growing ecology, altitude, harvest time and maturation stage (Ercişli, 2007; Çelik et al., 2009; Akkuş, 2016).

Due to its high vitamin C content, which is regarded as criteria of selection for cultivar breeding efforts, rosehip is used not only for making marmalade and juice, but also as additive material to enrich the vitamin C content of several fruit juices (Çelik et al., 2009). The promising genotypes had a range of 560-1025 mg 100g⁻¹ for Vitamin C content. In many studies, the ranges of vitamin C content per 100 g fresh weight for rosehip genotypes and selections were reported as 1074-2557 mg (Ercişli and Eşitgen, 2004), 301-1183 mg (Kazankaya et al., 2005), 305-945 mg (Kızılcı, 2005), 108-908 mg (Dölek, 2008), 517-1032 mg (Çelik et al., 2009), 438-766 mg (Sağır, 2010), 616-867 mg (Rosu et al., 2011), 330-535 mg (Yıldız and Çelik, 2011), 414-916 mg (Ekincialp and Kazankaya, 2012), 372-737 mg (Cheikh-Affene et al., 2013), 332-1603 mg (Ersoy and Özen, 2013), 53-563 mg (Soare et al., 2015), 540-1315 mg (Akkuş, 2016) and 402-511 mg (Alp et al., 2016). Many selected genotype of this study had vitamin C content similar to those of related studies.

TSS content of the selected genotypes varied between 13.6% and 24.4%. For rose hip (*Rosa* spp.) genotypes from different areas, TSS ranges were reported as 31-36.7% (Ercişli and Eşitgen, 2004), 14.8-36.2% (Kazankaya et al., 2005), 14-30.8% (Kızılcı, 2005), 22-40% (Türkben et al., 2005), 15.9-32.8% (Dölek, 2008), 17.7-28.4% (Çelik et al., 2009), 23.2-33.9 (Sağır, 2010), 11.5-17.6% (Rosu et al., 2011), 15-26.2% (Yıldız and Çelik, 2011), 14.2-27.5% (Ekincialp and Kazankaya, 2012), 24.1-30.5% (Ersoy and Özen, 2013), 10-18% (Soare et al., 2015), 9-32% (Akkuş, 2016) and 17.6-22.8% (Alp et al., 2016). In addition, the promising selections had a range of 1.06-2.48% for TA. The range of TA for numerous many rose hip (*Rosa* spp.) genotypes were recorded as 1.25-3.23% (Kızılcı, 2005), 0.66-0.85% (Doğan and Kazankaya, 2006), 1.09-2.50% (Dölek, 2008), 0.67-1.89% (Sağır,

2010), 1.38-3.50% (Yıldız and Çelik, 2011), 1.4-3.6% (Soare et al., 2015), 0.05-0.22% (Akkuş, 2016) and 0.04-1.55% (Ersoy and Özen, 2016). The findings on TSS and TA contents were in agreement with above many literatures.

On the other hand, the productivity and thorny status of the rose hip plant are also among the valuable characters for the variety breeding efforts (Ercişli and Eşitgen, 2004; Çelik, 2007). In this study, the thorny density was high for 8 genotypes, medium for 5 genotypes and low for 5 genotypes. In the researches conducted on the genetic resources in Turkey, numerous few, medium and very thorny and fruitful rose hip genotypes have been identified. In addition, a small number of thornless genotypes have also been reported (Ercişli and Eşitgen, 2004; Çelik et al., 2009; Çelik et al. 2015; Akkuş, 2016).

As an excellent resource of rose hip genetic material, the diversity could contribute to future breeding efforts that aim at the valuable traits, such as high yield, fruit characteristics, bioactive compounds, and resistance to disease and pests (Sanderson and Fillmore, 2010). The results indicated genetic variation in the native rosehip germplasm of the district.

4. Conclusion

Rosehip, which has a wide spreading area in the world, has started to draw attention with the studies carried out in recent years. Turkey are rich in rose hips genetic resources. In this study, 19 rose hip genotypes selected from Akkuş district of Ordu were described. The two genotypes (AK-75 and AK-20) were evaluated as promising in terms of fruit weight and fruit flesh ratio. In addition, AK-63 for TSS content and AK-16 for vitamin C content were found remarkable. The data obtained from the genotypes are the values reached in natural land conditions. In this respect, the repeated trials are needed under controlled conditions in order to reveal the true values of genotypes. Some genotypes could be valuable as genetic material for future breeding efforts.

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