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Pomological Changes in Some Rosehip Species During Ripening

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Abstract: Some pomological characteristics of some rosehips (*Rosa* sp) belonging to different *Rosa* species were investigated during the ripening period. Rosehip fruits were harvested in 6 different periods from July to September depending on the ripening of the species. In the determination of the first four times of the harvest, the color convention of the fruits and in the determination of the last two times, the status of the flesh fruit softening was based. The fruit characteristics such as the fruit weight, the soluble solid matter, the dry matter, the percentage of fruit flesh, the fruit firmness, the pH, the titratable acidity, and fruit color changes were determined.
harvest to last As a result, the fruit weight of the genotypes reflected a steady trend from the first one. The soluble solid and dry matters, the percentage of fruit flesh, and the titratable acidity increased during ripening. The pH changed as the acidic and fruit firmness decreased. While the fruit lightness (L) and yellowness (b) decreased, the redness (a) increased. A positive correlation was found between the soluble solid matter and the titratable acidity. Also, the same correlation was recorded between both the pH and the titratable acidity. As a result of the obtained results, it was concluded that the most suitable harvest time in rosehips were the end of the fourth period or the beginning of the fifth period when the fruit did not soften yet.

Keywords: Flesh, firmness, harvest time*, Rosa*, soluble solid

Bazı Kuşburnu Türlerinde Olgunlaşma Sürecindeki Pomolojik Değişimler

Öz: Bu çalışmada farklı türlere ait kuşburnu meyvelerinde olgunlaşma boyunca meydana gelen bazı pomolojik değişimler araştırılmıştır. Temmuz-Eylül ayları arasında meydana gelen olgunlaşma süresince kuşburnu meyveleri altı dönemde toplanmıştır. İlk dört hasat meyve renk dönüşümü esas alınarak, son iki hasat dönemi ise meyve etindeki yumuşama dikkate alınarak yapılmıştır. İlk hasat, meyvelerin yeşilden sarıya döndüğü, ikinci hasat sarı rengin hakim olduğu, üçüncü hasat meyvelerin turuncu rengi aldığı dördüncü hasat ise meyvenin türüne göre koyu turuncu veya kırmızı rengi aldığı zaman yapılmıştır. Beşinci hasat meyve etinde kısmen yumuşamaların olduğu ve altıncı hasat ise meyve etinin büyük oranda yumuşadığı dönem yapılmıştır. Çalışmada olgunlaşma sürecinde meyve ağırlığı, meyve eti oranı, meyve eti sertliği, suda çözünebilir kuru madde, titre edilebilir asitlik ve toplam kuru madde gibi özellikler özellikler çalışılmıştır. Bu özelliklerden meyve ağırlığının yatay bir seyir izlediği, suda çözünebilir kuru madde, toplam kuru madde, meyve eti oranı ve titre edilebilir asitlikte artış meydana geldiği, pH değerinin asidik yönde değiştiği, meyve eti sertliğinin azaldığı görülmüştür. Meyve renk değerlerinden L* (parlaklık) ve b* (+sarı;-mavi) değerlerinin azaldığı, a* (+kırmızı;-yeşil) değerinin yani kırmızı rengin ise arttığı tespit edilmiştir. Meyvelerin suda çözünebilir kuru madde ve titre edilebilir asit değerleri arasında pozitif bir ilişkinin olduğu görülmüştür. Yine pH ve titre edilebilir asitlik arasında da benzer bir ilişkinin varlığı belirlenmiştir. Elde edilen veriler sonucunda kuşburnunda en uygun hasat zamanının meyvenin tam olgun rengini aldığı ve etinin henüz yumuşamadığı dördüncü dönem sonu veya beşinci dönemin başı olması gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: Hasat zamanı, meyve eti, *Rosa*, sertlik, suda çözünebilir kuru madde

1. Introduction

Rosehip, having about 30 species and sub-species, and several more inter-species crosses and genotypes, grows naturally in the flora of Turkey (Kutbay and Kilinc, 1996). Some studies on domesticating or improving rosehips have been completed or are continuing. Some promising genotypes reached the registration stage. Also, two of them were registered as rosehip cultivars (Anonymous 2012a, 2015).

Rosehip products are consumed all over the world and this consumption is increasing each year. Rosehip fruits are harvested and then sold in public bazaars when they ripen in either August or September. Rosehip is also available for consumers as jam, fruit juice, and herbal tea after being processed for traditional uses by families. However, rosehip is harvested earlier than its optimal ripeness because it grows wild and as such is free to be harvested at any time. This situation negatively affects its product quality. Therefore, the determination of the optimal harvesting date is important in order to obtain rosehip suitable for the desired processed product. As a matter of fact, the food industry demands rosehip in its optimal fruit maturity.

Determining the optimal harvesting time is also important for increasing its processed product quality and food value for people by obtaining the best time for vitamin C, antosiyanins, carotenoids, organic acids, phenolics, sugars, and other components. Studies on the determination of the optimal harvest time of rosehips are very limited. In addition, there is no more than one harvest focused on in many studies except for Yamankaradeniz (1983) and Uggla (2004). The presence of new or registered rosehip cultivars, the premature fruit harvesting causing a decrease in rosehip products' quality, and the lack of any detailed study on the optimization in the rosehip fruit harvest time are the reasons that make this study significant.

The aim of this study is to determine the development of some pomological fruit characteristics of some rosehip species during the ripening period and consequently to determine the appropriate harvesting time.

2. Material and Methods

2.1 Plant material

The fruits of *Rosa dumalis* (MR-12 and MR-15*), R. canina* (MR-26), *R. dumalis* ssp. *boissieri* (MR-46) and *R.villosa* (MR-84) were provided from the rosehip orchard consisting of promising advanced genotypes which were established in the experimental research area of the Horticultural Department of Agricultural Faculty of Gaziosmanpasa University in 2000. The research area is located in + 40 ° 20 ' 1.91 " North latitude + 36 ° 28' 38.44 " in the East longitude.

2.2 Methods

2.2.1 Determination of harvest time

The fruits were harvested five times in 2010, and six times in 2011 and 2012. Fruit color change was used as a basis for determining the harvest time of the first four harvests, while the softening of the fruit flesh was taken as a basis for the remaining two harvests. In this context, the first harvest was performed when the fruit color changed slightly from green to yellow. The second harvest was performed when the fruit color changed to full yellow. The third harvest was performed when the fruit color changed to light orange. The fourth harvest was performed when the fruit became dark orange or red depending on the species. The fifth harvest was performed when the fruit flesh started to soften partly and the sixth harvest was performed when the fruit flesh mostly softened (Figure 1).

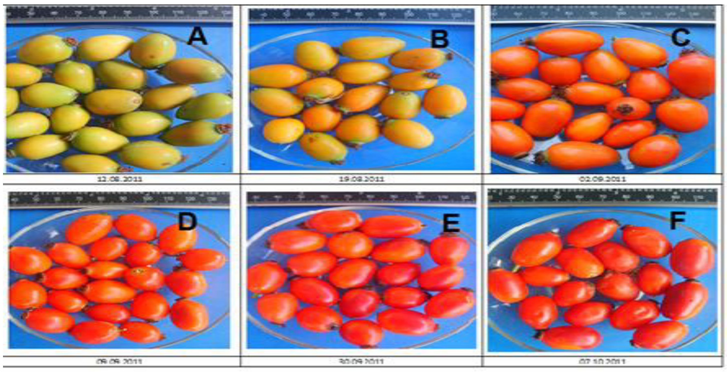

Figure 1. Color scale of rosehip in different ripening stages A:Harvest-1, B:Harvest-2, C:Harvest-3, D:Harvest-4, E:Harvest-5, F:Harvest-6

Şekil 1. Farklı olgunluk aşamalarındaki kuşburnunun renk skalası A:Hasat-1, B:Hasat-2, C:Hasat -3, D:Hasat-4, E:Hasat-5, F:Hasat-6

2.2.2 Mean Fruit weight, percentage of fruit flesh and flesh firmness

The fruit weight was calculated as the mean of 60 (3 replicates x 20 fruits) fruits. The percentage of the fruit flesh (w-w) was determined after separating the seeds from the flesh by hand. The fruit flesh firmness was determined by randomly selecting 10 fruits with some measuring equipment and by physical tests (Zwick Z.05) in 2011 and 2012. At the end of the fruit firmness measurements in 2011, it was noticed that there was 3 mm needle length contact with the seeds, so the needle length of equipment was set as 2 mm.

2.2.3 Soluble solids, pH, titratable acidity and dry matter

The content of the soluble solids was determined with a digital refractometer (Pal-1, Atago Mc Cormick Fruit Tech., Yakima, Wash., USA) and expressed as °Brix in juice from the three replicates. The pH was determined by a pH meter. The titratable acidity was measured in 10 g fruit flesh homogenized in 50 ml distilled water, and titrated with 0.1 M NaOH with an end-point of pH 8.1. The result was expressed as g citric acid/100 g fruit flesh. The dry matter was determined by weighing the fruit flesh, dried at 85 °C for the constant weight, and then weighed.

2.2.4 Measurement of color

The external color of 10 whole fruits from each replicate was determined with a Minolta Chroma Meter (Minolta Co., model CR-400, Tokyo, Japan). The CIE Lab coordinates (L*, a*, b*) were measured where +a* represents the increasing redness, -a* the increasing greeness, +b* the increasing yellowness, and –b* the increasing blueness. The L* value expressed either lightness (White=100) or darkness (black=0) (Uggla, 2004).

2.2.5 Experimental layout and statistical analyses

The experiment was set up in completely randomized plot design. The analyses and measurements of the characters were determined with three replicates. A bush or plant was taken as a replicate and twenty fruits were collected from each bush. The obtained data was subjected to analysis of variance (SSPS 15.0 Statistical software) for each genotypes ($P \leq 0.05$). Harvets time was used as variations source. The differences between the means of harvest times were determined by using the Duncan's multiple comparison test ($P \leq 0.05$)

3. Results and Discussion

Some climatic data of central district of Tokat belonging to 2010, 2011 and 2012 years were summarized in Table 1 and the results relationship with some pomological characteristics during the ripening (different harvest times) of the advanced genotypes belonging to some rosehip species were presented in Table 2 and Table 3.

Table 1. Some climatic data of central district of Tokat belonging to 2010, 2011 and 2012 years (Anonymous, 2012b)
Çizelge 1. *Tokat Merkez ilçesinin 2010, 2011 ve 2012 yıllarına ait bazı ikli verileri (Anonymous, 2012b)*

Month	Monthly Rainfall (mm)			Average Temperature (°C)			Average Relative Humidity (%)			Monthly Average Cloudiness			Average Wind Speed (m/s)		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
1	78.8	23.2	41.8	5.0	3.2	1.2	73.0	67.1	67.4	5.6	5.4	5.4	0.9	1.1	1.1
2	55.6	22.4	46.3	8.5	4.6	-1.6	64.7	60.1	71.2	6.0	5.2	4.1	1.0	1.2	1.0
3	59.7	67.7	44.3	9.5	7.9	3.5	60.4	58.0	63.8	4.6	5.1	4.9	1.2	1.3	1.2
4	64.5	73.5	14.8	12.0	10.8	15.6	62.5	64.1	44.1	4.2	6.0	3.3	1.1	1.4	1.3
5	45.2	59.1	114.7	18.5	15.2	17.6	56.7	64.9	62.6	3.4	4.4	4.6	1.0	1.1	1.0
6	59.6	76.4	36.3	23.7	19.1	21.4	57.3	61.6	56.5	4.5	3.4	2.3	1.1	1.2	1.1
7	6.4	37.9	30.7	24.7	23.9	23.6	60.6	55.9	54.6	2.6	2.8	2.2	1.1	1.4	1.1
8	0	16.5	1.5	25.9	21.8	23.4	56.5	57.9	51.8	1.1	2.9	3.1	1.0	1.4	1.3
9	3.2	14.8	5.1	23.3	18.3	20.3	53.9	58.0	50.9	2.8	2.1	1.8	1.2	1.1	1.2
10	119.0	24.0		14.1	12.9		74.6	59.9		5.1	4.3		0.9	1.2	
11	4.1	29.5		10.5	3.4		63.4	67.8		1.7	4.7		0.8	0.9	
12	35.9	18.0		7.5	4.0		67.4	61.8		4.5	3.9		1.1	0.9	

1.1. Fruit weight

The differences between the means of the fruit weights of *Rosa dumalis* (MR-12) were significant in 2010, but not in 2011 and 2012 depending on the harvest times. No significant differences occurred between the means of the fruit weights of *R. dumalis* (MR-15) in 2010 and 2011, but significant differences were recorded in 2012. The mean fruit weights of *R. canina* (MR-26) were significant in all three years related to the harvest time. The differences between the means of the fruit weights of *R. dumalis* ssp. *boissieri* (MR-46) were significant in 2010 and 2012, but not significant in 2011. The differences in the mean fruit weights of *R. villosa* (MR-84) were affected significantly in all three years as *R. canina* by the harvest time (Table 2). Considerable decreases were recorded in the fruit weights in the species after the fifth harvest. The decreasing of the fruit weight in R. *canina* at the sixth harvest was also remarkable. The fruit weight decreasing in the last harvest may be due to the dehydration of the fruit that was overripe.This means that the weight of the fruit is completed until the beginning of the color transformation of the fruit. Yamankaradeniz (1983) and Uggla (2004) reported the fruit weights of rosehip species studied between 0.61-4.96 g and 1.5-2.8 g respectively. Our results were higher then the Uggla (2004) but similar to the Yamankaradeniz (1983) in general. Determined differences are thought to be caused by the species and some ecological and growing conditions. The high temperatures and drought in the 2010 summer season made this clear and significant (Table 1).

1.2. Percentage of fruit flesh

The differences between the means of the fruit flesh percentages of *Rosa dumalis* (both MR-12 and MR-15) were significant in all three years; depending on the harvest time. The means percentage of the fruit flesh of *Rosa canina* (MR-26) was significant in 2011, but not significant in 2010 and 2012. The percentage of the fruit flesh of *Rosa dumalis* ssp *boissieri* (MR-46) was significant in 2011 and 2012, but was not significant in 2010. The percentage of the fruit flesh of *Rosa villosa* (MR-84) was significant in 2010 and 2011, but was not significant in 2012

(Table 2). Ercişli et al. (2001), Güneş and Şen (2001) Kovacs et al. (2005), Çelik (2007), Güneş and Dölek (2010) found the percentage of fruit flesh studied species between 63.11-78.14%; 57.22-77.38%; 72.2-81.5%; 45.68-100% and 45.82-79.47% respectively. The percentage of the fruit flesh obtained was similar to previous works. Although there were some variations in the percentages of the fruit flesh related to the harvest time, it is possible to say that a slight increase occurred in the fruit flesh depending on the ripening.

Table 2. Fruit weight, percentage of fruit flesh and solible solid changes during ripening of rosehip species

Çizelge 2. *Bazı kuşburnu türlerinde olgunlaşma süresince meyve ağırlığı, meyve eti yüzdesi ve suda çözünbilir kuru madde değişimleri*

Harvest Time	Fruit Weight (g)			Fruit Flesh (%)			Solible Solids (%)		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
				***Rosa dumalis* (MR-12)**					
1	2.98bc*	3.35a	3.70a	63.19b	66.81 b	63.78b	10.50b	14.00c	12.33d
2	2.80c	3.11a	3.93a	64.44b	67.9ab	64.86b	11.17b	15.67c	14.33cd
3	3.21ab	3.68a	3.96a	68.63a	68.75ab	66.35ab	13.00b	16.33c	15.33c
4	3.17ab	3.49a	3.75a	67.26a	68.01ab	66.76ab	17.33a	22.33b	17.00bc
5	3.42a	3.49a	3.47a	68.31a	69.61ab	69.22a	20.00a	24.00ab	19.00b
6	-	3.52a	3.70a	-	70.30 a	66.12ab	-	25.33a	22.67a
				***Rosa dumalis* (MR-15)**					
1	2.39a	2.91a	2.76ab	70.26 c	73.73ab	69.77b	10.00a	13.33c	12.67c
2	2.42a	3.06a	2.80a	72.78bc	70.95 b	69.93b	13.00a	14.67c	13.00bc
3	2.35a	3.01a	2.57bc	73.76ab	73.17ab	70.44b	13.67a	15.67c	14.00bc
4	2.45a	2.81a	2.57bc	71.34bc	70.93b	71.9ab	13.67a	21.00b	15.67ab
5	2.44a	3.01a	2.49cd	76.14 a	72.85ab	75.16a	14.67a	23.00ab	17.67a
6	-	2.87a	2.29d	-	74.94a	69.01b	-	26.33a	18.33a
				***Rosa canina* (MR-26)**					
1	3.48a	3.79b	3.75b	70.61a	71.07c	67.87a	10.00d	12.00c	11.33d
2	3.43a	4.19ab	4.34a	71.91a	73.29abc	67.60a	13.67c	13.00c	12.00cd
3	3.24ab	4.35a	4.33a	70.64a	75.14a	66.69a	18.00b	13.67bc	13.33c
4	3.27ab	4.34a	4.23a	72.38a	73.95ab	68.37a	23.67a	16.67b	17.33b
5	2.99b	4.09ab	3.73b	70.74a	71.63bc	66.54a	24.00a	20.00a	18.00b
6	-	3.70b	3.02c	-	73.52abc	69.64a	-	20.67a	21.67a
				***Rosa dumalis* ssp. *boissieri* (MR-46)**					
1	2.56ab	3.06a	2.54bc	62.59a	62.59bc	56.53c	4.00d	11.33f	9.33d
2	2.83a	2.92a	2.74a	64.33a	60.35bc	61.35ab	4.67d	14.00e	11.67c
3	2.67ab	3.00a	2.46c	63.64a	58.64 c	57.57bc	8.33c	17.00d	12.00c
4	2.42b	3.27a	2.18d	63.82a	59.80bc	55.94c	14.00b	20.33c	15.00b
5	2.67ab	3.20a	2.53bc	64.15a	63.55ab	65.10a	17.67a	23.67b	19.00a
6	-	2.96a	2.73ab	-	67.45 a	65.62a	-	28.33a	20.33a
				***Rosa villosa* (MR-84)**					
1	2.46b	3.13b	3.33ab	62.71b	68.15c	66.41a	9.83b	14.00c	12.33c
2	2.70ab	3.06b	3.53a	68.61a	68.07c	67.72a	14.17a	15.67c	12.67c
3	3.04a	3.89a	3.09b	69.12a	73.39a	66.21a	14.83a	20.00b	13.00c
4	2.71ab	3.42b	3.11b	68.91a	69.28c	67.43a	17.83a	21.67b	15.33b
5	2.87ab	3.22b	2.58c	70.59a	72.19ab	67.36a	16.67a	22.00b	16.67b
6	-	3.30b	2.03d	-	70.48bc	63.13a	-	27.67a	22.00a

** The difference between the averages indicated by different letters in the same column of the same species ($P \leq 0.05$) is significant.*

1.3. Soluble solids

The differences between the means of the soluble solid content of *Rosa dumalis* (MR-12), *Rosa canina* (MR-26), *Rosa dumalis* ssp *boissieri* (MR-46), and *Rosa villosa* (MR-84), were significant in all three years. The differences between the means of the soluble solids of *Rosa dumalis* (MR-15) were significant in 2011 and 2012, but no significant differences were found among the harvest times in 2010. The content of the soluble solids in the fruit flesh increased both significantly and regularly during the ripening period (Table 2). This is an expected outcome. In some previous studies, the soluble solid increased (from 10.2 to 16.3%) regularly during the ripening period (Uggla, 2004; Uggla et al. 2005). The total dry matter and increase in the total sugar content, also provided the increase in the total soluble solid level.

Table 3. pH, titratable acidity, dry matter and flesh firmness changes during ripening of rosehip species

Çizelge 3. *Bazı kuşburnu türlerinde olgunlaşma süresince pH, titreedilebilir asit, kurum madde ve meyve eti sertliği değişimleri*

pH			**Titratable Acidity (%)**			**Dry Matter (%)**			**Flesh Firmness (N)**	
2010	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**	**2011**	**2012**
***Rosa dumalis* (MR-12)**										
4.81a	4.20a	4.23e	1.01c	1.52d	0.93c	45.10b	40.86d	41.88c	7.16a	4.10a
4.79a	4.07b	4.13de	1.12bc	1.65d	1.13c	43.22b	43.00c	42.88bc	5.40b	4.22a
4.64a	3.85c	4.06cd	1.14bc	1.93cd	1.21bc	44.06b	43.94c	44.45bc	5.25b	3.88a
4.46b	3.65d	3.95bc	1.63a	2.26bc	1.34bc	44.41b	48.78b	44.90b	4.86b	3.93a
4.42b	3.44e	3.83ab	1.49ab	2.59ab	1.58ab	50.61a	49.63ab	47.48a	4.82b	4.00a
-	3.46e	3.75a	-	2.86a	1.94a	-	50.51a	49.74a	4.30b	3.21b
***Rosa dumalis* (MR-15)**										
4.09a	3.89bc	4.26a	1.13b	1.58c	0.98c	43.56b	40.66 b	39.57b	4.54a	3.63ab
4.03a	4.26a	4.12b	1.87ab	1.54c	1.18bc	44.12b	41.32 b	42.54ab	4.55a	3.80a
4.05a	4.01b	4.08b	1.84ab	2.06b	1.20bc	47.71a	45.86ab	44.77ab	4.61a	3.72ab
3.99a	3.72d	3.94c	1.72ab	2.24b	1.34b	47.80a	48.41 a	45.22ab	4.63a	3.91a
3.84b	3.76cd	3.85d	2.22a	2.72a	1.74a	47.67a	49.19 a	48.10a	2.58b	3.33b
-	3.65d	3.84d	-	3.05a	1.77a	-	48.75 a	48.30a	2.24b	2.83c
***Rosa canina* (MR-26)**										
4.32a	4.00ab	4.08a	1.79d	1.33 b	1.11c	33.17b	33.64b	38.28d	6.34a	4.99a
4.03b	3.94abc	4.06a	2.35cd	1.50ab	1.13c	35.9ab	34.80b	38.80cd	6.38a	5.23a
4.07b	4.12a	3.99a	2.86bc	1.58ab	1.21c	37.31ab	34.92b	39.53bcd	4.89b	4.01b
4.03b	3.81bc	3.76b	3.67a	1.61ab	1.61bc	38.73ab	37.69b	41.56bc	4.97b	4.03b
3.93b	3.73c	3.67bc	3.51ab	2.02a	1.81ab	39.92a	42.63a	42.67b	4.74b	3.30c
-	3.70c	3.55c	-	2.03a	2.19a	-	43.61a	47.00a	4.80b	2.40d
***Rosa dumalis* ssp. *boissieri* (MR-46)**										
4.70a	4.31a	4.64a	0.88b	1.16d	0.69c	47.93b	44.86b	44.62e	6.28a	4.18c
4.65a	4.33a	4.44b	0.91b	1.35d	0.84c	45.77b	45.98b	46.76d	5.82a	4.44b
4.46b	4.16ab	4.34b	1.44ab	1.60cd	0.94c	45.27b	46.67b	47.09d	6.12a	4.53b
4.23c	3.76bc	4.07c	1.37ab	1.87c	1.41b	48.95ab	54.94a	51.44c	6.86a	4.89a
4.05d	3.64c	3.83d	1.87a	2.69b	1.70a	54.49a	57.11a	53.75b	6.54a	5.08a
-	3.33c	3.75d	-	3.21a	1.97a	-	55.15a	57.47a	6.28a	3.90d
***Rosa villosa* (MR-84)**										
4.90a	4.15a	4.17a	1.02b	1.34c	1.00c	44.43a	40.99d	39.61c	6.85a	3.82ab
4.63b	3.92b	4.09b	1.13ab	1.93bc	1.12bc	45.19a	45.25d	40.61bc	5.16b	3.96a
4.62b	3.70c	4.06b	1.23ab	2.44ab	1.16bc	44.67a	45.24c	40.80bc	5.46b	3.76ab
4.52b	3.60d	3.91c	1.05ab	2.28ab	1.29bc	41.34a	48.33bc	45.19b	5.60b	3.65ab
4.48b	3.49e	3.87c	1.62a	2.49ab	1.37b	48.05a	49.82b	54.56a	5.52b	3.45b
-	3.34f	3.76d	-	2.69a	1.78a	-	54.68a	55.95a	5.64b	2.15c

** The difference between the averages indicated by different letters in the same column of the same species ($P \leq 0.05$) is significant*

1.4. Fruit firmness

The fruit firmness of the species was measured in 2011 and 2012. The differences between the harvests were significant except in *Rosa dumalis* ssp. *boissieri* (MR-46) in 2011. The fruit firmness of the species did not change as significantly until the last two harvests, but decreased significantly. There were remarkable differences between the two years and the harvest times (Table 3). At the end of the first year, from the fruit firmness measurement, the needle length and the contact with the seeds became clear, so the needle length was reduced from 3 mm to 2 mm. It is thought that these differences, especially between the two years, were caused by the needle length. Similar results were obtained from plum varieties harvested six times as 59.0-21.3 N (Usenik et al. 2008), and was obtained from cherries harvested over five periods as 3.32-2.35 N mm^{-1} (Serradill et al. 2011).

1.5. Total dry matter

The total dry matter was determined between 33.17-57.47%. The dry matter increased depending on the ripening period, and the differences between the means of all the species were significant; except in the means of *R. villosa* belonging to 2010. The dry matter of the species was low in the first harvest, but increased during the ripening period. The dry matter of *R. canina* was lower when compared to the other species. The dry matter of *Rosa dumalis* ssp. *boissieri* was the highest, but this situation was due to the high number of seeds that the fruit included (Table 3). The obtained findings for the dry matter were similar to Ercişli et al. (2001) (34.82-40.98%), Kazankaya et al. (2001) (29.66-58.50%), Doğan and Kazankaya (2006) (46.22-50.27%), Çelik (2007) (30.46-64.43%), Güneş and Dölek (2010) (32.08-54.36%). Türkben et al. (2010) reported that the rosehips in the reddish-orange maturity stage had a greater total dry matter than the red fruits. We obtained the best results from the fifth and sixth harvests.

1.6. pH

The differences between the means in the pH values of all the species were significant in all three years. While more or less increases occurred in the pH during the maturation of other fruits species, a decrease was observed in the rosehips accessions (Table 3). The pH change in the rosehip fruit during ripening could not be discussed because as yet, no studies on pH have been conducted. The decreasing in the pH or the increase in acidity could be regarded as an advantage because an increase in the acidity provides more resistant to microbial degradation. If the pH is below 4.5, it may be necessary to replace pasteurization and sterilization during the heat treatment must admit that it meant the preservation of several metabolites. When the pH is below 4.5, there is no need for sterilization, and pasteurization may be required, and so many metabolites could be preserved during the low heat treatment procedures (Cemeroğlu 1992).

1.7. Titratable acidity

The titratable acidity increased depending on the ripening, and the differences between the means of the titratable acidity in all of the species were significant in all three years (Table 3). Ercişli et al. (2001) found the titratable acidity between 0.87-2.20%, Kazankaya et al. (2001) and Doğan and Kazankaya (2006) reported between 0.57-4.65%, 0.66-0.85% respecitevly, Çelik (2007) found as 0.67-3.29% and Güneş and Dölek (2010) recorded between 0.60-4.0% in the fruits of some rose species that had been harvested in the optimal harvest time. Uggla (2004) reported the acidity between 0.6-8.8 g/100g as malic and researcher reported that the total acidity increased during the ripening period, but no significant difference was found in the total acidity among our studied species.

1.8. Fruit color

The L* (lightness) and b* values (+yellow;-blue) decreased and a* (+red;-green) increased and differences between the harvest times were significant in all of the species (data not presented). The obtained data through the fruit color was similar to (L=50.07-39.03) Uggla (2004) and Ercişli (2007) (L=48.06-52.02; a=40.69-43.31; b=39,39-47,73), but significant differences were found between our data and Egea et al. (2010) (L=38.02, a=34,72; b=23,69). These differences are thought to have been caused by the species, the harvest time, and some ecological and growing conditions.

The following results were reached in the research: The fruit weight is almost completed when the rosehip color conversion is initiated. Unlike other fruit species, the pH decreases during the rosehip fruit maturation. This decrease in the pH value during ripening may be advantageous during processing into the product. Titratable acidity increases. Fruit flesh firmness decreases during ripening and local softening occurred in the fruit flesh. The total dry matter and soluble solids increase during fruit ripening. A linear regression was found between the soluble solid and the titratable acidity, or between the pH and titratable acidity. Also, it was concluded that the most suitable harvest time in rosehip species were the end of the fourth period or the beginning of the fifth period when the fruit was colored as full but did not soften yet. Because more softening can be resulted in deformation of fruit and loss of secondary metabolite contents of fruit.

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