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Quality Performance of Some Local Pear Cultivars on BA29 Rootstock under High Density Planting

Bazı Yerli Armut Çeşitlerinin Sık Dikim Altında BA29 Anacı Üzerindeki Kalite Performansı

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Abstract: The study aimed to assess the fruit quality characteristics of some local pears grafted on BA29 quince clone rootstock in 2021 and 2022. Pomological, chemical and sensory analyzes were carried out to evaluate fruit quality characteristics. All examined pomological properties were found to be statistically significant. The fruit weight (195.47 g), fruit width (73.56 mm), fruit height (73.72 mm), fruit stalk thickness (3.94 mm) and fruit volume (193.30 ml) of the 'Karpuz' pear were higher than the other cultivars. The highest fruit length (90.96 mm) and fruit stalk length (40.22 mm) in the 'Eşek' pear; the highest flesh firmness (9.35 kg cm^{-2}) was determined in the 'Harman' pear. The total Soluble solid (TSS) content of the 'Kara' and 'Rıza' pears was higher (16.83% and 16.50%) than the other cultivars. In the color of the fruit skin; the highest L* value was determined in 'Gelin', a* value in the 'Harman', b* and chroma values in the 'Karpuz' and hue angle in the 'Rıza' cultivar. The highest L* value was in the 'Harman', a* value was in the 'Kuşak', b*, chroma and hue angle values were in the 'Gelin' pear in terms of fruit flesh color. While 'Macar', 'Harman' and 'Eşek' cultivars had the highest juiciness value, 'Macar' and 'Kuşak' had the lowest taste and aroma. The highest taste and aroma values were in the 'Kadın PArmak' pear; the best visual quality was determined in the 'Eşek' cultivar. The highest titratable acid content was observed from the 'Rıza' (0.60%). In the study, it was found that the 'Karpuz' had higher pomological properties. In general, 'Karpuz', 'Eşek', and 'Gelin' pears exhibited better quality performances in the study. According to the results of the research, 'Karpuz', 'Eşek' and 'Gelin' local cultivars can be recommended for more detailed evoluations. In addition, the local cultivars used in the research can be used as genetic resources.

Keywords: Pear, Fruit quality, Local cultivars, Quince clonal rootstock

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Öz: Araştırmanın amacı, 2021 ve 2022 yıllarında BA29 ayva klon anacı üzerine aşılanmış bazı yerel armutların meyve kalite özelliklerini değerlendirmektir. Meyve kalite özelliklerinin değerlendirilmesi için pomolojik, kimyasal ve duyusal incelemeler yapılmıştır. İncelenen tüm pomolojik özellikler istatistiksel olarak anlamlı bulunmuştur. 'Karpuz' armudunun meyve ağırlığı (195.47 g), meyve eni (73.56 mm), meyve yüksekliği (73.72 mm), meyve sapı kalınlığı (3.94 mm) ve meyve hacminin (193.30 ml) diğer çeşitlerden daha yüksek olduğu belirlenmiştir. En yüksek meyve boyu (90.96 mm), meyve sapı uzunluğu (40.22 mm) 'Eşek' armudu; en yüksek meyve eti sertliği (9.35 kg cm^{-2}) 'Harman' armudunda tespit edilmiştir. 'Kara' ve 'Rıza' armudunun suda çözünür kuru madde içeriğinin diğer çeşitlerden daha yüksek (%16.83 ve %16.50) olduğu saptanmıştır. Meyve kabuğu renginde; en yüksek L* değerleri 'Gelin', a* değeri 'Harman', b* ve kroma değeri 'Karpuz', hue açısı ise 'Rıza' çeşidinde saptanmıştır. Meyve et rengi bakımından en yüksek L* değeri 'Harman', a* değeri 'Kuşak', b*, kroma ve hue açısı değerinin 'Gelin' armudunda olduğu belirlenmiştir. 'Macar', 'Harman' ve 'Eşek' çeşitleri en yüksek sululuk değerine sahip olurken 'Macar' ve 'Kuşak' çeşitlerinin en düşük tat ve aromaya sahip olduğu saptanmıştır. 'Kadın Parmak' armudunda en yüksek tat ve aroma değerleri; 'Eşek' çeşidinde ise en yüksek görsel kalite belirlenmiştir. En yüksek titredilebilir asit içeriği 'Rıza' armudunda belirlenmiştir (% 0.60). Araştırmada 'Karpuz' çeşidinin daha iyi pomolojik özelliklere sahip olduğu bulunmuştur. Genel olarak, çalışmada 'Karpuz', 'Eşek' ve 'Gelin' armutlarının daha iyi kalite performansları sergilediği belirlenmiştir. Araştırma sonuçlarına göre 'Karpuz', 'Eşek' ve 'Gelin' çeşitlerini daha ayrıntılı çalışmalar için önerebiliriz. Ayrıca araştırmada kullanılan yerel çeşitlerden genetik kaynak olarak yararlanılabilir.

Anahtar Kelimeler: Armut, Meyve kalitesi, Yerel çeşitler, Ayva klon anacı

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INTRODUCTION

Pears are belong to the genus of *Pyrus*, subfamily Maloideae in the family of Rosaceae. Among the fruit tree species, pear fruit is considered the oldest of the world's fruit (Jackson, 2003; Pasquariello et al., 2013). Pear (*Pyrus communis* L.) is the second most grown and consumed pome fruit worldwide (Ozcagiran et al., 2005; Hancock and Labous, 2008). Pear is more resistant to drought and heat than apples but has less resistance to cold. The nutritional quality of pear fruit is high as it consists of 15.46 g carbohydrates, 0.12 g fats, 0.38 g proteins, 9.80 g sugars, 83.71% water, 4.20 mg ascorbic acid, 119 mg potassium, 11 mg magnesium, 7 mg iron, and 0.10 mg zinc (Ozcagiran et al., 2005; USDA, 2011). Türkiye is an important pear producing country that ranks 5th (2.3% production share) after China, Italy, USA and Argentina in world pear production, which is 23.1 million tons (FAOSTAT, 2022). In Türkiye, which has very different ecological conditions, pears can be grown in almost all regions and there are more than 600 local pear varieties (Ercisli, 2004). Among these local cultivars, there are many local cultivars selected as a result of breeding studies due to their different characteristics in terms of fruit quality and resistance to diseases and pests. These selected cultivars' yield and quality performances should be evaluated in the same ecological conditions in the common orchards outside their local area. For this purpose, evaluating cultivars on the same rootstocks in the same field conditions reveals more objective results. To establish modern fruit orchards, rootstocks that provide stunting is necessary (Öztürk et al., 2013; Bolat and Ikinci, 2019; Kurt et al., 2022). Rootstock use in fruit production is due to its adaptation to adverse climatic conditions, good performance in various soil situations, increased fruit quality and yield, and high tolerance to diseases and pests (Corso and Bonghi, 2014). BA29 is one of the quince clonal rootstocks, which European pear growers widely use to establish modern pear orchards. BA29 quince rootstock was selected from Province quinces at the fruit breeding station in France in 1963. It forms a canopy about 50% higher than standard quince rootstocks and shows a slightly stronger growth than QA rootstocks. BA29 propagation rate is slow, but the yield efficiency is high. However, it is resistant to pear powdery mildew and root cancer but has poor tolerance to leaf spot and fire blight diseases. BA29 is resistant to pear dent and cotton louse, and dwarf trees can be obtained by dense planting (Jackson, 2003; Özçağıran et al., 2005). In this study, it was tried to determine the effect of BA29 quince clonal rootstock on the quality of some local pear cultivars used in pear cultivation of Türkiye.
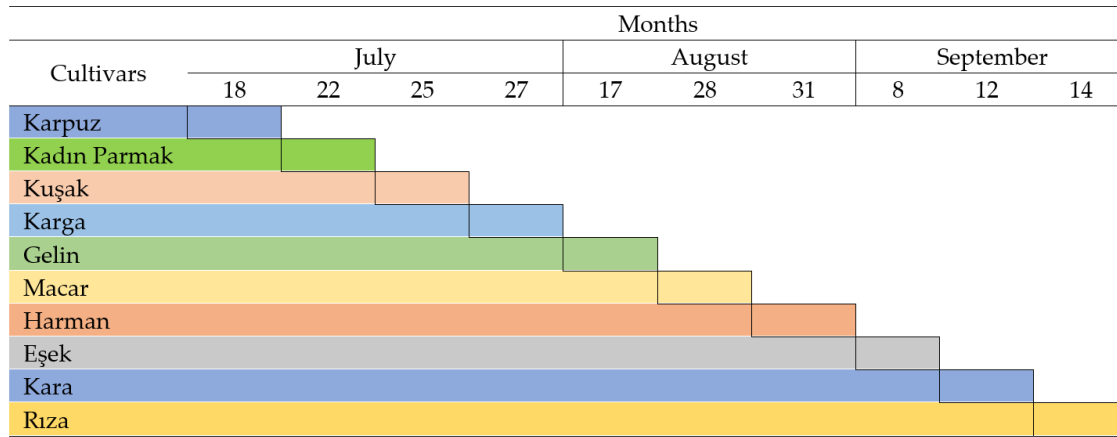
MATERIAL AND METHOD

Materials

In this study, 'Karpuz', 'Kadın Parmak', 'Karga', 'Kuşak', 'Gelin', 'Macar', 'Harman', 'Rıza', 'Kara', and 'Eşek', grafted on BA29 quince clone rootstock 10 local pear cultivars were used in Samsun, Türkiye. The experimental pear orchard was established in 2009 in the Agriculture Faculty Research Station of Ondokuz Mayis University (41° 33' 50'' N; 35° 52' 21'' E; altitude 160 m). The study was done in 2021-2022. The experimental area has a hot and humid climate in summers and a cool climate in winters, and precipitation mainly occurs in late autumn and early winter. The experimental area has an average maximum temperature of 26.2 °C, an average minimum temperature of 3.3 °C and an average annual temperature of 14.1 °C (TSMS, 2022). Trees were pruned by using modified leader system after being planted at intervals of 3.5 m x 1.5 m (1910 trees ha^{-1}). A system of metal poles was used to support the newly planted trees, standing the saplings against the wind and tying together the branches to keep them against breaking when they were ready to bear fruit. For this reason, three rows of wire were fastened to the poles at the height of 0.5, 1.0, and 1.5 meters. Regular irrigation of the trees was carried out using pressure-compensating drippers spaced 1.20 m apart and two pipes per row on either side of the trees. The experimental orchard also received regular annual weeding and pruning.

Methods

When the fruits reached their physiologıcal maturities, as shown in Figure 1 were harvested and brought to the laboratory for pomological, chemical and sensory evaluations. According to previous researches (Massai et al., 2008; Akcay et al., 2009; Stern and Doron 2009; Kucuker et al., 2016; Ozturk et al., 2022), pomological characteristics like fruit weight (g) were measured in randomize harvested 30 fruits in each replication with 0.01 g sensitive digital balance (CAMRY L-500). Fruit width (mm), fruit length (mm), fruit

height (mm), fruit stalk length (mm), fruit stalk thickness (mm), fruit skin thickness (mm) were determined with a 0.01 mm digital caliper (Mitutoyo CD-20CPX). Fruit volume (ml) was measured by using a 1000 ml graduated cylinder. Fruit skin and flesh color L*, a*, b*, chroma and hue degree (h°) were analyzed by reading the skin color of the fruit from 2 different points on the equatorial of the fruit part, and fruit flesh color was immediately measured by transversely cutting the fruits in two equal parts with the help of a colorimeter made of Tokyo, Japan (Minolta, model CR-300) as described by (Erdem and Ozturk, 2012; Kurt et al., 2022). Fruit firmness (kg cm^{-2}) was measured with a digital penetrometer, according to Ozturk and Faizi (2022). Total soluble solids (TSS %) were determined with a digital refractometer (ATAGO, PAL-1, Japan), titratable acidity (%) was evaluated by using 0.1N NaOH in the titration method, and pH from the extracted fruit juice was also measured with pH meter (Ranganna, 2005). A well-known group of 12 panelists did a sensory evaluation of fruit samples. The panelist rated the fruits from 1 (don't like at all) to 7 (like extremely) score after a sensory investigation in case of juiciness, taste, aroma, and visual quality (Pasquariello et al., 2013).

	Months									
Cultivars	July				August			September		
	18	22	25	27	17	28	31	8	12	14
Karpuz										
Kadın Parmak										
Kuşak										
Karga										
Gelin										
Macar										
Harman										
Eşek										
Kara										
Rıza										

Figure 1. Maturity dates of local cultivars used in the research.
Şekil 1. Denemede kullanılan yerel çeşitlerin hasat olgunluğu tarihleri.

Statistical Analysis

Ten trees were included in each of the 3 replications of the Randomized Complete Block Design method. In each replication, 30 fruits were used for the quality assessment. IBM SPSS 21.0 (SPSS Inc. Chicago, ABD) was used to evaluate the data when they were collected. The Duncan Multiple Comparison Test (DMRT) was used to compare the means at the 5 levels of significance (p>0.05), while the ANOVA indicated significant results.

RESULTS AND DISCUSSION

Pomological Characteristics

The variance analysis of research data on pomological characteristics of some local pear cultivars on BA29 quince clonal rootstock was given in Table 1 and Table 2. All the pomological characteristics were found to be statistically significant. 'Karpuz' pears were found to have higher fruit weight (FWgt), fruit width (FWdt), fruit height (FH), fruit stalk thickness (FStT), and fruit volume (FV). While the highest fruit length (FL), fruit stalk length (FSL) in 'Eşek' pear, and highest fruit skin thickness (FSkT) in 'Rıza' pear, and highest fruit firmness (FF) in 'Harman' pear. Except for FL and FStT, which were lower in 'Kuşak' and 'Macar' pears, respectively, all other pomological features were lower in the 'Kadın Parmak' pear cultivar.

The size of pear fruit from a marketing point is a crucial feature (Jackson 2003; Stern and Doron 2009). Ozcagiran et al. (2005) reported the fruit weight of pears from 80 to 400 g. Ozturk et al. (2009) mentioned the fruit weight 190.36 g, fruit width was 64.25 mm, and fruit length 107.27 mm in the pear. The fruit weight of 'Santa Maria' on BA29 rootstock varied from 147.5 to 169.4 g by Erdem and Ozturk (2012), 140.0 to 156.2 g by Kucuker et al. (2016), and fruit weight from 183.00 to 290.00 g and fruit width 61.18 to 81.86 mm by Lepaja et al. (2014), and 304.1 g by Ikinci et al. (2016). Polat and Az (2017) cited that fruit weight varied from

373.97 to 22.04 g, fruit width varied from 87.33 to 35.02 mm, and fruit length varied from 141.27 to 30.55 mm in local pear cultivars on QA rootstock. Pear fruit weight varies according to the research years and cultivars (Kucuker and Aglar, 2021). Jovanovic et al. (2022) stated the fruit weight was 188.4 g, fruit length 8.8 cm, and fruit width 6.5 cm in the 'Santa Maria' pear cultivar. Stalk thickness of pear fruit was recorded at 3.1 mm ('T. de Vienne'/QA) and 5.6 mm ('Beurre Clairgeau'/QA) by Kaplan (1997); 3.81 mm ('Deveci'/QA) and 4.12 mm ('Williams'/QA) by Akcay et al. (2009); 3.94 to 4.75 mm ('Deveci'/BA29) by Uysal et al. (2016); 4.6 to 5 mm ('Abate Fetel'/QA) by Ozturk et al. (2016). Fruit stalk length observed 18 mm (Beurre Hardy/QA) and 42.8 mm ('Akca'/QA) by Kaplan (1997); 24.73 mm ('Deveci'/QA) and 29.43 mm ('Williams'/QA) by Akcay et al. (2009); 31.54 to 32.56 mm ('Deveci'/BA29) by Uysal et al. (2016); 11.1 to 14.2 mm ('Abate Fetel'/QA) by Ozturk et al. (2016). The maturity of pear fruit can be considered by firmness (Kawamura 2000; Jackson 2003) and changes based on rootstocks, growing years, and managemental practices in the pear orchards (du Plooy and Van Huyssteen 2000; Kosina 2003; Urbina et al. 2003; Ikinci 2017).

Table 1. Pomological characteristics of some local pear cultivars.
Çizelge 1. Bazı yerel armut çeşitlerin pomolojik özellikleri.

Cultivars	Fruit weight (g)	Fruit width (mm)	Fruit length (mm)	Fruit height (mm)	Fruit volume (ml)
Karpuz	195.47 a	73.56 a	71.58 b	73.72 a	193.30 a
Kadın Parmak	53.44 g	42.22 e	57.82 d	41.69 g	50.70 f
Karga	63.44 g	47.78 d	54.80 e	47.74 f	55.83 f
Kuşak	111.75 e	60.88 b	51.56 f	61.01 d	114.23 d
Gelin	83.24 f	55.55 c	51.62 f	56.39 e	82.00 e
Macar	205.03 a	60.85 b	64.30 c	67.29 b	168.10 b
Harman	114.07 e	59.03 b	51.92 f	62.13 cd	120.17 d
Rıza	128.73 d	60.75 b	56.44 de	62.95 cd	133.90 cd
Kara	141.44 c	59.01 b	70.94 b	64.04 c	145.20 c
Eşek	154.60 b	61.03 b	90.96 a	64.14 c	178.13 ab
Significance	0.001	0.001	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

Table 2. Pomological characteristics of some local pear cultivars.
Çizelge 2. Bazı yerel armut çeşitlerin pomolojik özellikleri.

Cultivars	Fruit stalk length (mm)	Fruit stalk thickness (mm)	Fruit skin thickness (mm)	Flesh firmness (kg cm^{-2})
Karpuz	37.76 abc	3.94 a	0.86 e	6.00 b
Kadın Parmak	35.17 bc	2.02 d	0.60 e	2.38 c
Karga	33.91 cd	2.30 d	0.70 e	3.34 c
Kuşak	33.28 cd	3.26 bc	1.37 d	5.90 b
Gelin	39.79 ab	3.25 bc	1.56 d	8.44 a
Macar	17.60 e	3.79 a	2.49 a	6.58 b
Harman	33.17 cd	3.07 c	2.07 bc	9.35 a
Rıza	29.10 d	3.16 bc	2.51 a	5.76 b
Kara	32.97 cd	3.51 abc	2.38 ab	8.35 a
Eşek	40.22 a	3.64 ab	2.02 c	3.79 c
Significance	0.001	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

Firmness decreases as fruits ripen and closely associated with the cell wall composition, structure, and cell wall changes during ripening. Rigidity and strength provide by cell wall, and it is the opposite of the resistance of the wall that the osmotic pressure of the protoplast exerts force and provides turgor. So it can be said that firmness is related to the physical anatomy of the tissue, particularly cell size, shape, wall thickness, strength, and cell-to-cell adhesion status. When the pear fruit ripening process starts, these

factors may change, leading to larger air spaces and reduced intercellular contact. Then fruits with larger cells and more intercellular spaces are considered to have weaker tissues than pear fruits with smaller cells and fewer intercellular spaces, so tissues with small cells tend to have higher cell-to-cell contact and lesser intercellular air spaces, thus making the fruit firmer (Pasquariello et al., 2013). Pear fruit firmness reported 4.96 kg cm^{-2} in 'Santa Maria' by Lepaja et al. (2014), 22.3 lb by Ikinci et al. (2016), 62.11 - 66.46 N in 'Santa Maria' by Pasa et al. (2017) and 9.92-12.65 kg in local pear cultivars by Polat and Az (2017), 2.06-7.77 kg cm^{-2} in local pears by Akın and Bostan (2018). The pear fruit firmness was reported 52.9 N for 'Etrusca', 51.8 N for 'Carmen', 50.4 N for 'Precoce of Fiorano', 50.2 N for 'Coscia', 48.8 N for 'Turandot' and 48.3 N for 'Tosca' (Pasquariello et al., 2013). In the some local pear cultivars, fruit skin thickness was reported 0.20 to 0.50 by Özrenk et al (2010), 0.37 – 0.59 mm by Balta et al. (2019). Some pomological properties of the 'Le Conte' cultivar of European pear reported as the following fruit weight 192.04 g, fruit volume 207.67 cm^3 and fruit firmness 7.53 kg.cm^{-2} (Sajid et al., 2022).

Fruit Chemical Characteristics

The research data on chemical traits of local pear cultivars on BA29 quince clonal rootstock were shown in Table 3. It was found that each chemical traits were significant. The 'Kara' pear had higher total soluble solids (TSS) than other pears, on the contrary, the lowest TSS was observed in 'Gelin' pear. The highest titreatable acidity was obtained in the 'Rıza', while the lowest acidity was measured in the 'Harman' pear. The pH value of the 'Kadın Parmak' pear was higher than other cultivars, and vice versa, the lowest pH was determined in the 'Rıza' pear.

In pear fruits ripening of total soluble solids (TSS) is a withstand factor and increases with the increase of maturity; on the contrary, fruit acidity decreases (Kawamura 2000). TSS was reported 9.16 to 9.77 in pear cv. 'Santa Maria' by (Ozturk and Faizi, 2022), 12.38 °Brix by (Sajid et al., 2022). In local pear cultivars, TSS was determined between 7.60-19.25 % (Orman and Yarılgac, 2016; Polat and Az, 2017; Akın and Bostan, 2018; Balta et al., 2019; Kalkısım et al., 2021). In pear fruit, titratable acidity was reported between 0.13 – 1.51% (Orman and Yarılgac, 2016; Polat and Az, 2017; Balta et al., 2019; Kalkısım et al., 2021; Ozturk, 2021; Sajid et al., 2022). pH was reported 4.28 by Erturk et al. (2009), 3.94 by Ozturk et al. (2009), 3.98 to 4 by Erdem ve Ozturk (2012), 3.98 to 4.06 by Kucuker et al. (2016), 3.40 by Ekinci and Akcay (2016), 3.18 to 4.99 by Orman and Yarılgac (2016), 2.90 to 4.81 by Polat and Az (2017), 4.77 to 5.39 by Akın and Bostan (2018), 4.29 to 5.18 by Balta et al. (2019), 3.80 to 3.96 by Mertoglu and Evrensoglu (2019), 4.22 to 5.35 by Kalkısım et al (2021) and 5.31 by Sajid et al. (2022).

Table 3. Chemical characteristics of some local pear cultivars.
Çizelge 3. Yerel armut çeşitlerin kimyasal özellikleri.

Cultivars	Total soluble solids (%)	Acidity (%)	pH
Karpuz	14.70 c	0.29 e	4.67 c
Kadın Parmak	13.37 de	0.23 f	4.87 a
Karga	13.87 d	0.31 de	4.69 b
Kuşak	13.57 de	0.36 cd	4.34 e
Gelin	12.67 f	0.34 cde	3.99 g
Macar	13.70 d	0.35 cd	4.04 f
Harman	12.90 ef	0.19 f	4.57 d
Rıza	16.50 a	0.60 a	3.50 h
Kara	16.83 a	0.38 c	3.99 g
Eşek	15.57 b	0.52 b	3.98 g
Significance	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

Fruit Skin and Flesh Color Characteristics

The research data on fruit skin and flesh color features of some indigenous pear cultivars on BA29 quince clonal rootstock were given in Table 4 and Table 5. It became revealed that all fruit skin and flesh color

characteristics were statistically significant. In the case of fruit skin color, the highest values of L* in 'Gelin', a* in 'Harman', b* and chroma in 'Karpuz', and hue angle in 'Rıza' were recorded. While lowest values were recorded as the following L*, b* and chroma in 'Kara', a* in 'Rıza', and hue angle in 'Harman'. Regarding fruit flesh color, the highest values of L* in 'Harman', a* in 'Kuşak', b*, chroma and hue angle in 'Gelin' pear were observed. Furthermore, the lowest values were found to be as the following L* in 'Kadın Parmak', a* in 'Gelin', b* in 'Rıza', chroma in 'Karpuz', and hue angle in 'Kuşak' cultivar.

As an appearance characteristic color is an important quality feature which consider with L* (0 = white, 100 = black), a* (if positive = red, if negative = green), b* (if positive = yellowness, if negative = blueness), Chroma (express the color saturation level), and h° (0° = red, 90° = yellow, 180° = green, and 270° = blue) (McGuire 1992). The most important color parameters indicating the fruit maturity level in pear are L* and b*. The increase in the b* value indicated higher sugar content in the pear fruit (Kawamura 2000). The fruit skin color of pear cv. 'Santa Maria' was reported as the following L* (57.59 to 60.87), a* (-17.14 to -17.18), b* (24.60 to 27.01), chroma (30.10 to 31.71), and hue° (118.30 to 132.50) by (Ozturk and Faizi, 2022).

Table 4. Fruit skin color of some local pear cultivars.
Çizelge 4. Bazı yerel armut çeşitlerin meyve kabuk renk özellikleri.

Cultivars	L*	a*	b*	Chroma	h°
Karpuz	67.83 bc	-15.11 cde	39.92 a	42.16 a	111.78 bc
Kadın Parmak	68.60 bc	-13.40 bcd	36.15 abc	40.43 ab	109.30 cde
Karga	62.87 ef	-10.24 b	35.30 abc	38.11 bc	105.50 def
Kuşak	63.40 def	-16.09 de	33.93 bcd	37.36 bc	115.42 ab
Gelin	74.45 a	-10.28 b	38.16 ab	40.36 ab	101.49 fg
Macar	66.90 bcd	-10.27 b	35.39 abc	36.43 c	104.18 efg
Harman	70.38 b	-4.61 a	35.01 abc	35.55 cd	99.29 g
Rıza	62.15 f	-17.90 e	31.84 cd	37.93 bc	119.54 a
Kara	55.67 g	-11.79 bc	29.24 d	33.03 d	111.09 bc
Eşek	66.44 cde	-14.11 cd	37.08 abc	40.25 ab	110.32 bcd
Significance	0.001	0.001	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

Table 5. Fruit flesh color of some local pear cultivars.
Çizelge 5. Bazı yerel armut çeşitlerin meyve et renk özellikleri.

Cultivars	L*	a*	b*	Chroma	h°
Karpuz	70.13 b	-1.96 b	16.08 cdef	13.67 d	99.94 b
Kadın Parmak	59.77 d	-0.46 a	14.24 ef	13.89 d	92.39 d
Karga	66.31 c	-1.87 b	21.04 ab	22.25 a	95.56 c
Kuşak	71.29 b	0.13 a	16.86 cde	15.32 cd	92.22 d
Gelin	88.36 a	-4.85 e	22.30 a	22.65 a	105.16 a
Macar	89.45 a	-3.27 d	17.75 cd	16.97 bc	98.04 b
Harman	89.94 a	-2.89 cd	17.82 c	18.53 b	98.39 b
Rıza	69.79 b	-2.28 bc	13.55 f	14.00 d	100.54 b
Kara	69.93 b	-2.25 bc	14.96 def	18.13 b	94.95 c
Eşek	68.76 bc	-0.45 a	18.85 bc	15.24 cd	95.22 c
Significance	0.001	0.001	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

Sensory Evaluation

Research findings on the sensory evaluation of local pear cultivars on BA29 quince clonal rootstock are presented in Table 6. Each chemical characteristic was proven to be significant. It was determined that 'Macar' pear had a higher value of juiciness but the lowest taste and aroma values than other pears. The highest taste and aroma values recorded in 'Kadın Parmak' pear and the highest visual quality (VQ) in the 'Eşek' cultivar. The lowest juiciness was measured in the 'Kara' pear and the lowest VQ in the 'Harman' cultivar.

The eating quality of fruit is difficult to measure objectively; therefore, sensory analysis has been defined as a scientific discipline used to evoke, measure, analysis and interpret reactions to those characteristics of fruits as the senses of sight to perceive them, smell, taste, touch, and hearing (Pasquariello et al., 2013). A sensory analysis was therefore used to define the sensory attributes related to consumer preference, such as juiciness, taste, aroma, and visual quality (a general consideration of shape, size and color) all of which are important determinants of pears fruit eating quality (Eccher Zerbini, 2002). The juiciness of pear fruit reported to be the highest in 'Tosca' and 'Coscia' on the contrary, the lowest in 'Etrusca' and 'Carmen', and mentioned that juiciness could be effective by the pectic enzyme activity (pectinmethylesterase) (Pasquariello et al., 2013). Predieri et al. (2005) found that sweetness and pear aroma correlated highly with consumer preference. The sweetness and sourness of pear fruit differ based on the cultivar. They are the most important characteristics when considering taste due to the composition of soluble sugars, organic acids, and volatile substances (Eccher Zerbini, 2002). In the organoleptic evaluation of pear fruit, the aroma is a crucial sensory attribute (Zhang et al., 2008), which comes from the combination of sugars, acids and aromatic materials within the fruit. Many factors can significantly affect the pear fruit aroma, consisting of pre-harvest factors, genetic differences, maturity at harvest, storage conditions and fruit physiology (interfruit volatile localization, ripening, senescence and presence of disorders) (Rapparini and Predieri, 2002). The shape of pear fruits can range from round to elongated (Pasquariello et al., 2013). Terms such as pyriform, elongate-pyriform and intermediate-straight can also be used to describe the intermediate shape of pears (Gamble et al., 2006). The cultivars we used in our research, 'Karpuz', 'Karga', 'Gelin' and 'Kara' were pyriform. At the same time 'Eşek' and 'Kadın Parmak' were elongated- pyriform, and 'Macar', 'Harman', 'Kuşak', and 'Rıza' had round shapes.

Table 6. Organoleptic characteristics of some local pear cultivars.
Çizelge 6. Bazı yerel armut çeşitlerin duyusal özellikleri.

Cultivars	Juiciness	Taste	Aroma	Visual quality
Karpuz	5.00 ab	4.75 abc	5.00 abc	6.25 a
Kadın Parmak	5.58 ab	5.92 a	5.83 a	5.33 b
Karga	5.25 ab	4.00 cd	4.17 bcd	4.17 cde
Kuşak	4.25 bc	3.33 d	3.83 cd	4.00 de
Gelin	4.50 bc	4.92 abc	4.67 abc	4.92 bc
Macar	6.25 a	3.33 d	3.25 d	4.42 cd
Harman	5.92 a	5.33 ab	5.25 ab	2.25 f
Rıza	4.50 bc	4.75 abc	4.58 abcd	3.50 e
Kara	3.58 c	4.50 bcd	4.42 bcd	4.58 bcd
Eşek	6.08 a	5.39 ab	5.19 abc	6.36 a
Significance	0.001	0.001	0.001	0.001

*: Averages shown with different letters in the same column, the difference between them is statistically significant.

CONCLUSION

From our research findings, it was revealed that the 'Karpuz' cultivar recorded higher fruit weight (FWgt), fruit width (FWdt), fruit height (FH), fruit volume (FV) and fruit stalk thickness (FStT). While the highest fruit length (FL), fruit stalk length (FSL) in 'Eşek' pear, and highest fruit skin thickness (FSkT) in the 'Rıza' cultivar, and highest fruit firmness (FF) in the 'Harman'. It was determined that 'Kara' pear had higher total soluble solids (TSS) compared to the others, on the contrary, the lowest TSS was observed in 'Gelin' pear. The highest acid content was obtained in the 'Rıza' pear, while the lowest acidity was measured in the 'Harman' pear. The pH value of the 'Kadın Parmak' pear was higher than other cultivars, and vice versa the lowest pH was determined in the 'Rıza' pear. In the case of fruit skin color, the highest values of L* in 'Gelin', a* in 'Harman', b* and chroma in 'Karpuz', and hue angle in 'Rıza' were recorded. While lowest values were recorded as the following L* b* and chroma in 'Kara', a* in 'Rıza', and hue angle in 'Harman'. In consideration of fruit flesh color, the highest values of L* in 'Harman', a* in 'Kuşak', b*, chroma and hue angle in 'Gelin' pear were observed. And the lowest values found to be as the following L* in 'Kadın

parmağı', a* in 'Gelin', b* in 'Rıza', chroma in 'Karpuz', and hue angle in 'Kuşak' cultivar. It was determined that 'Macar ' pear had a higher value of juiciness but the lowest taste and aroma values than other pears. The highest taste and aroma values recorded in the 'Kadın Parmak' pear and the highest visual quality (VQ) in the 'Eşek' cultivar. The lowest juiciness was measured in the 'Kara' pear and the lowest VQ in the 'Harman' cultivar. In conclusion, it was revealed that the 'Karpuz' cultivar shown better pomological features, and the visual quality of the 'Eşek' pear was recorded the best. So 'Karpuz', 'Eşek' and 'Gelin' pears quality performances found to be higher, and we recommend them for further consideration.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

DECLARATION OF AUTHOR CONTRIBUTION

Ahmet ÖZTÜRK: Supervision, Review and editing. **Zaki Ahmad FAIZI:** Investigations, Data analysing, Visualization, Writing of original draft.

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