RESEARCH ARTICLE

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Investigation of the local pear genotypes grown in Malatya

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Abstract
This study was carried out between 2020 and 2021 on local pear genotypes grown in the Malatya region (Türkiye), especially in the yard of Apple-Pear Germplasm of Malatya Turgut Özal University. In the study, phenological, pomological, and phytochemical characteristics of nine pear genotypes were analyzed. The following dates were identified for the selected characteristics: the bud swell between March 9 and 27, the bud bursts between March 14 and April 1, the start of flowering between March 28 and April 7, full bloom between April 2 and 11, the end of flowering between April 6 and 15, harvest between August 10 and November 13, defoliation between December 3 and 17, and the number of days from full bloom to harvest ranged between 128 and 216 days. The following results were obtained: fruit weights were 46.3-202.6 g, fruit lengths were 44.8-91.2 mm, fruit diameters were 43.8-76.2 mm, fruit flesh firmness were 2.4-9.62 kg/cm^2, fruit volume was 45.5-204.3 ml, and fruit color values were 21.3-77.1 as *L* value, -2.49-0.1 *as a* value, and -2.03-54 *as b* value. The water-soluble dry matter content of the genotypes ranged between 10.3-15.9, pH values ranged between 3.99-5.37, total phenolic content ranged between 167-992 mg GAE /1000g, and total antioxidant activities ranged from 284 to 1454 mg TEAC/1000 g. Aliseydi from the summer pear genotypes and Parlak and Armut1 genotypes from the autumn genotypes were important. It is thought that Biber, Dudunun and Efendi genotypes from winter genotypes may be important materials for future studies.
Keywords: *Pyrus comminus*, Local pear, Phenology, Pomology, Antioxidants

INTRODUCTION

As a member of the pome fruit group, the pear belongs to the genus *Pyrus* L. the subfamily *Pomoideae* of the family Rosaceae of the order Rosales. This genus contains many distinct species. Considering pomiculture, 13 species have gained significance in developing as fruit cultivars and using rootstocks (Özbek, 1978). *P. communis* L. is one of the most significant species of pears and has spread over a broad geographical area. It also plays a critical role in developing pear cultivars (Özbek, 1978). The number of local pear varieties in Türkiye, one of the gene centers of *P. communis*, reportedly exceeds 600 (Özbek, 1947; Davis, 1972).

Ülkümen (1938) states that Türkiye constitutes a significant fruit production region. He also emphasizes that pears and apples are grown in Türkiye, especially in eastern and western provinces.

According to the most recent statistics, the global pear production is 39.210.669 tons annually in an area of 135.190.430 decares. Türkiye also ranks fifth among pear-producing countries with a production figure of 545.569 tons which corresponds to 1.4% of the total in an area of 260.707 decares. Türkiye's pear

production is growing in tandem with global pear production (FAO, 2022).

The province of Malatya is known for apricot production and has considerable potential for producing other fruit species that grow best in temperate climates. According to 2021 production statistics in Malatya province, the pear yield was 40 kg per tree, amounting to a total production of 6.635 tons (TUIK, 2021). In Battalgazi district, where the current study was conducted, the pear yield in 62 decares was 356 tons (TUIK, 2021). There are local varieties in addition to the well-known standard pear cultivars.

In Türkiye, which has a diverse fruit-growing culture, there are many explicit local varieties in pear production, along with the standard cultivars, which are economically worthless in many regions and generally appraise at domestic consumption or in local markets. Besides, these species create a different taste and serve as an exceptional source of genetic material for breeding studies, constituting a significant genetic source to develop new varieties. The larger the fruit population, the more likely it is to find the desired material in breeding studies. Preserving local cultivars and wild species can ensure the continuity of crop production, while it is also important to protect wild species and local genotypes to achieve sustainable crop production. In this context, there are numerous studies in Türkiye on protecting genetic resources. The pomological studies have also revealed the value of fruit varieties (Doğan and Güleryüz 2001; Bayındır 2017).

The aim of this study is to reveal the local pear varieties grown in Malatya province and its districts, which have an important place in terms of cultural fruit growing and natural resources, to bring them into the economy, to preserve many pear genotypes, which are about to disappear and have genetic and commercial value, and to use them as a genetic material.

MATERIALS AND METHODS

Materials

This study was conducted between 2020 and 2021 in the yard of Apple-Pear Germplasm of Malatya Turgut Özal University, Faculty of Agriculture, where the local pear genotypes which are well-known to the local population and have been grown for many years have been planted. The genotypes in the Germplasm parcel were created with superior genotypes determined from the genotypes grown in the province of Malatya and districts within the scope of the Project of Identification and Conservation of Malatya's Important Genetic Resources (Asma et al.,2003). In 2020 and 2021, bud swell, bud burst, beginning of flowering, full flowering, end of flowering, eating maturity were observed from tress belonging to 9 genotypes (Abbas, Aliseydi, Armut1, Biber, Dududnun, Efendi, Hacı Hasan, Kış and Parlak pear) determined by preliminary selection. Harvest and leaf fall dates were determined. Fruit weight, fruit length, fruit diameter, fruit flesh firmness, fruit volume, fruit color values, amount of water-soluble dry matter, Ph, total phenolic content, and total antioxidant activity were assessed in 30 fruits randomly taken from the determined trees in analysis of both years.

Methods

Both the pomological analyses and phenological observations took place in 2020. However, the phenological and pomological characteristics of the fruits collected in 2020 from the local pear genotypes were analyzed in 2021.

The pH was measured using a pH meter and the amount of Water-Soluble Dry Matter was observed using a hand refractometer.

The Folin-Ciocalteu method was used to determine total phenolic content and the results were expressed as gallic acid equivalent. 50 µL of extract, 950 µL of distilled water, and 1 mL of Folin-Ciocalteu solution were added into a tube and waited for 3 minutes. Then, 1 mL of 2% Na2CO3 solution was added and waited for another 1 hour in the dark. The absorbance of the solution was measured at a wavelength of 765 nm and the results were expressed as gallic acid equivalent.

ABTS (2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt) radical scavenging assay was applied to determine antioxidant capacity. ABTS of 0.0384 g was weighed and dissolved in 2 mL of distilled water. After adding 2 mL of potassium persulfate solution, it was completed up to 10 ml with distilled water. After keeping the solution in the refrigerator for 1 night, its absorbance was adjusted with methanol to give an absorbance of 0.700 at 734 nm. 0.40 mL of the extract and 2.96 mL of the adjusted ABTS solution were added into a tube and the absorbance was measured at 734 nm. Results are expressed as trolox equivalents.

SPSS 25.0 statistical software was used to interpret the data. In order to determine the differences between the tested applications, ANOVA or DUNCAN test was applied at the significance level of 0.05.

RESULTS AND DISCUSSION

The observation-based findings of the nine genotypes between 2020 and 2021 revealed that in both years, bud swell initially began between March 9 and 13 (Aliseydi) and ended between March 20 and 27 (Kış). The earliest bud burst occurred between March 14 and 19 (Aliseydi) and the latest bud burst occurred between March 31 and April 1 (Kış). While the first flower bloomed between March 28 and April 1 (Aliseydi), the last flower bloomed between March 31 and 7 April (Kış). Additionally, the initial full bloom was observed between April 2-5 (Aliseydi) and the latest full bloom took place between April 6 and 11 (Kış). Considering the end of flowering dates between 2020 and 2021, dates of April 6–9 (Aliseydi) and April 11–15 (Kış) were the first and last observed days for the end of flowering, respectively. The genotypes that reached the earliest harvest maturity in 2020 were Aliseydi and Hacı Hasan (August 10), whereas their harvest dates for 2021 were August 15-22. On the other hand, the genotypes that reached the last harvest maturity in 2020-2021 were Kış and Armut1 (between October 22 and November 13). The shortest period between full bloom and harvest identified among the genotypes in both years was 128-137 days (Hacı Hasan), and the longest period was 202-216 days (Armut1) (Table 1, 2).

According to the observations, in both years bud swell occurred at the earliest (March 9-13) in the Aliseydi pear genotype and at the latest (March 20-27) in the Kış pear genotype, bud burst occurred at the earliest between March 14 and 19 (Aliseydi) and at the latest between March 31 and April 1 (Kış). There was a difference of 4-11 days between the dates of bud swell and bud burst in both years. The average temperature of March 2021, when bud swell and bud burst were observed, decreased by 2.5 °C compared to March 2020 and the differences were observed in these phenological stages.

Table 1. Phenological observation dates for 2020 and 2021.

Genotypes	Bud Swelling		Bud Burst		First Flower Bloom		Full Bloom	
	2020	2021	2020	2021	2020	2021	2020	2021
Abbas	13.03	19.03	20.03	30.03	30.03	05.04	03.04	08.04
Aliseydi	09.03	13.03	14.03	19.03	28.03	01.04	02.04	05.04
Armut1	13.03	21.03	20.03	31.03	29.03	07.04	03.04	11.04
Biber	13.03	23.03	20.03	31.03	30.03	06.04	03.04	11.04
Dudunun	15.03	25.03	20.03	31.03	30.03	07.04	03.04	11.04
Efendi	13.03	23.03	20.03	31.03	30.03	05.04	03.04	08.04
Hacı Hasan	13.03	20.03	20.03	26.03	31.03	04.04	04.04	07.04
Kış	20.03	27.03	25.03	01.04	31.03	07.04	06.04	11.04
Parlak	10.03	25.03	20.03	31.03	29.03	06.04	04.04	11.04

Table 2. Phenological observation dates for 2020 and 2021.

Genotypes	End of Flowering		Harvest		Leaf Fall		S.P	
	2020	2021	2020	2021	2020	2021	2020	2021
Abbas	07.04	12.04	03.10	10.10	7.12	11.12	183	185
Aliseydi	06.04	09.04	10.08	15.08	03.12	10.12	131	136
Armut1	07.04	14.04	22.10	13.11	08.12	15.12	202	216
Biber	07.04	14.04	-	10.10	07.12	15.12	-	186
Dudunun	07.04	14.04	25.09	29.09	07.12	15.12	172	171
Efendi	07.04	11.04	-	10.10	14.12	08.12	-	185
Hacı Hasan	08.04	12.04	10.08	22.08	07.12	11.12	128	137
Kış	11.04	15.04	22.10	13.11	10.12	17.12	201	216
Parlak	07.04	12.04	03.10	10.10	7.12	11.12	183	185

S.P: The shortest period between full bloom and harvest

The measurements made in 2020 and 2021 revealed that the highest fruit weight of the pear genotypes ranged from 202.59 (Armut1) to 175.79 (Parlak), respectively. However, the lowest fruit weight in both years ranged between 56.96 and 46.35 (Hacı Hasan). The fruit length of pear genotypes ranged from 44.78 mm (Kış) to 91.18 mm (Parlak), and the average fruit diameter ranged between 43.78 mm and 76.17 mm. Fruit flesh firmness ranged from 2.44 kg/cm^2 (Aliseydi) to 9.62 kg/cm^2 (Abbas) and the fruit volume ranged between 45.48 and 204.34 ml. Considering the lowest and highest values, the L* color values were 21.29-22.24 (Kış) and 76.93-77.63 (Aliseydi), and the value on the green-red scale was -2.49 -1.92 (Hacı Hasan) and -0.2 (Dudunun) in 2020 and -1.92 (Hacı Hasan) and 0.1 (Kış) in 2021. Similarly, the b value on the blue-yellow scale varied between 1.32 (Kış) and 53.64 (Aliseydi) in 2020 and -1.97 (Abbas) and 53.96 (Hacı Hasan) in 2021. Among the genotypes analyzed, the lowest and highest water-soluble dry matter contents were

10.3-10.8 (Dudunun and Hacı Hasan) and 14.6-14.3 (Aliseydi), respectively. However, the lowest and highest pH values were 3.95-3.99 (Parlak) and 5.37-5.31 (Aliseydi), respectively. While the lowest total phenolic content was 168-221 mg/1000 g GAE (Aliseydi-Dudunun), the highest total phenolic content was 814 -849 mg/1000 g GAE (Kış-Efendi). The antioxidant activity analysis results of pear genotypes also revealed that it ranged between 208 mg/1000 g TEAC and 1454 mg/1000 g TEAC in 2020; whereas, it remained between 275 mg/1000 g TEAC and 1201 mg/1000 g TEAC in 2021 (Tables 3, 4, and 5, Figures 1, 2, 3, and 4).

Table 3. Pomological Characteristics of Pear Genotypes in 2020 and 2021

Genotypes	Fruit Weight (g)	Fruit Length (mm)	Fruit Diameter (mm)	Fruit Flesh Hardness (kg/cm²)	Fruit Volume (ml)
Abbas	101,03±20,39b	60,87±4,57c	60,26±4,08c	8,34±1,59a	126,14±6,42b
Aliseydi	101,77±16,55b	53,18±3,29d	61,7±2,36c	2,41±0,36e	109±7,71c
Armut1	202,59±40,17a	62,46±5,37c	76,17±13,71a	7,63±0,63b	135,27±7,29b
Biber	0	0	0	0	0
Dudunun	101,34±20,68b	68,13±7,59b	59,64±4,66c	5,35±0,67d	106,19±2,09c
Efendi	0	0	0	0	0
Hacı Hasan	56,96±4,07c	48,76±2,17e	44,49±4,02e	2,97±0,69e	54,09±5,93e
Kış	66,84±17,68c	46,89±4,95e	50,23±4,45d	8,14±1,26a	92±0d
Parlak	183,44±53,54a	91,18±6,99a	70,17±4,72b	6,56±0,83c	200,17±32,82a

Table 4. Pomological Characteristics of Pear Genotypes in 2020 and 2021

Genotypes	Fruit Weight (g)	Fruit Length (mm)	Fruit Diameter (mm)	Fruit Flesh Hardness kg/cm²)	Fruit Volume (ml)
Abbas	131,49±35,2b	64,3±4,2c	68,66±5,08ab	9,62±1,62a	129,34±5,17b
Aliseydi	72,25±16,15cd	46,56±5,92e	51,62±4,77d	2,44±0,37c	83,27±13,11d
Armut1	139,01±30,3b	59,48±4,98d	71,06±7,91a	9,13±1,57a	131,4±6,02b
Biber	133,14±48,19b	55,29±7,69d	62,81±7,83c	6,53±0,7b	116,67±4,93c
Dudunun	83,55±33,06c	57,3±5,95d	51,88±5,94d	5,73±1,05c	84±0d
Efendi	156,17±41,87ab	74,64±7,41b	66±6,49cb	7,05±0,52b	126,74±6,68b
Hacı Hasan	46,35±8,88d	47,67±4e	43,78±3,67e	2,93±0,58c	45,48±4,06e
Kış	67,84±15,95cd	44,78±3,92e	50,21±2,95d	7,82±0,82a	66,66±0e
Parlak	175,79±60,64a	80,73±7,6a	70,21±5,55ab	6,06±1bc	204,34±16,55a

Table 5. Pomological Characteristics of Pear Genotypes in 2020 and 2021

	Color					
	2020			2021		
Genotypes	L	a	b	L	a	b
Abbas	21,51±0,83b	-0,2±0,03a	-1,2±0,05c	22,1±0,71b	0,05±0,02a	-1,97±0,04b
Aliseydi	76,93±3,01a	-1,6±2,54b	53,64±3,79a	77,63±3,45a	-1,92±1,25b	51,66±8,81a
Armut1	21,79±1,04b	-0,12±0,16a	-1,22±0,08c	22,05±0,79b	-0,06±0,17a	-2,03±2,71b
Biber	0	0	0	21,99±0,41b	0,04±0,04a	-1,92±0,04b
Dudunun	21,33±0,79b	-0,2±0,02a	-1,21±0,08c	21,76±0,76b	-0,09±0,06a	-1,47±1,2b
Efendi	0	0	0	21,59±1b	0,12±0,13a	-1,95±0,1b
Hacı Hasan	73,95±14,77a	-2,49±0,59b	53,2±3,49a	77,1±3,12a	-1,3±2,85a	53,96±3,4a
Kış	21,29±0,54b	-0,23±0,03a	-1,32±0,3c	22,24±0,4b	0,1±0,05a	-1,96±0,06b
Parlak	25,75±2,08a	-1,27±0,25b	-04,03±0,29b	21,71±0,92b	-0,03±0,02a	-1,96±0,12b

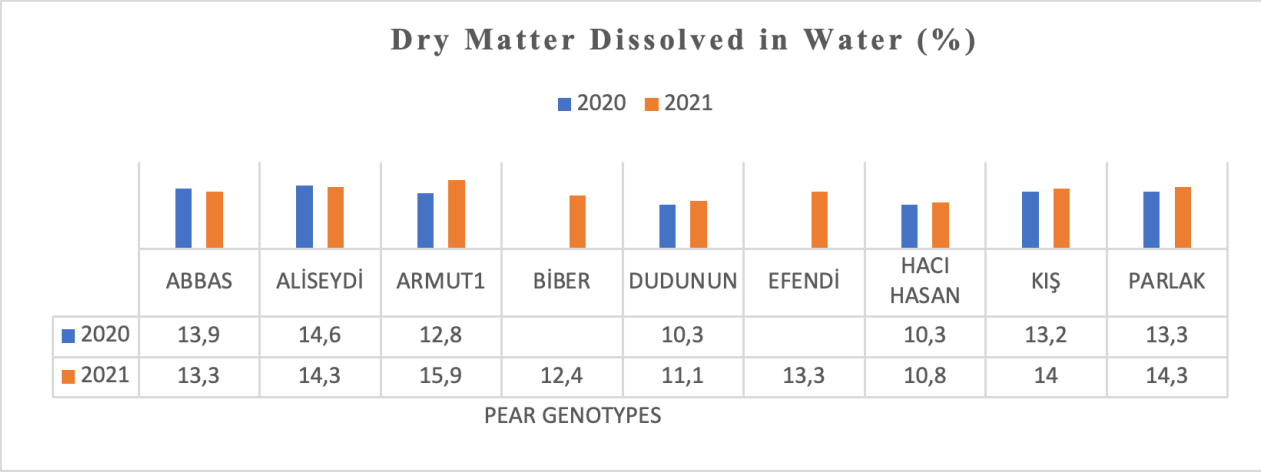

Figure 1. Dry Matter Dissolved in Water for values 2020 and 2021

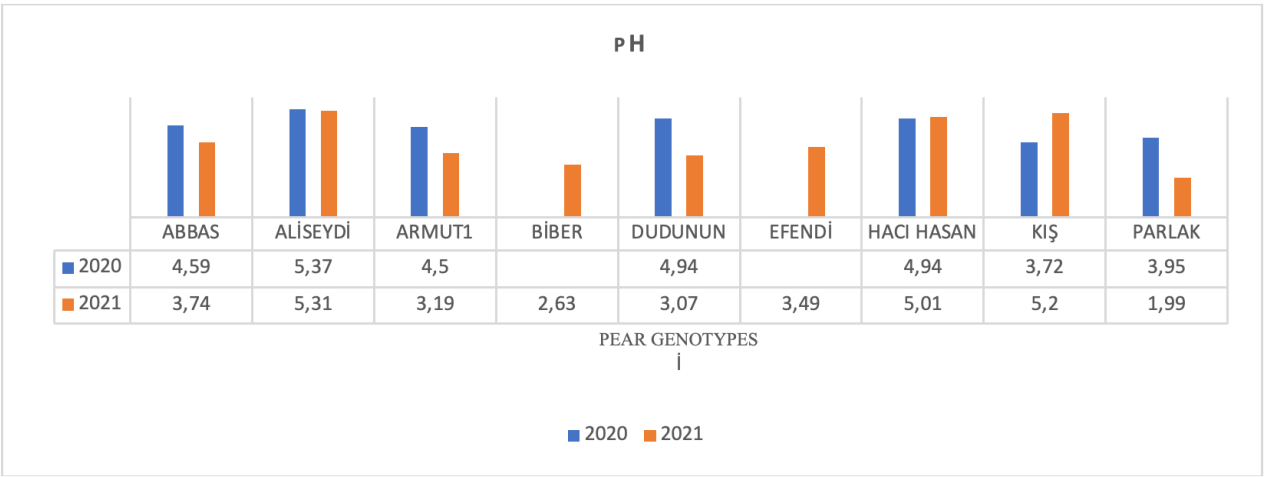

Figure 2. pH for values 2020 and 2021

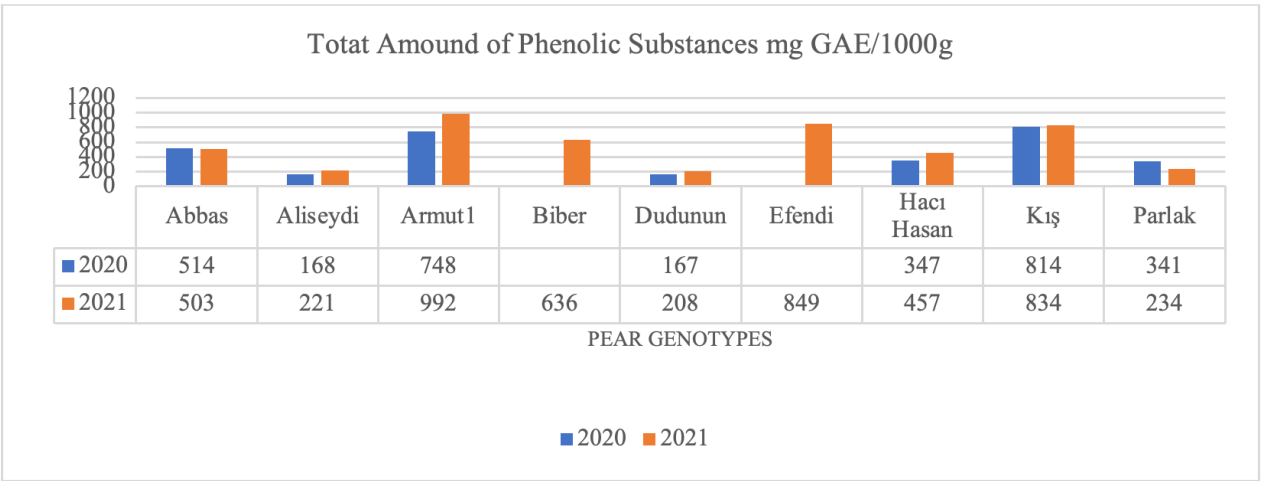

Figure 3. Totat Amound of Phenolic Substances for values 2020 and 2021

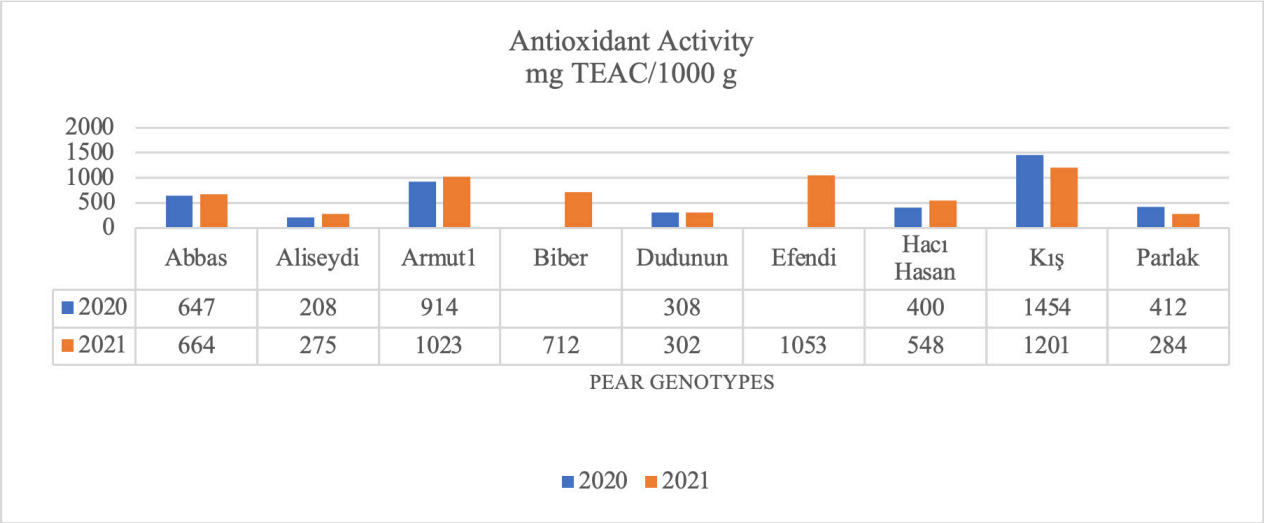

Figure 4. Antioxidant activity values for 2020-2021

Considering the previous studies conducted in Türkiye, the weight of pear species grown in Ünye district of Ordu province in 2012 was between 18.7 g and 258.3 g (Bostan and Acar, 2012) in Gürgentepe district of Ordu province, and the phenological, morphological and pomological characteristics of the local pear species grown in these districts were observed. A study conducted to identify some fruit characteristics of early pear (Pyrus communis L.) types grown in the Eğirdir district reported that the fruit weight ranged between 36.23 g and 146.65 g (Kılıç, 2015). Polat and Bağbozan (2017) reported the average measurements for fruit weight as 21.6-273 g, fruit width as 35.8-73.5 mm, and fruit length as 25.9-117.3 mm. Additionally, the water-soluble dry matter content of the fruits was 10.6-16.3%, TEA content was 0.1-0.9%, and fruit pH ranged between 3.2 and 5.4. As a result, they found that Yellow Pear and E2470 were promising among all pear genotypes. In another study focusing on selecting local pears grown in Malatya province, Bayındır et al., (2019) identified three promising genotypes based on the pomological analysis of the fruits. They accordingly reported that the fruit weight, fruit flesh firmness, water-soluble dry matter content, titratable acidity, and the pH measurements of these genotypes were between 121.8-163.98, 4.18-8.35 kg/cm^2, 13.60%-15.40%, 0.18%-0.21%, and 3.95-4.83, respectively. Mete and Seferoğlu (2019) observed that full bloom occurred between March 9 and 25, the number of days from full bloom to harvest varied between 101 days (Santa Maria) and 202 days (Ankara). In a study conducted by Murathan et al., in 2019, the total phenolic content of şakok pear was determined as 174.2 mg GAE/100g, and the ABTS radical scavenging activity was 48.2%. Furthermore, Turalı and Karadeniz (2020) reported bud swell between March 07 and April 5, the end of flowering between April 13 and May 9, and harvest between August 21 and October 20. They additionally found that the water-soluble dry matter content ranged between 7.50%-16.50% and 8.50%-15.50% and the pH value of the pears ranged between 2.82 and 6.12.

It was observed in the present study that the data obtained from the genotypes were compatible with other studies. One of the most important parts in pomology is fruit weight. While Armut1 (202.59g) and Parlak (175.79g) pear genotypes ranked first in terms of fruit weight, Hacı Hasan pear genotype, which was recorded as a summer genotype, had the lowest fruit weight in both years. When evaluated from a pomological perspective, two genotypes stand out (Parlak, Armut1). It was determined that the Parlak pear genotype, which is one of the genotypes with remarkable pomological characteristics, had a medium firmness and the fruit variety of the Armut1 genotype was higher than that of the Parlak pear genotype. The genotype with the highest fruit variety was the Abbas pear genotype. In terms of storage conditions, it remained intact for 2 months at 4°C.

CONCLUSION

Ensuring sustainable plant production can be possible only by preserving wild species. The current study conducted with nine genotypes with no commercial value is thought to set a precedent to prevent the extinction of local pear cultivars, identify their breeding characteristics, and select the superior ones for cultivation purposes. The current study, on the other hand, revealed that Aliseydi a summer genotype and Parlak and Armut1 the autumn genotypes are promising cultivars, additionally highlighting that the autumn genotypes, such as Biber, Dudunun, and Efendi, may also serve as considerable breeding materials for future studies.

COMPLIANCE WITH ETHICAL STANDARDS

Peer-review

Externally peer-reviewed.

Conflict of interest

The authors declare that they have no competing, actual, potential or perceived conflict of interest.

Author contribution

This article is derived from Hazal KARACA's Master thesis. 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.

Ethics committee approval

Ethics committee approval is not required.

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Data availability

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

REFERENCES

Asma, B. M., Seçkin, T., Birhanlı, O., Kan, T. (2003). Malatya'nın Önemli Meyve Genetik Kaynaklarının Belirlenmesi ve Muhafaza Edilmesi Projesi. Inönü Üniversitesi Bilimsel Araştırma Projeleri Birimi Proje No: İ.Ü. BAPB 2000/21 (in Turkish)

Bayındır, Y. , Çöçen, E. , Macit, T. , Gültekin, N. İ Toprak Özcan, E. , Aslani A. & Aslantaş, R. (2019). Malatya İli Yazlık Yerel Armut Genotiplerinin Seleksiyonu . Dergi Park Ziraat Mühendisliği , 54-65. (in Turkish)

Bayındır, Y. (2017). Malatya'nın Pötürge ve Doğanyol ilçelerindeki armut (Pyrus communis L.) genotiplerinin seleksiyonu, Erciyes Üniversitesi Fen Bilimleri Enstitüsü Bahçe Bitkileri Anabilim Dalı Yüksek Lisans Tezi. (in Turkish)

Bostan. S.Z., Acar. S. (2012). Ünye'de (ORDU) Yetiştirilen Yerel Armut Çeşitlerinin Pomolojik Özellikleri. Akademik Ziraat Dergisi 1(2): 97-106. (in Turkish)

Davis P H (1972). Flora of Turkey, Vol. IV. Edinburg University Press, Edinburg.

Doğan, A., Güleryüz, M. (2001). Sakı Elma Çeşidinde Klon Seleksiyonu, Türkiye 5. Ulusal Bahçe Bitkileri Kongresi, Bildiriler Kitabı, Erzurum, 185-189. (in Turkish)

FAO (2022). http://www.fao.org/faostat/en/#data/QC (Erişim Tarihi: 06/04/2022)

Kılıç, D. (2015). Gürgentepe (Ordu) İlçesinde Yetiştirilen Yerel Armut Çeşitlerinin Meyve ve Ağaç Özellikleri. Ordu Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi. (in Turkish)

Mete, İ. (2019). Bazı Armut Çeşitlerinde Fenolojik, Morfolojik ve Pomolojik Özelliklerin Belirlenmesi. Aydın Adnan Menderes Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi. (in Turkish)

Murathan, Z. T., Erbil, N., Düzgüner, V., Arslan, M. (2019). Şakok Armudunun (Pyrus Elaeagnifila Pallas) Antioksidan, Antimikrobiyal Ve Mutajenik Özelliklerinin İncelenmesi. Erzincan Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 12(1), 447-456. (in Turkish)

Özbek, S., (1947). Türkiye'de armut yetiştiriciliği ve önemli armut çeşitlerimiz, Yüksek Ziraat Enstitüsü Basımevi, 95. (in Turkish)

Özbek, S. (1978). Özel Meyvecilik. Çukurova Üniv. Ziraat Fak. Yayın No: 128, Adana. 486 s. Polat, M., Bağbozan, B. 2017. Eğirdir (Isparta) Ekolojisinde Yetiştirilen Erkenci Yerli Armut (*Pyrus communis* L.) Tiplerinin Bazı Meyve Özelliklerinin Belirlenmesi. Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü Dergisi, 21, 9-12, Isparta. (in Turkish)

TUİK (2021). Türkiye İstatistik Kurumu. Bitkisel Üretim İstatistikleri. Erişim Tarihi: 23.03.2023 (www.tuik.gov.tr).

Turalı, R. (2020). Bolu Dağı Batı Yakasında yetişen mahalli armut çeşit ve genotiplerinin pomolojik, fenolojik, morfolojik özellikleri. Bolu Abant İzzet Baysal Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi. (in Turkish)

Ülkümen, L. (1938). Malatya›nın mühim meyva çeşitleri üzerinde morfolojik, fizyolojik ve biyolojik araştırmalar. Ankara Yüksek Ziraat Enst., 65 ,. Ankara. (in Turkish)