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Determination of Some Phytochemical Properties and Antioxidant Capacity of "Gelincik" Apple (*Malus Spp.*) and "Hüsnüyusuf" Pear (*Pyrus Spp.*) Fruit Species of Kütahya

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Kütahya İli "Gelincik" Elma (Malus Spp.) ve "Hüsnüyusuf" Armut (Pyrus Spp.) Meyve Türlerinin Bazı Fitokimyasal Özelliklerinin ve Antioksidan Kapasitelerinin Belirlenmesi

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Öz

Bu çalışmanın amacı Kütahya'ya has meyvelerden olan Gelincik elması ve Hüsnüyusuf armudunun bazı fitokimyasal özelliklerini ve antioksidan aktivitesini belirlemektir. Çalışmada fitokimyasal özellikler olarak meyvelerin kuru madde miktarı, suda çözünür kuru madde miktarı (SÇKM), pH, titre edilebilir asitlik (TEA), C vitamini, toplam ve indirgen şeker miktarları tespit edilmiştir. Ayrıca DPPH deneyi ile antioksidan aktivite düzeyleri belirlenmiştir. Çalışma bulgularına göre, Gelincik elması ve Hüsnüyusuf armudu örneklerinin SÇKM miktarları sırasıyla %12,8-13,3 ve %11,8-12,9, arasında değişmiştir. Gelincik elması pH ve TEA değerleri sırasıyla 4,73±0,21 ile 4,65±0,44 ve %0,13±0,05 ile 0,17±0,09 aralığında, Hüsnüyusuf armudunun pH ve TEA değerleri sırasıyla 3,56-3,90 ve %0,32-0,59 aralığında bulunmuştur. Gelincik elmasının toplam şeker değerleri 9,14-11,10 g/100mL aralığında değişmekte iken, invert şeker miktarının 7,45-9,09 g/100mL arasında değiştiği tespit edilmiştir. Hüsnüyusuf armudunun toplam şeker içeriği 7,72-9,10 g/100mL arasında, invert şeker miktarı 5,98-7,05 g/100mL arasında değişmiştir. Gelincik elması ve Hüsnüyusuf armudunun DPPH radikal süpürme deneyi sonucu antioksidan aktiviteleri sırasıyla %63,91-72,18 ve %56,42-39,83 değerleri arasında bulunmuştur. Gelincik elması ve Hüsnüyusuf armudunun C vitamini miktarları ise sırasıyla 7,52-8,44 mg/100mL ve 6,60-5,84 mg/100mL arasındadır. Bu çalışma, Kütahya'nın botanik zenginliklerinden ikisi olan Gelincik elması ve Hüsnüyusuf armudunun tanıtılması, değerlendirilmesi ve mevcut genetik kaynakların korunması için farkındalık oluşturmak amacıyla yapılan ilk çalışmadır. Bu konudaki daha sonra yapılacak çalışmalara kaynak oluşturacağı düşünülmektedir.

Anahtar Kelimeler: *Antioksidan etki; Fitokimyasal özellikler; Gelincik elması; Hüsnüyusuf armudu; Kütahya; Malus; Pyrus.*

Abstract

This study aims to determine some phytochemical properties and antioxidant activities of Gelincik apple and Hüsnüyusuf pear, which are native to Kütahya. Dry matter and water-soluble dry matter amount (WDSM), pH, titratable acidity (TA), vitamin C, total and reducing sugars were determined as phytochemical properties. In addition, antioxidant activity level was determined by DPPH assay. According to this study, the WSDM content of Gelincik apple and Hüsnüyusuf pear samples ranged between 12.8-13.3%, and 11.8-12.9%, respectively. Gelincik apple pH and TA values were between 4.73-4.65 and 0.13-0.17%, respectively; Hüsnüyusuf pear pH and TA values were 3.56-3.90 and 0.32-0.59%, respectively. Total sugar values of Gelincik apple ranged between 9.10-11.10 g/100 mL, the reducing sugar content ranged between 7.45-9.09 g/100mL. The total sugar content of Hüsnüyusuf pear varied between 7.72-9.10 g/100mL, and reducing sugar content varied between 5.98-7.05 g/100 mL. As a result of the DPPH assay, the antioxidant activities of Gelincik apple and Hüsnüyusuf pear were found between 63.91-72.18 %, and 56.42-39.83 %, respectively. The vitamin C contents of Gelincik apple and Hüsnüyusuf pear were between 7.52-8.44 mg/100mL, and 6.60-5.84 mg/100mL, respectively. This study is the first study to raise awareness for the promotion and evaluation, and conservation of existing genetic resources of the Gelincik apple and the Hüsnüyusuf pear, two of the botanical riches of Kütahya. It is thought to be a source for future studies on this subject.

Keywords: *Antioxidant activity; Gelincik apple; Hüsnüyusuf pear; Kütahya; Malus; Phytochemical properties; Pyrus.*

1. Giriş

As the purchasing habits of environmentally aware consumers gradually change, the demand for healthy foods is also increasing. Traditionally grown indigenous fruit varieties are increasingly demanded by consumers due to their excellent taste, high nutritional value, and their traditionally known health benefits (Bvenura and Sivakumar 2017). This study determined some phytochemical properties of the Gelincik apple and the Hüsnüyusuf pear. These fruits are indigenous to Kütahya province. Kütahya province is located in the Aegean Region of Türkiye It is 966 m above sea level and is located between 28 37' 38"-30 18' 11" east longitude and 39 00'

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30"-39 56' 24" north latitude (Sahin et al. 2017). In Kütahya, the most precipitation is observed in the spring season, the winter season is cold and the first frosts of the year begin in September. For this reason, fruit orchards are concentrated in the valley floors and plains, which are milder and have less elevation (Akbaş and Sevindi 2019). The main fruits grown in Kütahya and its districts are grapes, apples, cherries, sour cherries, strawberries, chestnuts, walnuts, and pears. In addition to these, quince, apricot, nectarine, loquat, cranberry, cranberry, spindle, raspberry, strawberry, blackberry, mulberry, almond, hazelnut, pistachio, medlar, and, pomegranate is grown. However, the production of these fruits only meets people's own needs and does not go beyond the local market.

When we look at apple and pear cultivation, which is the subject of our study, according to FAO (Food and Agriculture Organization) 2020 data, apple cultivation ranks first in the world in terms of production area (4,717 thousand ha) and production amount (79.4 million tons). Türkiye is among the important countries in apple production in the world and ranks fourth in the world with a production of 3.6 million tons (Bayav and Karlı 2021). Apple cultivation in the world is followed by pears with a production area of 1,385 thousand ha and a production amount of 24,010 million tons. Türkiye ranks fourth with 531 thousand tons of pear production on 26.3 thousand hectares (Patel et al. 2012).

Apple, a type of fruit whose culture dates back to ancient times, is a plant belonging to the Malus genus from the Rosaceae family. Apple is the most produced and consumed type of temperate climate fruit due to its high ability to adapt to climate and soil conditions and many species. It contains many bioactive substances that are beneficial to human health, therefore it is very useful in human nutrition. Apples contain high concentrations of flavonols and antioxidant substances. The amount of these phytochemicals may vary depending on the apple variety, harvesting and storage method, climate, soil, and water characteristics (Patocka et al. 2020). Apples also contain vitamins C and E, β-carotene, and essential minerals such as zinc, sulfur, manganese, iron, calcium, magnesium, potassium, and copper (Yang et al. 2021). The main soluble sugars in apples are fructose, sucrose, and sorbitol, while the majority of organic acids are malic acid and citric acid Ma et al. 2014; Kalkisim et al. 2018). Since ancient times, apples have been used for various disorders such as asthma, arthritis, diarrheal, stomach aches, obesity, headaches, skin diseases, and respiratory conditions (Patocka et al. 2020).

Apple ranks second among the most cultivated fruits in Kütahya. Golden, Starking, Amasya, and Granny Smith apple varieties are widely grown in Kütahya. Gelincik apple is one of the apple varieties unique to this region (Figure 1). Gelincik apple, which has a unique taste and odor, is known as medicinal in the region. It is an endemic species. Its production is far from commercial concerns and is only intended to meet the needs of families.

Figure 1. Gelincik apple.

The culture of the pear dates back to ancient times, grows in the temperate zone and belongs to the genus Pyrus of Rosaceae family. Since Turkey has very different ecological conditions, more than 600 local pear varieties are grown (Erbil et al. 2018). The total and reducing sugar and organic acid content in pears plays a role in determining the taste, nutritional value, and quality of pears (Chen et al. 2007; Nour et al. 2010). Pear contains sucrose, reducing sugars, and sorbitol as sugar. As organic acids, it contains fumaric, malic, shikimic, and citric acid (Kırca et al. 2022; Öztürk et al. 2010). Pear fruit has high vitamins C, E, and B. It is a very good source of fiber, copper, and potassium (Cyril et al. 2023). Pears and their products have been traditionally used since ancient ages for their pain relieving, antidepressant, antibiotic, antimicrobial, resistance enhancing, and wound healing properties (Öztürk et al. 2015a).

A wide variety of pear varieties are grown in Kütahya. These are Hüsnüyusuf, İstanbul Akça, prickly Akça, and İstanbul pear. The most well-known of these pear varieties is Hüsnüyusuf. Hüsnüyusuf pear is a juicy, thin-skinned, yellow, and fleshy variety with a unique taste and smell (Figure 2). The fruit is small, short-necked and expands towards the lower part. It is harvested at the beginning of July. The production of Hüsnüyusuf pear, an endemic species, is decreasing day by day in Kütahya. It is only grown on old trees in the small gardens of those living in the city and no new trees are planted. While the pears produced are mostly consumed in local markets, there is no commercial production (Akbaş and Sevindi 2019).

Figure 2. Hüsnüyusuf pear (Internet resources-3).

The number of Gelincik apple and Hüsnüyusuf pear trees grown in Kütahya and their share in total fruit production is quite small. Today, many genetic resources, especially endemic ones, are about to be lost. The conservation and development of the genotypes of these endemic species and the improvement of their phytochemical content are important for botanical science. For this reason, several research has been studied define the phytochemical content of existing genetic resources (Gundoğdu et al. 2018; Acero et al. 2019; Mertoğlu and Evrenosoğlu 2019). Local genotypes are also preferred by consumers as they are used for processing of healthy and commercially valuable fruit products (juice, nectar, dried fruit, pure, jam, and pulp). This diversifies agricultural production. Therefore, more information on these local species could improve the conservation of their genetic traits and their processing in the food industry and craftsmanship, thus making them more competitive.

For these reasons, the aim of this study is; (a) to determine some phytochemical values (water-soluble dry matter, pH, titratable acidity, sugar, vitamin C) of traditionally grown Gelincik apple and Hüsnüyusuf pear and (b) to determine their antioxidant properties and to reveal their health benefits. In addition, this study is thought to contribute to the literature as it is the first study to examine these two local fruit varieties.

2. Materials and Methods

2.1. Fruit material

This study was conducted on samples of Gelincik apple and Hüsnüyusuf pear grown in the centre of Kütahya province in 2022. The fruits were obtained from local producers from 4 different regions of Kütahya in August and September when they were fully ripe. These regions are Aydoğdu, Demirciören, Doğuluşah and Kumarı (Figure 3).

2.2. Preparation of fruits for phytochemical analysis

The fruits from each tree were harvested separately and juiced with a juicer for phytochemical analysis. This juice was filtered with coarse filter paper. Analyses were performed using this filtrate and in 3 replicates (Mertoğlu and Evrenosoğlu 2019). In statistical analyses, results were expressed as mean±standard deviation.

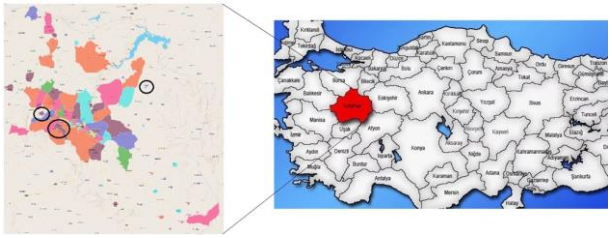

Figure 3. Fruit sampling regions on the map of Kütahya (circled) (Internet resources-1; Internet resources-2).

2.2.1. Titratable acidity (TA) determination

For titratable acidity determination, the juices were titrated with 0.1N NaOH solution in the presence of phenolphthalein indicator. The results were calculated by the following formula and expressed as % malic acid (Mertoğlu and Evrenosoğlu 2019).

Acidity % = $N_{(NaOH)}$ x $V_{(titrant)}$ x 0,067 / sample quantity x 100

2.2.2. Vitamin C determination

The titrimetric method was used to determine the amount of vitamin C. For this purpose, 25 mL of pure water, 5 mL of 10 % H_2SO_4 and 0.2 % starch indicator were added to 10 mL of filtered juice and titrated with 0.005 N iodine solution until a blue-black colour was formed. The calculation was made using the following formula (Sri et al. 2022).

Vitamin C content (mg/100 mL) = $N_{(iodine\ solution)}$ x $V_{(titrant)}$ x 88,07/sample amount x 100

2.2.3. Determination of water-soluble dry matter (WSDM) amount (brix degree)

After the temperature of the strained juice was brought to 20°C, the amount of dry matter dissolved in water was determined as % by hand refractometer (Dzoljic 2021).

2.2.4. pH determination

The filtered juice was measured with a pH meter (Mettler Toledo).

2.2.5. Determination of total sugar, reducing sugar and sucrose

Sugar determination was performed using the Lane-Eynon method as described by Sewwandi et. al. (Sewwandi et al. 2020). For this, the filtered juice was first clarified with Carrez solution. Then the clear filtrate was subjected to acid hydrolysis and acid neutralization, then titrated with Fehling solution for sugar determination. The results were calculated in g/100 mL.

2.2.6. Determination of total dry matter

Approximately 2 g pieces cut from the fruits were dried in an oven at 70°C. After cooling in a desiccator, they were weighed again. The % dry matter content was determined according to the weight change.

2.2.7. Determination of antioxidant activity

DPPH (2,2 Diphenyl 1 picrylhydrazyl) (abcr GmbH, Germany) radical scavenging assay was performed to determine the amount of antioxidant substances (Topuz and Bakkalbaşi 2022). First of all, the fruits were grated with a glass grater to ensure the extraction of antioxidant substances. 10 mL of methanol was added to 5 g of fresh fruit sample and mixed with a magnetic stirrer at room temperature and in the dark for 2 hours. It was then centrifuged at 8000 rpm at 10°C for 10 min and the supernatant was collected.

For DPPH analysis, 3.6 mL DPPH solution (0.025 g/L methanol) and 0.4 mL fruit extract were added to the test tube and incubated for 60 min at room temperature and in the dark. Absorbance values were then read at 515 nm wavelength on a spectrophotometer (Agilent Technologies Cary 60 UV-Vis). The witness sample was prepared by adding 0.4 mL methanol to 3.6 mL DPPH solution. DPPH radical scavenging ability was calculated by the following formula and the results were expressed as percentage (%).

$$\% \text{ DPPH radical scavenging activity} = ABS_{(witness)} - ABS_{(sample)} / ABS_{(witness)} \times 100$$

2.3. Statistical analysis

The mean ± standard deviation values of the results were determined using the IBM SPSS Statistics 20 (IBM, New York, USA) package program.

3. Results and discussion

The results of the phytochemical and antioxidant properties of Gelincik apple and Hüsnüyusuf pear are given in Tables 1 and 2.

Table 1. Results of phytochemical and antioxidant properties of Gelincik apple.

Location	Aydoğdu	Demirciören	Doğuluşah	Kumarı
WSDM*(%)	13.3 ± 0.71	12.8 ± 0.24	13.1 ± 0.48	13.0 ± 0.09
% Dry matter	18.81 ± 0.29	18.63 ± 0.39	19.84 ± 0.66	18.47 ± 0.81
pH	4.73 ± 0.21	4.68 ± 0.39	4.7 ± 0.62	4.65 ± 0.44
TA**(%)	0.13 ± 0.05	0.17 ± 0.09	0.13 ± 0.16	0.15 ± 0.13
Vitamin C (mg/100 mL)	7.71 ± 0.68	8.16 ± 0.28	7.52 ± 0.41	8.44 ± 0.32
Total sugar (g/100 mL)	10.60 ± 0.41	9.78 ± 0.17	11.10 ± 0.38	9.14 ± 0.29
Reducing sugar (g/100 mL)	8.39 ± 0.47	7.89 ± 0.38	9.09 ± 0.81	7.45 ± 0.26
Sucrose (g/100 mL)	2.21 ± 0.33	1.89 ± 0.49	2.01 ± 0.43	1.69 ± 0.36
Antioxidant activity (%)	70.80 ± 1.72	63.91 ± 0.74	67.90 ± 0.48	72.18 ± 2.12

*WSDM: Water-Soluble Dry Matter. **TA: Titratable Acidity

Table 2. Results of phytochemical and antioxidant properties of Hüsnüyusuf pear.

Location	Aydoğdu	Demirciören	Doğuluşah	Kumarı
WSDM*(%)	12.9 ± 0.33	12.2 ± 0.19	11.8 ± 0.26	12.5 ± 0.41
% Dry matter	18.58 ± 0.19	18.22 ± 0.72	17.95 ± 0.64	18.14 ± 0.56
pH	3.56 ± 0.56	3.72 ± 0.07	3.83 ± 0.52	3.9 ± 0.17
TA**(%)	0.47 ± 0.02	0.32 ± 0.12	0.37 ± 0.07	0.59 ± 0.09
Vitamin C (mg/100 mL)	6.03 ± 0.73	6.60 ± 0.42	6.32 ± 0.14	5.84 ± 0.08
Total sugar (g/100 mL)	8.13 ± 0.23	7.72 ± 0.64	9.10 ± 0.68	8.68 ± 0.53
Reducing sugar (g/100 mL)	6.72 ± 0.28	5.98 ± 0.54	7.05 ± 0.66	7.03 ± 0.53
Sucrose (g/100 mL)	1.41 ± 0.21	1.74 ± 0.92	2.05 ± 0.47	1.65 ± 0.64
Antioxidant activity (%)	56.42 ± 1.26	47.64 ± 0.92	52.50 ± 2.07	39.83 ± 1.32

*WSDM: Water-Soluble Dry Matter. **TA: Titratable Acidity.

3.1. Water-soluble dry matter (WSDM)

The chemical properties of fruits are a factor that determines the nutritional and taste characteristics of the fruit in this respect, it directs consumer preferences. According to the data of this study, the average WSDM amount of Gelincik apple samples obtained from different regions of Kütahya was between 12.8±0.24% and 13.3±0.71%, the average % dry matter amount was between 19.84±0.66% and 18.47±0.81%. It was determined that the average WSDM amount of Hüsnüyusuf pear was between 11.8±0.26% and 12.9±0.33%, the average % dry matter amount was between 17.95±0.64% and 18.58±0.19%. Karşı and Aslantaş (Karşı and Aslantaş 2016) found the WSDM amount of 13 standard apple varieties grown in Erzurum (Türkiye) to be 7.73-14.60%. Baydır et al. (Baydır et al. 2019) found the WSDM of 5 commercial apples grown in Afyonkarahisar (Türkiye) between 12.36% and 14.04%.

Karlıdağ and Eşitken (Karlıdağ and Eşitken 2006) determined the WSDM amount of 11 apple cultivars grown in İspir (Erzurum, Türkiye) to be 9.10-13.80%. Güleryüz et al. (Güleryüz et al. 2001) found that the WSDM values of apples in Erzincan (Türkiye) were between 11.22% and 14.28%. Bostan and Acar (Bostan and Acar 2009) reported that the WSDM of 12 local apple cultivars grown in Ünye (Ordu, Türkiye) was between 9.5% and 13.5%.

Similarly, Soylu et al. (Soylu et al. 2003) reported that 7 apple cultivars grown in Görükle (Bursa, Türkiye) had the highest amount of 15.8% WSDM, Tekintaş et al. (Tekintaş et al. 2006) determined the average WSDM values of 4 apple cultivars grown in Aydın (Türkiye) varied between 13.01% and 14.90%, Balta et al. (Balta et al. 2015) reported that the WSDM values of local apples grown in Ordu (Türkiye) were between 9.40% and 13.60%. It was determined by Özrenk et al. (Özrenk et al. 2011) that 15 local apple cultivars grown in Çatak (Van, Türkiye) and Tatvan (Bitlis, Türkiye) had a WSDM content between 15.4% and 10.0%. In addition, Şenyurt et al. (Şenyurt et al. 2015) reported that the WSDM of some standard and local apple species grown in Gümüşhane (Türkiye) ranged between 11.50% and 15.25%, Öztürk et al. (Öztürk et al. 2015b) reported that the WSDM of Breaburn apple grown in Tokat (Türkiye) ranged between 11.6% and 13.3%.

There have been many studies on this subject around the world. Schmutzler and Huck (Schmutzler et al. 2016) reported that the average amount of WSDM of 7 apple varieties grown in West Virginia (USA) was 13.2%, Kim et al. (Kim et al. 2017) reported that the average amount of WSDM of Fuji apples grown in Gyeongsang Province in South Korea was 13.32%, Zhang et al. (Zhang et al. 2019) found that the average amount of WSDM and dry matter of 8 apple varieties grown in New York (USA) were between 12.7% and 16.9% and 138.7 g/kg and 201.5 g/kg, respectively, while McGlone et al. (McGlone et al. 2003) found the average amount of WSDM and % dry matter of Royal Gala apples to be 11.5% and 13.73%, respectively. In a study conducted with apples grown in Aarslev (Denmark), Travers et al. (Travers et al. 2014) found that the average value of the average WSDM was 14.2% and the average value of the average dry matter was 14.9%.

Bayazit et al. (Bayazit et al. 2016) found the average WSDM content of 25 local pear varieties grown in Hatay (Türkiye) between 10.00% and 18.50%, Topuz and Bakkalbaşı (Topuz and Bakkalbaşı 2022) found the average amount of WSDM between 13.30% and 15.40% in 4 pear varieties grown in Van (Türkiye), Kırca et al. (Kırca et al. 2022) found the average amount of WSDM between 12.22% and 13.40% in 4 pear varieties grown in Tavas (Denizli, Türkiye). It was determined that 20 local pear cultivars grown in the Van Lake basin (Türkiye) had WSDM contents between 8.7% and 15.7% and 15 local pear cultivars grown in Adilcevaz (Bitlis, Türkiye) had WSDM contents between 9.8% and 16.0% (Yarılgaç and Yıldız, 2001; Özrenk et al. 2010). In a study on Alişar pear, a local pear cultivar grown in Şebinkarahisar (Giresun, Türkiye), an average of WSDM was found 16.9% (Balta et al. 2019). The WSDM contents were found between 11.0-17.1% in pears grown in Iskilip (Çorum, Türkiye) by Karadeniz and Çorumlu (Karadeniz and Çorumlu 2012), were found between 10.58-16.33% in Eğirdir (Isparta, Türkiye) by Polat and Bağbozan (Polat and Bağbozan, 2017), were found between 10.00-24.90% in Diyarbakır (Diyarbakır, Türkiye) by Oturmak et al. (Oturmak et al. 2017), were found between 9.7-16.6% in Çaykara (Trabzon, Türkiye) by Çubukçu and Bostan (Çubukçu and Bostan 2018).

Chen et al. (Chen et al. 2007) found that the WSDM of 8 pear cultivars grown in Beijing (China) was between 8.09% and 12.5%, Hussain et al. (Hussain et al. 2013), found that the WSDM of 4 pear cultivars grown in Hunga and Nagar Valley of Pakistan was between 11.03% and 14.42%, Fourie et al. (Fourie et al. 1991) found that the SCC of 6 pear cultivars grown in South Africa was between 13.98% and 17.63%.

3.2. pH and titratable acidity (TA)

Ecological conditions, soil structure, and irrigation are thought to have a direct effect on the pH values of local apple and pear varieties. pH value affects the taste and flavor characteristics of fruits. This is important in determining the ripeness of the fruit for eating and preservation.

According to our study, it was determined that the average pH values of Gelincik apple were between 4.73±0.21 and 4.65±0.44, and the average TA values were between 0.13±0.05% and 0.17±0.09%. The pH values of Hüsnüyusuf pear were found in the range of 3.56±0.56-3.9±0.17 and TA values were found in the range of 0.32±0.12%-0.59±0.09%.

In the study of Karşı and Aslantaş (Karşı and Aslantaş 2016), it was determined that TA was between 1.12 g/L and 4.06 g/L and pH value was between 2.9 and 3.9. It was reported that TA values of apples grown in İspir region were between 0.26% and 0.73%, TA values of Erzincan apples were between 0.235%-0.713%, and pH was between 3.24-3.99 (Güleryüz et al. 2001; Karlıdağ and Eşitken 2006). Similarly, Soylu et al. (Soylu et al. 2003)

reported that the pH of apples grown in Görükle varied between 3.15 and 4.04 and the highest TA value was 0.96%, Tekintaş et al. (Tekintaş et al. 2006) reported that the pH values of apples grown in Aydın varied between 3.35 and 4.03. The pH values of 5 commercial apple varieties in Afyonkarahisar were between 4.22-4.92, the pH values of local apples grown in Ünye were between 3.09 and 4.17, the pH values of local apple varieties grown in Kumru (Ordu) were between 2.83 to 4.11, pH values of local apple species grown around Çatak and Tatvan ranged between 4.6 and 3.4, and pH values of apples grown in Gümüşhane ranged between 3.53 and 4.87 (Bostan and Acar 2009; Özrenk et al. 2011; Balta et al. 2015; Şenyurt et al. 2015; Baydır et al. 2019).

Kim et al. (Kim et al. 2017) found the average pH value of Fuji apples in South Korea to be 4.14, Nour et al. (Nour et al. 2010) found the average TA value of 15 apple varieties grown in Romania to be 0.265%, Harker et al. (Harker et al. 2002) found TA values of apples grown in Havelock North (New Zealand) to be between 0.15-0.95%.

Bayazit et al. (Bayazit et al. 2016) found the pH values of 25 pear varieties between 3.00 and 4.94 and TA values between 0.1% and 0.87%, Kırca et al. (Kırca et al. 2022) found the pH of pears in Tavas between 3.51-7.01 and TA values between 0.17-0.34%. Öztürk et al. (Öztürk et al. 2015a) found that the pH values of 13 local and 4 standard pear species grown in the Western Black Sea region of Türkiye were 4.46 on average in the peel, 4.03 on average in the flesh, and TA values were 0.26g/100g on average in the peel and 0.33g/100g on average in the flesh. Yarılgaç and Yıldız (Yarılgaç and Yıldız 2001) reported that the pH and TA amounts of 11 different pears were between 3.02-5.62 % and 0.25-2.45 %, respectively, and Kalkışım et al. (Kalkışım et al. 2018) reported that the pH and TA values of 20 different pear varieties were between 4.08-5.57% and 0.13-1.33%, respectively. In other studies, pH and TA amounts of Deveci pear were determined as 4.29% and 0.60%, respectively, and TA values of 9 pear varieties grown in Van were determined as 11.48%-16.27% (Ozturk et al. 2009; Karadeniz and Kalkışım 1996). Balta et al. (Balta et al. 2019) reported that the average TA value of Alişar pear in Giresun was 1.19% and the average pH was 4.85.

Michailidis et al. (Michailidis et al. 2021) reported mean TA values of 2 pear cultivars in Greece between 0.28%-0.43%, Đurić et al. (Đurić et al. 2015) reported TA values of 10 local pear cultivars grown in Bosnia and Herzegovina between 0.16%-0.44% and pH values between 3.97-4.85, Galvis Sanchez et al. (Galvis Sanchez et al. 2003) determined the average TA values of 6 pear cultivars in southern Chile between 0.06%-0.23% and pH between 4.31-5.26, Li et al. (Li et al. 2013) determined the average pH of 3 pear cultivars widely grown in China as 4.89. Chen et al. (Chen et al. 2007) reported TA values of pears grown in China between 0.10% and 0.46%, Hussain et al. (Hussain et al. 2013) reported TA values between 0.12% and 0.26% and pH between 4.12-5.24 for 4 pear varieties in Pakistan. Similarly, TA values of some pear varieties grown in the Srebrenik region of Bosnia and Herzegovina were found between 0.61 g/kg and 3.89 g/kg (Akagic et al. 2022).

There are some differences between the pH and acidity results of our study and the results reported in the literature. pH and acidity characteristics of pear cultivars are genotype-specific, they may vary according to the soil conditions too (Ozturk et al. 2009).

3.3. Total and reducing sugar amount

Most of the water-soluble solids in fruit are sugars, and the entire sugar content of fruit is usually composed of reducing sugars (glucose-fructose). The sugars, organic acids, and trace elements present in fruit determine the quality of sensory and nutritional fruit. Fruits with a higher sugar and organic acid content and optimum mineral content are better quality. The sugar content of the fruit varies depending on climate, soil structure, and nutrient amount (Sestras et al. 2009).

According to the results of the sugar analysis of this study, it was determined that the total sugar values of Gelincik apples varied between 9.14±0.29 g/100 mL and 11.10±0.38, reducing sugar ranged between 7.45±0.26 g/100 mL and 9.09±0.81 g/100 mL, and sucrose ranged between 1.69±0.36 g/100 mL and 2.21±0.33 g/100 mL. The total sugar content of Hüsnüyusuf pear varied between 7.72±0.64 g/100 mL and 9.10±0.68 g/100 mL, reducing sugar content varied between 5.98±0.54 g/100 mL and 7.05±0.66 g/100 mL, sucrose content varied between 1.41±0.21 g/100 mL and 2.05±0.47 g/100 mL.

Karşı and Aslantaş (Karşı and Aslantaş 2016) determined that the total sugar amount of 13 standard apple varieties grown in Erzurum was between 5.84%-11.80%, and Alamur (Alamur 1997) found that the total sugar amount of Erzincan apples was between 9.04%-11.84%. Mordoğan and Ergun (Mordoğan and Ergun 2002) found the total sugar content of Golden Delicious and Starking Delicious apples grown in Denizli-Çivril (Türkiye) between 49.07% and 79.08% and sucrose content between 12.58% and 25.87%. Reducing sugars of 3 apple cultivars in Osmaniye (Türkiye) were found between 9.13% and 10.09% and total sugars between 12.38% and 13.74%

(Bolat et al. 2019). Studies conducted with different apple varieties in various regions of Türkiye show differences in reducing and total sugar contents. Reducing sugar content was found to be between 6.96%-8.97% in Erzincan apples, between 8.38%-12.72% in apple varieties grown in Çoruh Valley, and between 377.72 g/kg-425.28 g/kg in 5 apple varieties grown in Malatya (Güleryüz et al. 2001; Erdoğan and Bolat 2002; Turan and Karlıdağ 2022). The total sugar content of Malatya apples was determined as 543.20 g/kg and 612.40 g/kg (Turan and Karlıdağ 2022).

When we look at the studies in other countries, the total sugar number of apples in Romania was 12.129% on average, the total sugar amount in New Zealand was between 76.5 mg/g-105.0 mg/g, and the total sugar amount of 7 apple varieties in West Virginia (USA) was between 12.5% and 14.7% (Harker et al. 2002; Nour et al. 2010; Schmutzler and Huck 2016). Karadeniz (Karadeniz 1999) determined that the average total sugar content of 7 pear varieties grown in Bursa and Ankara was 7.99% and the average sucrose amount was 0.52%, Öz and Aslantaş (Öz and Aslantaş 2015) found that the total sugar amount of 17 pear varieties grown in Erzincan was between 107 mg/L and 257 mg/L. Chen et al. (Chen et al. 2007) determined that the total sugar amount of 8 pear varieties in Beijing was between 65 g/kg and 120 g/kg and sucrose content was between 3.3 g/kg and 21.4 g/kg, Hussain et al. (Hussain et al. 2013) reported that the total sugar content of pears in Pakistan was between 10.19% and 11.12% and reducing sugar content was between 5.14% and 5.37%.

3.4. Antioxidant activity

Antioxidants reduce or eliminate free radicals that negatively affect human health. Antioxidants are found in many natural food products and are protective against chronic diseases and oxidative stress. There is considerable evidence for the role of antioxidant components of fruits and vegetables in maintaining health and preventing diseases (Galvis Sanchez et al. 2003). According to the antioxidant activity results of this study, the antioxidant activity of Gelincik apple by DPPH radical scavenging assay was found between 63.91±0.74% and 72.18±2.12%, the antioxidant activity of Hüsnüyusuf pear was found between 56.42±1.26% and 39.83±1.32%.

Baydır et al. (Baydır et al. 2019) found DPPH antioxidant activity of 5 apple varieties in Afyonkarahisar between 4.46% and 17.24%. Karadeniz et al. (Karadeniz et al. 2005) found the antioxidant activity of 8 apple varieties grown in Ankara to be 25.7% on average, and Abacı et al. (Abacı et al. 2016) found the antioxidant activity of 26 apple varieties in Ardahan to be 30.5%-73.4% in fruit peel and 22.5%-57.8% in fruit flesh. Chong et al. found the average antioxidant activity of apples grown in Semenyih (Selangor, Malaysia) to be 26.29% by DPPH assay (Chong et al. 2013). It was reported that the antioxidant activity values of 15 different apple varieties grown in Prague (Czech Republic) were between 7.04% and 17.52%, and the DPPH values of 67 apple varieties grown in Western Europe were between 10.1 µmolTE/100 g-129 µmolTE/100 g (Lanchman et al. 2006; Wojdylo et al. 2008).

Antioxidant activities of various pear varieties have also been determined in previous studies. The DPPH antioxidant activity of 4 pear varieties grown in Van was found to be in the range of 149.49-366.07 mmol Trolox eq/g and that of 3 pear varieties grown in Ankara was found to be 13.7% (Karadeniz et al. 2005; Topuz and Bakkalbaşi 2022). Erecevit and Kırbağ (Erecevit and Kırbağ 2017) examined the DPPH free radical scavenging effect of pears grown in Elazığ and found that pear extract showed an increasing antioxidant activity starting from 100 µL concentrations. The highest effect was found at 250 µL. Kırca et al. found the % inhibition values between 28.56% and 48.78% by DPPH assay (Kırca et al. 2022).

The antioxidant activity level in pears by DPPH assay was found between 24.3% and 48.6% by Galvis Sanchez et al. (Galvis Sanchez et al. 2003), between 27.96% and 46.73% by Hussain et al. (Hussain et al. 2013), between 664.91 µg trolox/g and 779.05 µg trolox/g by Michailidis et al. Wang et al. (Wang et al. 2015) found DPPH antioxidant activity in the peel and pulp of pears grown in China to be between 17.1% and 73.0% and 61.7% and 81.8%, respectively, while the values in fruit flesh were between 94.6% and 465.4% and 500.3% and 867.3%, respectively. Although there are differences in the results obtained in the studies, it has been determined that apples and pears have antioxidant activity in all studies. Previous studies have already shown that the antioxidant level may vary depending on fruit variety, growing and storage conditions, care and pruning methods, and measuring methods.

3.5. Vitamin C

Vitamin C is important antioxidant in many fruits. For this reason, the amount of vitamin C was also investigated in our study. In this study, the average vitamin C content of the Gelincik apple was between 7.52±0.41 mg/100 mL and 8.44±0.32 mg/100 mL, and the average vitamin C content of the Hüsnüyusuf pear was between 6.60±0.42 mg/100 mL and 5.84±0.08 mg/100 mL. The amount of vitamin C in apples was found to be between 33 mg/L and

124 mg/L by Karşı and Aslantaş (Karşı and Aslantaş 2016), between 2.87 mg/100 g and 4.58 mg/100 g by Kırca et al. (Kırca et al. 2022) between 4.2 mg/100 g and 17.5 mg/100 g by Abacı and Sevindik (Abacı and Sevindik 2014). Similarly, Nour et al. (Nour et al. 2010) reported that the average vitamin C amount of 15 apple varieties in Romania was 6.18 mg/100 g, Planchon et al. (Planchon et al. 2004) determined that the average vitamin C amount of 30 local apple varieties grown in Belgium was 14.2 mg/100 g.

In the study of Erbil et al. (Erbil et al. 2018), the vitamin C content of 5 different varieties of pears collected from Posof, Ardahan (Türkiye) varied between 9.03 mg/100 g and 16.02 mg/100 g. Öz and Aslantaş (Öz and Aslantaş 2015) determined the vitamin C content of 17 pear varieties grown in Erzincan between 30 mg/L and 195 mg/L, Abacı et al. (Abacı et al. 2016) determined the vitamin C content of Gugum and Banda pears grown in Ardahan as 10.2 mg/100 g and 8.8 mg/100 g, respectively. Öztürk et al. (Öztürk et al. 2015b) found the vitamin C values of 17 pear varieties in the average range of 21.1 mg/100 g in the peel and 19.3 mg/100 g in the fruit flesh.

Vitamin C contents of pear varieties in different regions of the world were found to be between 2.6-5.3 mg/100 g in southern Chile, between 1.30-4.55 mg/100 mL in Beijing, between 2.80-4.30 mg/100 g in Pakistan and between 0.77-1.61 mg/100 g in Bosnia and Herzegovina (Galvis Sanchez et al. 2003; Chen et al. 2007; Ozturk et al. 2009; Hussain et al. 2013).

The results of phytochemical analyses of apple and pear cultivars, both in our study and in previous studies, show a wide range of distribution. The main reasons for this are genetic differences and changing ecological factors. Differences in cultivars and cultivation conditions have increased the range of variation of the findings. In previous studies, there were no satisfactory findings on the extent to which quantitative characters were affected by ecological factors. In this respect, different researches need to be planned.

4. Conclusion

In our country, there are apple and pear populations that have been grown locally for many years and used in the production of different valuable products. Many of these populations have not yet been introduced to large markets. It would be useful to reveal the content differences between local and standard varieties to form the basis for selection studies. This study is the first to introduce and evaluate the locally grown Gelincik apple and Hüsnüyusuf pear in Kütahya and to raise awareness for conserving existing genetic resources. In the study, the phytochemical properties of Gelincik apple and Hüsnüyusuf pear were determined in terms of WSDM, % dry matter, pH, TA, total and reducing sugar amount, vitamin C values, and antioxidant activity level.

The traits examined in our study are highly dependent on ecological conditions as they are quantitative in nature. Therefore, it is useful to investigate and repeat such studies under different environmental conditions periodically. In addition, since the heritability of quantitative traits is low, the genetic characteristics of local species should be determined and a basis should be prepared for the correct planning of breeding studies.

Declaration of Ethical Standards
The authors declare that they comply with all ethical standards.

Credit Authorship Contribution Statement
Author 1:The author performed the conceptualization, formal analysis, investigation, validation, writing-original draft, writing-review and editing.
Author 2: The author performed the conceptualization, formal analysis, investigation, validation, writing-original draft, writing-review and editing.

Declaration of Competing Interest
The authors have no conflicts of interest to declare regarding the content of this article.

Data Availability
All data studied or analyzed during this study are included in this published article.

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