Erwerbs-Obstbau (2018) 60:173–181
https://doi.org/10.1007/s10341-017-0354-6

ORIGINAL ARTICLE

Evaluation of Pomological and Morphological Characteristics and Chemical Compositions of Local Pear Varieties (*Pyrus communis* L.) Grown in Gumushane, Turkey

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Received: 5 January 2017 / Accepted: 22 September 2017 / Published online: 26 October 2017

Abstract The aim of the present research was to investigate the fruit quality of twenty different local pear varieties (*Pyrus communis* L.), namely Ahlat, Ankara, Arpa, Bıldırcın, Çermai, Cinci, Gelin Boğan, Hacı Hamza, Hahır, Kabak, Kızıl, Kokulu, Mehrani, Menendi, Sulu, Şalgam, Tokat Sultanı, Turşu, Yaz, and Yaz Meyriği, grown in Gumushane province in terms of pomological and morphological characteristics and chemical compositions. The fruit mass, fruit width and length, fruit stem thickness and length, fruit kernel width and length, hardness of pulp, number of seeds, leaf width and length, leaf stem length and thickness, and water soluble dry matter (WSDM) of the pear fruits have been determined as pomological and morphological characteristics. On the other hand, the chemical compositions of the pear varieties have been evaluated in terms of protein, ash, sucrose, fructose, glucose, total sugar, titratable acidity, moisture, and mineral element levels.

Both pomological and morphological results demonstrated that the local pear varieties are important in terms of rehabilitation studies and detailed selection studies on these local varieties should be performed. The chemical analyses result of the pear varieties revealed that there is no component that may be harmful to human health when consumed, and also these varieties contains the necessary amount of mineral elements.

Keywords Local pear · Pomological and morphological properties · Chemical composition · Gumushane · *Pyrus communis* L

Pomologische und morphologische Eigenschaften sowie Inhaltsstoffe lokaler Birnensorten (*Pyrus communis* L.) in Gumushane (Türkei)

Zusammenfassung Das Ziel dieser Arbeit war es, die Qualität der Früchte von zwanzig lokalen Birnensorten, namentlich: Ahlat, Ankara, Arpa, Bildircin, Cermai, Cinci, Gelin Bogan, Haci Hamza, Hahir, Kabak, Kizil, Kokulu, Mehrani, Menendi, Sulu, Salgam, Tokat Sulatani, Tursu, Yaz und Yaz Meyrigi, die alle in der Provinz Gümüshane vorkommen, hinsichtlich ihrer pomologischen und morphologischen Eigenschaften und chemischen Zusammensetzung zu untersuchen. Die Fruchmasse, -größe, -länge, -kerndicke und -kerngröße, Härte des Fruchtkerns, Anzahl der Kerne, Blattgröße und Blattlänge, die Länge und der Durchmesser des Stammes und die lösliche Trockensubstanz der Birnenfrüchte wurden als pomoligsche und morphologische Eigenschaften bestimmt. Weiterhin wurden der Protein-, Aschegehalt, der Gehalt an Saccharose, Fructose, Glucose und Gesamtzucker und tritierbarer Säure, der

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Feuchtigkeitsgehalt und der Gehalt an Mineralstoffen bestimmt.

Sowohl pomologische als auch morphologische Eigenschaften zeigen, dass detaillierte Selektionsstudien zu diesen lokalen Sorten durchgeführt werden sollten. Die chemischen Analysenergebnisse der Birnensorten zeigen, dass es keine Inhaltsstoffe gibt, die für die menschliche Gesundheit schädlich sein könnten, wenn die Früchte verzehrt werden. Weiterhin enthalten diese Sorten auch nennenswerte Mengen an mineralischen Elementen.

Schlüsselwörter Birnen · *Pyrus communis* L · Inhaltsstoffe · Lokalsorten · Gumushane

Introduction

Pear fruit, which grows in mild temperate zone and its culture is based on very old, is classified as a *Pyrus* specie of the *Rosaceae* family of *Rosales* team. The gene centers of pear (*Pyrus communis L.*), whose consumption is a common type of fruit, are China, Caucasia, Central and West Asia (Durić et al. 2015a; Kiprjanovski and Ristevski 2009; Blanke and Kunz 2009; Fischer 2005). The cultivation of pear is based on the years before the Christ and it an important fruit species in the world (Yilmaz et al. 2015a; Durić et al. 2014, 2015b). Turkey, located in the gene center, is a considerably rich country in terms of varieties (Davis 1972; Westwood 1978). Since our country has very different ecological conditions, more than 600 local pear varieties are grown locally (Yilmaz et al. 2015b).

According to the United Nations Food and Agriculture Organization report, the world pear production is 25,203,754 tons (Morgan 2015). The production amount in our country is 462,336 tons and this production is carried out on 249,673 decares of land. 12,539 tons of this production in Turkey is made in the Eastern Black Sea region (Anonim 2012). In our country, the pear cultivation is mostly done to satisfy the local needs and the consumption of it remains locally (Bayazit et al. 2016).

Gumushane is located in Eastern Black Sea Region with an approximate altitude of 1100 m above sea level. The climate characteristics of the city exhibit a transition between the continental climate and the Eastern Black Sea climate. The climate of the regions present in the Eastern Black Sea basin is humid and warm. In the Kelkit County the winters are cold, the summers are arid and hotter than in Harşit basin. The rains are more in winter and in the spring. The average annual rainfall is 435 millimeters. There are many kinds of fruit growing in Gumushane and pear is one of the leading fruits.

The local pear varieties in Gumushane province are grown in order to meet economically the needs of family and also to provide the consumers even if a small amount in local markets. These varieties are important as genetic materials and have a unique value for rehabilitation studies. Despite the fact that fruit rehabilitation studies are performed in our country, these researches are not enough and many local fruit varieties, whose importance are emphasized in fruit improvement, are disappearing ultimately.

In the direction of introducing the pear genotypes grown in Gumushane province as improvement materials into our country and protecting the local pear varieties richness, the presented study, performed to identificate the local pear varieties well-adapted to the region and to determinate some morphological, pomological and chemical contents of them, will add significant value to the literature.

In the presented study the leaf width and length, leaf stem thickness and length, fruit flavor, fruit mass, fruit width and length, fruit stem thickness and length, number of seeds, fruit kernel width and height, hardness of pulp, water soluble dry matter (WSDM) as pomological and morphological properties and moisture, ash, mineral element, protein, nitrogen and sugar analyses, pH, and titratable acidity as chemical contents of 20 local pear varieties grown in Gumushane province have been investigated. Thus, a foundation was established for the estimation of whether these species are suitable for growing. It is aimed to bring these species to the national economy with the selection studies which will be performed after this study. In addition, this research is a preliminary study for the introduction of local pears into the literature, and we believe that it will be possible to lead up new studies for appropriate types and even to study patents.

Material and Methods

Materials

In the presented study the local pear varieties, which has reached until today by sieving for many years with natural selection and consumed widely by the people, was used as material. At the places where pear trees located the land scan were carried out and the face to face interviews were made with the growers. The areas where pear trees are grown and intensively located were visited and the detected pear trees were photographed. In addition, the coordinates and altitudes of the trees were determined. For each determined species, ten fruits were collected from three selected pear trees. The collected fruits were arranged as three replications in the random test pattern.

Method

In this research, it was aimed to determine the morphological and pomological properties and chemical contents of local pears, which are unique to Gumushane province and have been growing in this region for many years. For that purpose, leaf width and length, leaf stem thickness and length, fruit width and length, fruit stem thickness and length, fruit kernel width and lengths were measured by using a digital caliper with a sensitivity of 0.001 mm. Fruit flavor (sour, bitter, sweet) was determined by degustation analysis (taste analysis). Fruit mass were determined by an analytical balance with a sensitivity of 0.01 mg. The collected fruits were cut and the numbers of the seeds were counted. Hardness of pulp was determined with a penetrometer by removing a thin shell from the fruit surface. The amount of water soluble dry matter of pear fruits was observed by hand refractometer.

The titratable acidity was determined by titration method. For that purpose, 25 mL of freshly prepared pear juices were placed in 250 mL beakers. After addition of 50 mL of distilled water, the mixture was heated with stirring in a water bath for 30 min. Then the mixture was cooled and the beaker content was filtered through the filter paper. Then the filtrates were diluted to 100 mL with distilled water. The mixture was taken up in 250 mL Erlenmeyer flask and titrated with 0.1 *N* NaOH solution in the presence of fenolftaleyn indicator to the turning point (Campeanu et al. 2009).

In order to determine the moisture content, approximately 1.5 g of pear samples were weighted into metal containers and heated in an oven at 105 °C for about 7 h. At the end of this period of time, after cooling the samples to room temperature, they were weighted again and their moisture contents (%) were determined.

For determination of pH, freshly collected pear samples were slurried by grinding in a blender and then fruit juice was obtained by filtration them through filter paper. 50 mL of fresh juices were taken to determine their pH values by using Hanna pH 211 model pH meter.

In order to investigate the ash content, approximately 1.5 g of dried pear samples were weighted into tarred porcelain crucibles and heated to 550–600 °C in the muffle furnace until their color became silver. Then they were removed from the furnace and cooled to room temperature. After that, the ash contents (%) of the samples were determined.

Prior to mineral element analysis, the pear samples were digested in a closed microwave digestion system (Milestone Start D model) using appropriate solvent mixtures. For that purpose 0.500 g of fruit samples were placed in Teflon vessels, separately. 6.0 mL of HNO_3 and 2.0 mL of H_2O_2 were added into the vessels. Digestion conditions for the samples were performed according to the literature (Duran et al. 2015). The volumes of the obtained clear solutions were made up 50 mL with distilled/deionized water and then the analyses of mineral elements were carried out by using ICP-MS (Agilent 7700 Series).

The protein and nitrogen analyses were performed according to TS 1620 method while for saccarose, fructose, glucose and total sugar analyses, IHC method was used.

The SPSS 20.0 package program was used for the statistical analysis. The mean and standard deviation values of the determined criteria for local pear varieties were calculated. The ANOVA test was utilized to control the significance tests for differences between the mean values. In addition, the DUNCAN test was used for multiple comparison of the mean data.

Results and Discussion

In the presented study, the pomological and morphological characteristics and chemical contents of twenty important local pear varieties, identified by face to face interview with the producers in Gumushane province, were determined.

As a result of the investigations, it is seen that the mass of pear fruits varied in the range of 23.89–140.63 g. The first three pear species, have the highest fruit weight, were determined as Kabak (140.63 g), Menendi (109.12 g) and Mehrani (94.14 g), respectively (Table 1). Demirsoy et al. (2007) have observed the fruit weights in the range of 36.2–263.4 g in the study conducted in Camili region of Artvin province. In a similar study, the fruit mass of pear samples was reported between 18.7 g (Ketencik) and 258.3 g (Acı Kabak) (Bostan and Acar 2012). Karlıdağ and Eşitken (2006) have determined that the Ankara pear is the heaviest variety with a mass of 211.03 g among the examined pear varieties. These studies demonstrated that the local pear varieties grown in Gumushane exhibit different characteristics and have different genetic richness.

When examined the fruit width and length of the local pear varieties, it was observed that the highest value of fruit width was obtained for Kabak (64.33 mm), Menendi (61.33 mm) and Mehrani (55.60 mm), while Ankara pear (71.79 mm), Sulu pear (71.54 mm) and Kabak (66.30 mm) have the highest fruit length. On the other hand, among the local varieties, Ahlat species have the lowest fruit width (25.85 mm) and fruit length (24.05 mm) (Table 1). In a study conducted in İspir district, lemon was found to be the widest species with 70.98 mm, and Ankara is the longest pear with 91.40 mm (Karlıdağ and Eşitken 2006). The fruit width and lenghts of pear varieties were reported in the ranges of 83.54–42.61 mm and 72.83–108.25 mm, respectively in a study carried out in Marmara region (Akçay

Table 1 The pomological and morphological properties of local pear varieties grown in Gumushane

Pear Varieties	Fruit Mass[1]	Fruit Width[2]	Fruit Length[2]	Fruit Stem Length[2]	Fruit Stem Thickness[2]	Fruit Kernel Width[2]	Fruit Kernel Length[2]	Hardness of Pulp[3]
Ahlat	10.48 ± 0.23^{a}	25.85 ± 1.32^{a}	24.05 ± 1.35^{a}	37.46 ± 1.35^{gh}	3.87 ± 0.22^{a}	16.09 ± 0.29^{b}	15.02 ± 0.36^{a}	4.33 ± 0.11^{a}
Ankara	77.44 ± 4.57^{g}	48.12 ± 0.92^{fg}	71.79 ± 1.66^{k}	17.16 ± 0.83^{abcd}	3.02 ± 0.19^{def}	21.62 ± 0.39^{gh}	25.42 ± 0.56^{ij}	6.02 ± 0.34^{bc}
Arpa	23.89 ± 0.71^{b}	33.50 ± 0.36^{b}	45.31 ± 1.11^{cd}	30.14 ± 0.71^{efg}	2.38 ± 0.04^{abcd}	13.30 ± 0.71^{a}	15.82 ± 0.25^{a}	12.29 ± 0.75^{ghı}
Bıldırcın	48.06 ± 2.07^{de}	42.91 ± 2.21^{de}	49.37 ± 0.92^{def}	14.66 ± 0.52^{abc}	2.45 ± 0.27^{abcd}	19.61 ± 0.63^{defg}	19.71 ± 0.71^{cde}	11.52 ± 0.47^{gh}
Cermai	92.01 ± 4.00^{h}	54.31 ± 0.95^{h}	61.19 ± 0.99^{hı}	30.34 ± 1.83^{efg}	2.12 ± 0.24^{ab}	20.49 ± 1.59^{defg}	25.70 ± 0.57^{j}	10.78 ± 0.48^{g}
Cinci	44.77 ± 1.37^{cd}	43.21 ± 0.53^{de}	48.28 ± 0.60^{de}	30.43 ± 2.14^{efg}	1.77 ± 0.12^{a}	15.69 ± 1.24^{b}	18.19 ± 0.53^{bc}	11.55 ± 0.54^{gh}
Gelin Boğan	89.46 ± 4.08^{h}	49.53 ± 1.04^{g}	65.17 ± 1.47^{ij}	24.90 ± 2.34^{cde}	2.67 ± 0.22^{bcdef}	18.99 ± 0.44^{de}	20.83 ± 0.63^{def}	14.31 ± 0.63^{j}
Haci Hamza	71.51 ± 4.93^{g}	49.47 ± 1.45^{g}	61.08 ± 1.96^{hı}	19.59 ± 2.07^{abcde}	2.33 ± 0.23^{abcd}	20.52 ± 0.40^{defg}	22.23 ± 0.50^{fgh}	6.67 ± 0.43^{cd}
Hahır	69.10 ± 2.38^{g}	49.73 ± 0.63^{g}	54.23 ± 0.96^{fg}	25.58 ± 1.24^{cde}	3.21 ± 0.15^{f}	20.87 ± 0.27^{efg}	23.83 ± 0.35^{hıj}	4.83 ± 0.23^{ab}
Kabak	140.63 ± 3.64^{j}	64.33 ± 0.53^{j}	66.30 ± 0.96^{j}	43.88 ± 14.43^{h}	3.94 ± 0.09^{g}	19.39 ± 0.19^{de}	21.57 ± 0.34^{efg}	6.90 ± 0.28^{cde}
Kızıl	24.33 ± 1.44^{b}	33.27 ± 0.75^{b}	39.15 ± 0.84^{b}	13.10 ± 0.87^{ab}	2.50 ± 0.19^{bcde}	19.99 ± 0.44^{defg}	19.71 ± 1.52^{cde}	8.38 ± 0.15^{ef}
Kokulu	35.83 ± 0.80^{c}	38.71 ± 0.44^{c}	39.74 ± 0.38^{b}	24.14 ± 1.09^{bcde}	3.15 ± 0.32^{ef}	17.10 ± 0.29^{bc}	21.26 ± 0.40^{ef}	5.65 ± 0.40^{abc}
Mehrani	94.14 ± 4.68^{h}	55.60 ± 1.10^{h}	57.18 ± 1.27^{gh}	31.14 ± 1.99^{efg}	2.17 ± 0.17^{ab}	18.73 ± 0.61^{cd}	21.24 ± 0.74^{ef}	13.00 ± 1.20^{hıj}
Menendi	109.12 ± 7.05^{ı}	61.33 ± 1.29^{ı}	56.58 ± 1.23^{gh}	22.60 ± 0.89^{abcde}	5.44 ± 0.43^{h}	22.78 ± 0.49^{h}	20.74 ± 0.64^{def}	6.67 ± 0.48^{cd}
Sulu	69.22 ± 4.20^{g}	45.12 ± 0.93^{ef}	71.54 ± 1.43^{k}	26.30 ± 2.17^{defg}	3.32 ± 0.09^{fg}	20.15 ± 0.44^{defg}	23.43 ± 0.45^{ghı}	8.19 ± 0.19^{def}
Şalgam	54.74 ± 2.37^{ef}	47.66 ± 0.98^{fg}	42.48 ± 0.79^{bc}	25.88 ± 0.90^{cdef}	2.32 ± 0.05^{abc}	20.54 ± 0.67^{defg}	18.74 ± 0.52^{bcd}	9.17 ± 0.34^{f}
Tokat Sultanı	70.32 ± 2.58^{g}	50.38 ± 0.74^{g}	53.26 ± 1.58^{fg}	26.03 ± 0.47^{cdef}	2.68 ± 0.15^{bcdef}	19.53 ± 0.21^{def}	22.59 ± 0.23^{fgh}	13.33 ± 0.43^{ij}
Turşu	42.49 ± 1.83^{cd}	40.17 ± 0.62^{cd}	50.08 ± 0.70^{def}	37.06 ± 0.89^{fgh}	2.79 ± 0.08^{bcdef}	19.65 ± 0.28^{defg}	23.92 ± 0.49^{hıj}	6.71 ± 0.23^{cd}
Yaz	55.45 ± 9.42^{ef}	46.31 ± 0.72^{f}	56.47 ± 0.90^{gh}	20.90 ± 0.55^{abcde}	3.33 ± 0.07^{fg}	15.69 ± 0.50^{b}	16.76 ± 0.29^{ab}	7.12 ± 0.32^{cde}
Yaz Meyriği	58.76 ± 2.55^{f}	43.10 ± 0.75^{de}	52.48 ± 4.80^{efg}	11.83 ± 0.90^{a}	2.93 ± 0.36^{cdef}	21.53 ± 0.51^{fgh}	20.44 ± 1.52^{def}	16.82 ± 0.68^{k}

[1]In "g" unit
[2]In "mm" unit
[3]In "lb" unit

et al. 2009). It is seen that the results obtained in these researchers differ from the presented study.

When taken into consideration the fruit stem length and fruit stem thickness, it is seen that the highest values were obtained in Kabak pear as 43.88 mm and 3.94 mm, respectively. The lowest values of fruit stem length and fruit stem thickness were determined in Yaz Meyriği (11.83 mm) and in Cinci pear (11.83 mm), respectively (Table 1). In a similar study, the fruit stem length and fruit stem thickness were reported in the ranges of 43.58–15.49 mm and 6.14–2.87 mm, respectively (Akçay et al. 2009). In other previous researches, the fruit stem length and fruit stem thickness of the pear varieties were observed in the ranges of 56.6–23.7 mm and 6.6–2.3 mm, respectively by Demirsoy et al. (2007) and obtained in the ranges of 14.99–40.67 mm and 1.49–5.10 mm, respectively by Az (2015). It is observed that the results obtained in this study are compatible with the literature data.

The fruit kernel width and fruit kernel length were investigated in the ranges of 22.78–13.30 mm and 25.70–15.02 mm, respectively. Among the local pear varieties, the highest fruit kernel width was determined in Menendi (22.78 mm), Ankara (21.62 mm) and Yaz Meyriği (21.53 mm), while the highest fruit kernel length was observed in Çermai (25.70 mm), Ankara (25.42 mm) and Turşu (23.92 mm) varieties (Table 1). In a similar study, the fruit kernel width and the fruit kernel length of pear varieties grown in Ünye district of Ordu province were reported in the ranges of 25.5–15.8 mm and 37.0–14.4 mm, respectively (Bostan and Acar 2012). In other respects, these pomological properties of pear varieties grown İskilip pears were determined in the ranges of 27.92–19.16 mm and 33.90–20.28 mm, respectively (Karadeniz and Çorumlu 2012). It is clear that the results obtained in this study differ from those given in the literature and these differences are important in terms of rehabilitation studies.

The hardness of pulp was obtained in the range of 16.82–4.33 lb. The highest values were obtained in Yaz Meyriği (16.82 lb), Gelin Boğan (14.31 lb) and Tokat Sultanı (13.33 lb), while the lowest data was observed in Ahlat (4.33 lb) varieties (Table 1). The hardness of pulp values of different pear varieties was reported in the ranges of

Table 2 Continue

Pear Varieties	Number of Seeds	Leaf Width[1]	Leaf Length[1]	Leaf Stem Length[1]	Leaf Stem Thickness[1]	WSDM	Fruit Taste
Ahlat	6.38 ± 0.31^{e}	26.79 ± 0.63^{a}	52.42 ± 2.68^{a}	11.80 ± 1.41^{a}	0.80 ± 0.04^{abc}	20	Sweet
Ankara	7.37 ± 0.31^{ef}	41.40 ± 1.39^{fg}	76.46 ± 3.32^{ı}	52.74 ± 2.68^{j}	0.96 ± 0.03^{defg}	12	Sweet
Arpa	3.05 ± 0.22^{ab}	43.37 ± 1.32^{gh}	59.70 ± 1.90^{bcd}	37.94 ± 1.99^{bcdefg}	0.86 ± 0.07^{bcd}	13	Sweet
Bıldırcın	6.21 ± 0.52^{de}	35.56 ± 1.02^{bcd}	61.48 ± 2.15^{cde}	31.45 ± 1.95^{bc}	0.92 ± 0.03^{def}	15	Sweet
Cermai	6.52 ± 0.4^{e}	45.54 ± 1.36^{h}	62.36 ± 1.68^{cde}	45.19 ± 2.46^{ghı}	0.85 ± 0.03^{bcd}	12	Tart
Cinci	4.05 ± 0.39^{bc}	45.43 ± 1.36^{h}	63.07 ± 2.38^{cde}	39.19 ± 3.07^{cdefgh}	0.89 ± 0.03^{cde}	21	Tart
Gelin Boğan	2.76 ± 0.28^{a}	38.29 ± 1.04^{cdef}	57.46 ± 1.97^{abc}	34.71 ± 1.61^{bcde}	0.95 ± 0.05^{defg}	13	Tart
Haci Hamza	6.52 ± 0.48^{e}	38.80 ± 0.81^{def}	66.51 ± 1.13^{efg}	42.19 ± 2.34^{efgh}	0.96 ± 0.02^{defg}	10	Sweet
Hahır	7.38 ± 0.33^{ef}	40.45 ± 1.07^{fg}	75.05 ± 1.48^{hı}	37.33 ± 2.97^{bcdef}	1.09 ± 0.04^{h}	14	Sweet
Kabak	2.90 ± 0.46^{a}	39.93 ± 0.70^{efg}	53.73 ± 0.80^{ab}	33.33 ± 1.94^{bcd}	0.89 ± 0.02^{cde}	10	Sweet
Kızıl	6.43 ± 0.28^{e}	43.48 ± 0.87^{gh}	65.37 ± 1.12^{def}	46.20 ± 2.60^{hıj}	0.99 ± 0.01^{efgh}	15	Sweet
Kokulu	4.24 ± 0.36^{c}	41.24 ± 1.84^{fg}	61.47 ± 0.31^{cde}	49.52 ± 3.24^{ıj}	0.76 ± 0.04^{ab}	16	Tart
Mehrani	4.57 ± 0.33^{c}	46.22 ± 1.38^{h}	60.68 ± 1.30^{cde}	36.96 ± 1.47^{bcdef}	0.93 ± 0.03^{def}	15	Sour
Menendi	6.14 ± 0.44^{de}	43.28 ± 0.95^{gh}	60.99 ± 2.13^{cde}	39.86 ± 3.40^{defgh}	0.85 ± 0.02^{bcd}	15	Sweet
Sulu	6.14 ± 0.49^{de}	41.74 ± 1.67^{fg}	71.60 ± 1.92^{ghı}	38.03 ± 2.89^{bcdefg}	1.03 ± 0.04^{fgh}	11	Sweet
Şalgam	8.05 ± 0.41^{f}	33.54 ± 1.15^{b}	53.76 ± 2.12^{ab}	31.11 ± 2.27^{b}	1.03 ± 0.05^{fgh}	16	Sweet
Tokat Sultanı	5.19 ± 0.36^{cd}	36.42 ± 1.06^{bcde}	54.63 ± 1.33^{ab}	31.91 ± 1.49^{bc}	1.06 ± 0.04^{gh}	14	Sour
Turşu	6.90 ± 0.34^{ef}	36.39 ± 0.63^{bcde}	64.31 ± 1.65^{def}	36.79 ± 1.62^{bcdef}	0.91 ± 0.02^{cde}	21	Sour
Yaz	7.38 ± 0.51^{ef}	34.78 ± 0.81^{bc}	69.34 ± 2.03^{fgh}	42.70 ± 1.99^{fghı}	0.95 ± 0.03^{defg}	12	Sweet
Yaz Meyriği	7.04 ± 0.18^{ef}	36.61 ± 0.79^{bcde}	66.46 ± 1.95^{efg}	40.51 ± 2.24^{defgh}	0.70 ± 0.02^{a}	11	Sweet

[1]In "mm" unit

13–3.07 lb (Özrenk et al. 2010), and it was observed as 12.05 ± 0.63 lb in Kışlık Küçük Armut and 3.81 ± 0.55 lb in Kum Armudu (Yarılgaç and Yıldız 2001).

The mean number of seeds of the examined local pears was determined between 2.76 (Gelin Boğan) and 8.05 (Şalgam armudu). After the Şalgam pear, the highest number of seeds was found in the Yaz and Hahır pears with an average value of 7.38 (Table 2). The number of seeds were observed in the ranges of 0.8–5.4 and 2.0–6.5 in the studies performed in İskilip region (Karadeniz and Çorumlu 2012) and Bitlis province (Özrenk et al. 2010), respectively. It has been revealed that the number of seeds of the local pear varieties grown in Gumushane province is higher than the other studies in literature. This may be due to the higher rate of pollination and insemination in Gumushane province due to the higher insect activity compared to the other regions in which similar studies conducted.

The highest leaf width was obtained in Mehrani (46.22 mm), Çermai (45.54 mm) and Cinci (45.43 mm), while the highest leaf length was observed in Ankara (76.46 mm), Hahır (75.05 mm) and Sulu pear (71.60 mm) varieties. The lowest leaf width (26.79 mm) and leaf length (52.42 mm) was determined in Ahlat (Table 2). Bostan and Acar (2012) have reported the leaf width of pear varieties, grown in Ünye district of Ordu province, between 67.6 mm (Gönye) and 38.4 mm (Batum Şeker), and they have obtained the leaf length of same pear fruits between 91.2 mm (Şeker) and 55.7 mm (Atina). The data obtained in the presented study exhibit a wide variation and are compatible with the literature.

The leaf stem length of the pear fruits was observed between 52.74 mm (Ankara) and 11.80 mm (Ahlat), while the leaf stem thickness of them was determined between 1.09 mm (Hahır) and 0.70 mm (Yaz Meyriği), respectively (Table 2). Bağbozan (2015) has determined the highest leaf stem length as 70.56 mm in E 2508 Aranzap variety. The results obtained in the presented investigation were found to be consistent with the previous researches in the literature.

The highest level of water soluble dry matter of the pear fruits was obtained as 21% in Cinci and Turşu varieties and the lowest value of it was determined as 10% in Kabak pear (Table 2). In similar studies the water soluble dry matter levels of different pear fruits were observed in the ranges of 17.87% (Coscia)–21.75% (Santa Maria) (Ertürk et al. 2009), 9.8% (Tavşan Başı)–17.0% (Karçın) (Yarılgaç and Yıldız 2001) and 10.0–15.4% (Özrenk et al. 2010).

As a result of taste analysis, it is seen that the tastes of the local apple varieties grown in Gumushane exhibited an alteration between sweet and sour. In addition, the taste of most of them is sweet (Table 2). Yarılgaç (2007) has classified the pear fruits as sour and sweet in terms of their tastes.

As a result of the statistical evaluation made for comparison of the pomological and morphological characteristics of

Table 3 Chemical compositions of local pear varieties grown in Gumushane

Pear Varieties	Protein	Ash[1]	Sucrose[1]	Fructose[1]	Glucose[1]	Total sugar[1]	pH	Acidity[1]	Moisture[1]
Tokat Sultanı	1.04 ± 0.12	1.86 ± 0.04	2.76 ± 0.01	30.53 ± 0.03	18.21 ± 0.01	51.50 ± 0.03	4.07	0.65	81.63
Ankara	4.16 ± 0.12	2.47 ± 0.04	2.50 ± 0.01	35.31 ± 0.01	10.49 ± 0.01	48.30 ± 0.01	4.67	0.25	86.99
Arpa	2.44 ± 0.12	3.36 ± 0.04	14.92 ± 0.03	25.64 ± 0.02	14.50 ± 0.02	55.06 ± 0.01	5.55	0.3	81.94
Sulu	2.42 ± 0.12	2.41 ± 0.04	6.72 ± 0.01	34.82 ± 0.03	15.20 ± 0.02	55.06 ± 0.01	4.25	0.32	87.78
Cinci	1.94 ± 0.12	3.79 ± 0.04	8.07 ± 0.01	21.27 ± 0.02	22.08 ± 0.02	51.42 ± 0.01	4.68	0.29	76.32
Yaz Meyriği	2.46 ± 0.12	2.38 ± 0.02	3.18 ± 0.04	29.77 ± 0.02	24.94 ± 0.01	57.89 ± 0.09	4.71	0.59	84.76
Cermai	4.02 ± 0.12	3.46 ± 0.04	1.32 ± 0.01	18.13 ± 0.01	14.23 ± 0.03	33.68 ± 0.01	4.32	0.33	81.71
Yaz	2.56 ± 0.12	2.84 ± 0.04	3.15 ± 0.01	43.79 ± 0.01	19.04 ± 0.01	65.99 ± 0.01	4.25	0.32	83.07
Kokulu	1.90 ± 0.12	1.49 ± 0.04	1.82 ± 0.11	35.37 ± 0.01	2.01 ± 0.01	39.20 ± 0.21	5.17	0.53	79.16
Mehrani	2.53 ± 0.12	2.79 ± 0.04	0.87 ± 0.03	16.52 ± 0.11	24.95 ± 0.06	42.33 ± 0.12	4.25	0.37	81.8
Gelin Boğan	2.80 ± 0.12	1.90 ± 0.04	0.71 ± 0.12	28.70 ± 0.02	20.50 ± 0.06	49.90 ± 0.13	4.57	0.83	81.31
Bıldırcın	1.74 ± 0.12	6.37 ± 0.04	2.26 ± 0.01	26.84 ± 0.08	34.56 ± 0.01	63.66 ± 0.07	4.9	1.33	78.28
Şalgam	1.47 ± 0.12	4.60 ± 0.04	0.86 ± 0.04	18.78 ± 0.02	22.39 ± 0.11	42.03 ± 0.09	4.82	0.2	79.28
Menendi	1.87 ± 0.12	6.28 ± 0.04	1.98 ± 0.04	29.51 ± 0.03	16.93 ± 0.01	48.42 ± 0.13	5.56	0.16	79.2
Kabak	1.48 ± 0.12	1.02 ± 0.04	0.23 ± 0.01	34.18 ± 0.01	0.16 ± 0.01	34.57 ± 0.01	4.41	0.13	82.58
Hahır	1.38 ± 0.12	6.01 ± 0.04	0.21 ± 0.02	37.47 ± 0.01	1.01 ± 0.11	38.68 ± 0.05	4.86	0.3	80.19
Turşu	1.64 ± 0.12	1.87 ± 0.04	1.55 ± 0.01	18.32 ± 0.01	6.52 ± 0.01	27.46 ± 0.01	4.26	0.5	75.52
Ahlat	5.09 ± 0.12	2.54 ± 0.04	2.63 ± 0.01	18.32 ± 0.01	6.52 ± 0.01	27.46 ± 0.01	4.5	0.81	63.51
Hacı Hamza	4.88 ± 0.12	2.58 ± 0.04	1.13 ± 0.01	26.91 ± 0.21	9.41 ± 0.04	37.44 ± 0.06	4.38	0.29	88.25
Kızıl	2.93 ± 0.12	3.36 ± 0.04	0.79 ± 0.01	23.67 ± 0.80	11.33 ± 0.55	35.79 ± 0.01	5.01	0.24	79.9

[1]%

the local pear varieties, it is seen that Kabak pear has a significant difference in terms of fruit mass, fruit width, and fruit stem length and fruit stem thickness. Ankara, Menendi, Cermai, Yaz Meyriği, and Şalgam pears have shown significant differences in terms of fruit length, fruit kernel width, fruit kernel length, hardness of pulp and number of seeds, respectively (Table 1 and 2).

By the evaluation of the chemical analyses results, it is seen that the Ahlat pear (5.09%) has the highest and Tokat Sultanı (1.04%) has the lowest protein level (Table 3). The ash content of the pear samples was determined in the range of 1.02% (Kabak)–6.37% (Bıldırcın). The protein and ash ratios of 15 promising walnut genotypes selected from Ahlat region were determined in the ranges of 15.5–23.3% and 2.2–4.2%, respectively (Muradoğlu and Balta 2010).

The sugar content, which is directly effective in the purchase of fresh fruits and in the fruit quality, shows alteration with climate, soil structure and the type and amount of nutrients (Davidescu and Davidescu 1999; Mitre et al. 2009; Sestras et al. 2009). The sucrose, fructose, and glucose amounts of pear samples varied in the ranges of 0.21% (Hahır)–14.92% (Arpa), 16.52% (Mehrani)–43.79% (Yaz), and 0.16% (Kabak)–34.56% (Bıldırcın), respectively. On the other hand, the lowest total sugar amount was found to be in Turşu and Ahlat (27.46%), while the highest level of it was observed in Yaz pear (65.99%) (Table 3). The high sugar contents were obtained in the local pear varieties grown in Gumushane province as because of the high temperature and adequate mineral element levels of soils, which permitted the assimilation of sugars (Campeanu et al. 2009; Durić et al. 2015a; Lukic et al. 2012). In a study carried out for the evaluation of the sugar contents of Akça, Ankara, Passe Crassane, Santa Maria, Starkrimson, Seker and Williams varieties, it was determined that the fructose (5.41%) is the most abundant sugar in the pear juice samples and this is followed by glucose (2.06%) and sucrose (0.52%) (Karadeniz 1999).

As a result of pH assessment of the pear samples, it was concluded that Tokat Sultanı and Menendi has the lowest (4.07) and the highest (5.56) values, respectively (Table 3). The ecological conditions, soil structure and watering are considered as directly effective factors on the pH values of local pear varieties (Hulme and Rhodes 1970). The results obtained in this study are in agreement with the literature data.

The taste of the pear samples can be predicted by considering the titratable acidity values (Harker et al. 2002). The highest titratable acidity was determined in Bıldırcın as 1.33%, while Menendi has the lowest value as 0.16% (Table 3). The titratable acidity levels of the pear genotypes grown in Eğirdir district of Isparta province and in Adilcevaz district were reported in the ranges of 0.1–0.94%

Table 4 The mineral element contents of local pear varieties grown in Gumushane

Pear Varieties	Fe[1]	Cu[1]	Mn[1]	Mg[1]	Zn[1]	Na[1]	K[1]	Ca[1]	P[1]	N[2]
Tokat Sultanı	11.59 ± 0.01	11.59 ± 0.01	1.24 ± 0.01	295.72 ± 0.09	5.80 ± 0.01	42.40 ± 0.01	3858.85 ± 0.13	353.87 ± 0.15	560.93 ± 0.08	0.17 ± 0.02
Ankara	15.88 ± 0.01	3.65 ± 0.02	6.84 ± 0.01	396.34 ± 0.06	11.07 ± 0.01	27.75 ± 0.01	6004.40 ± 1.15	895.95 ± 0.34	914.89 ± 0.18	0.67 ± 0.02
Arpa	12.47 ± 0.01	4.09 ± 0.01	2.73 ± 0.01	407.11 ± 0.09	9.66 ± 0.01	46.07 ± 0.01	6410.06 ± 0.99	762.68 ± 0.43	863.09 ± 0.01	0.39 ± 0.02
Sulu	12.86 ± 0.01	3.74 ± 0.01	2.45 ± 0.01	462.01 ± 0.17	9.30 ± 0.01	138.63 ± 0.05	6320.43 ± 2.37	761.54 ± 0.61	1130.79 ± 0.42	0.39 ± 0.02
Cinci	12.28 ± 0.01	1.98 ± 0.02	1.38 ± 0.01	217.05 ± 0.18	7.82 ± 0.01	30.67 ± 0.03	4815.42 ± 4.08	491.38 ± 0.09	651.95 ± 0.55	0.31 ± 0.02
Yaz Meyriği	15.97 ± 0.01	6.70 ± 0.04	2.16 ± 0.01	419.67 ± 0.09	8.25 ± 0.01	102.65 ± 0.01	6158.57 ± 0.55	611.20 ± 0.37	872.23 ± 0.09	0.39 ± 0.04
Cermai	17.74 ± 0.01	5.73 ± 0.04	3.42 ± 0.01	468.92 ± 0.06	16.87 ± 0.01	15.71 ± 0.01	7213.60 ± 1.21	1150.61 ± 0.18	1387.05 ± 0.22	0.64 ± 0.02
Yaz	20.22 ± 0.01	5.83 ± 0.03	2.50 ± 0.01	376.60 ± 0.08	13.27 ± 0.01	42.27 ± 0.02	5887.24 ± 0.73	1207.14 ± 0.09	463.03 ± 0.07	0.41 ± 0.02
Kokulu	46.42 ± 0.11	3.92 ± 0.03	2.73 ± 0.01	331.19 ± 0.05	10.64 ± 0.01	65.89 ± 0.01	4165.17 ± 0.42	905.45 ± 0.18	752.91 ± 0.06	0.30 ± 0.02
Mehrani	9.39 ± 0.01	2.19 ± 0.01	1.29 ± 0.01	311.43 ± 0.03	2.93 ± 0.01	0.00 ± 0.01	6293.92 ± 1.01	350.28 ± 0.16	887.62 ± 0.16	0.41 ± 0.02
Gelin Boğan	8.82 ± 0.01	3.48 ± 0.06	2.98 ± 0.01	439.85 ± 0.09	9.33 ± 0.01	12.34 ± 0.01	5477.68 ± 0.85	896.65 ± 0.25	768.60 ± 0.12	0.45 ± 0.02
Bıldırcın	13.72 ± 0.01	3.14 ± 0.01	1.21 ± 0.01	316.22 ± 0.06	5.64 ± 0.01	15.78 ± 0.01	6644.29 ± 0.51	303.08 ± 0.13	638.50 ± 0.03	0.28 ± 0.02
Şalgam	9.32 ± 0.01	3.76 ± 0.05	2.63 ± 0.01	372.38 ± 0.05	5.04 ± 0.01	0.00 ± 0.01	6234.36 ± 1.81	497.73 ± 0.32	761.58 ± 0.28	0.24 ± 0.02
Menendi	11.04 ± 0.01	1.89 ± 0.04	1.25 ± 0.11	16.01 ± 0.01	4.93 ± 0.01	16.01 ± 0.01	6832.11 ± 0.55	497.67 ± 0.01	930.18 ± 0.03	0.30 ± 0.02
Kabak	8.57 ± 0.01	4.46 ± 0.02	1.58 ± 0.01	223.70 ± 0.04	6.88 ± 0.01	26.93 ± 0.01	2685.12 ± 0.35	485.58 ± 0.23	790.64 ± 0.12	0.24 ± 0.02
Hahır	6.02 ± 0.01	1.49 ± 0.00	1.75 ± 0.01	240.34 ± 0.09	2.79 ± 0.01	14.58 ± 0.01	6748.60 ± 1.75	394.84 ± 0.24	459.23 ± 0.15	0.22 ± 0.02
Turşu	6.04 ± 0.01	1.48 ± 0.00	1.44 ± 0.01	226.01 ± 0.29	12.60 ± 0.02	14.10 ± 0.03	5098.80 ± 6.10	1586.19 ± 1.49	353.26 ± 0.43	0.26 ± 0.02
Ahlat	17.34 ± 0.11	4.19 ± 0.07	3.99 ± 0.01	693.21 ± 0.09	14.26 ± 0.01	3.21 ± 0.01	7772.27 ± 1.48	2424.94 ± 0.90	1591.28 ± 0.30	0.81 ± 0.02
Hacı Hamza	51.99 ± 0.06	2.08 ± 0.03	3.55 ± 0.01	624.91 ± 0.60	14.46 ± 0.02	75.47 ± 0.08	7875.36 ± 7.70	1705.88 ± 1.77	1450.81 ± 1.54	0.78 ± 0.02
Kızıl	17.15 ± 0.01	4.11 ± 0.02	3.79 ± 0.01	765.31 ± 0.16	16.70 ± 0.01	16.69 ± 0.12	9212.66 ± 1.94	1290.32 ± 0.75	1799.78 ± 0.55	0.47 ± 0.02

[1]mg kg^{-1}
[2]%

(Bağbozan 2015) and 0.24–2.45% (Yarılgaç and Yıldız 2001), respectively.

The highest and the lowest moisture contents of the pear fruits were obtained as 88.25% and 63.51% for Hacı Hamza and Ahlat pear, respectively (Table 3).

Mineral elements have a significant role in bones and teeth structure, nerve and muscle function, blood production, and transportation of oxygen. As in other fruit species pear is considered as a good source of mineral elements (Faust et al. 1969). The levels of macro elements (Na, K, Ca, Mg, N and P) and micro elements (Fe, Cu, Zn and Mn) of the local pear varieties grown in Gumushane are given in Table 4. The highest Na, K, Ca, Mg, N, P, Fe, Cu, Zn and Mn levels were obtained in Sulu (138.63 mg kg^{-1}), Kızıl (9212.66 mg kg^{-1}), Ahlat (2424.94 mg kg^{-1}), Kızıl (765.31 mg kg^{-1}), Ahlat (0.81 mg kg^{-1}), Kızıl (1799.78 mg kg^{-1}), Hacı Hamza (51.99 mg kg^{-1}), Tokat Sultanı (11.59 mg kg^{-1}), Cermai (16.87 mg kg^{-1}) and Ankara (6.84 mg kg^{-1}), respectively while the lowest amounts of them were determined in Ahlat (3.21 mg kg^{-1}), Kabak (2685.12 mg kg^{-1}), Bıldırcın (303.08 mg kg^{-1}), Menendi (16.01 mg kg^{-1}), Tokat Sultanı (0.17 mg kg^{-1}), Turşu (353.26 mg kg^{-1}), Hahır (6.02 mg kg^{-1}), Turşu (1.48 mg kg^{-1}), Hahır (2.79 mg kg^{-1}), Bıldırcın (1.21 mg kg^{-1}), respectively. Gündoğdu and Yılmaz (2013) have determined the N, P, K, Ca, Fe Mn, Zn, Cu and Mg levels of pomegranate genotypes in the ranges of 111.57–1007.33 ppm, 215.98–338.35 ppm, 547.15–1651.30 ppm, 21.91–69.81 ppm, 2.52–5.38 ppm, 0.150–0.649 ppm, 0.413–1.201 ppm, 0.253–2.388 ppm and 26.76–128.40 ppm, respectively.

Conclusions

Twenty pear fruit varieties grown in Gumushane province were evaluated for the first time in the presented study in terms of pomological and morphological properties, and chemical compositions in order to protect the species as a genetic resource and to predict the fruit quality.

The pomological and morphological analysis results were obtained in the following ranges: fruit mass; 10.48–140.63 g, fruit width; 25.85–64.33 mm, fruit length; 24.05–71.79 mm, fruit stem thickness; 1.77–3.94 mm, fruit stem length; 11.83–43.88 mm, fruit kernel width; 13.30–22.78 mm, fruit kernel length; 15.02–25.70 mm, hardness of pulp; 4.33–16.82 mm, number of seeds; 2.76–8.05 mm, leaf width; 26.79–46.22 mm, leaf length; 52.42–76.46 mm, leaf stem length; 11.80–52.74 mm, leaf stem thickness; 0.70–1.09 mm, and water soluble dry matter; 10–21%. The chemical composition analysis results were determined in the following ranges: protein content; 1.04–5.09%, ash content; 1.02–6.37%, sucrose; 0.21–14.92%, fructose; 16.52–43.79%, glucose; 0.16–34.56%, total sugar; 27.46–65.99%, pH; 4.07–5.56, Titratable acidity; 0.13–1.33%, moisture content; 63.51–88.25%, Na; 3.21–138.63 mg kg^{-1}, K; 2685.12–9212.66 mg kg^{-1}, Ca; 303.08–2424.94 mg kg^{-1}, Mg; 16.01–765.31 mg kg^{-1}, N; 0.17–0.81%, P; 353.26–1799.78 mg kg^{-1}, Fe; 6.02–51.99 mg kg^{-1}, Cu; 1.48–11.59 mg kg^{-1}, Zn; 2.79 – 16.87 mg kg^{-1}, and Mn; 1.21–6.84 mg kg^{-1}.

There are pear populations in our country that have been cultivated especially locally for hundreds of years and offer rich variety to different consumption demands. Within this population, there are many valuable local varieties which have not yet been introduced to the wide markets. It is necessary to provide a basis for the selection studies by revealing the differences between the local and standard varieties in terms of their ingredients. This study, carried out for introducing and evaluating the local pear varieties and for protecting the existing genetic resources, constitutes the first step of the selection studies of local pear varieties grown in Gumushane which has not been investigated until now.

Acknowledgements The authors wish to thank the Research Council of the Gumushane University (Project No: 16.B0123.02.01) for the financial support of this study.

Compliance with ethical guidelines

Conflict of interest O. Kalkisim, Z. Okcu, B. Karabulut, D. Ozdes and C. Duran declare that they have no competing interests.

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