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ORIGINAL ARTICLE

Determination of Pomological and Morphological Characteristics and Chemical Compositions of Local Apple Varieties Grown in Gumushane, Turkey

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Abstract The present study was conducted in order to determine the pomological and morphological characteristics and chemical compositions of some local apple varieties grown in Gumushane. As a result of field work in Gumushane province, sixteen different apples, which are Summer Apple, English apple, Green Belly, Black Belly and Yellow Belly Apples, Amasya Marble, Bey Apple, Chest Apple, Mahsusa, Arabian Girl, Willow Apple, Tavşanbaşı, Yellow Hıdır, Local Marble, Bride Apple, and Fatty Apple were collected in order to analyze. The average results of pomological and morphological properties and chemical compositions were obtained as following: fruit mass; 127.36 g, fruit width; 65.23 mm, fruit length; 57.30 mm, fruit stalk thickness; 2.17 mm, fruit stalk length; 17.63 mm, stalk pit depth; 12.75 mm, flower pit depth; 10.29 mm, fruit firmness; 13.79 kg/cm^2, seed house width; 15.89 mm, seed house length; 17.39 mm, number of seeds; 4.3, water soluble dry matter content; 14.53 %, ash content; 1.11 %, pH; 3.8, titratable acidity; 0.69 g/L, water content; 83.8 %, reducing sugar; 5.04 g/100 g, sucrose; 2.25 g/100 g, and the amount of total sugars; 7.29 g/100. The fruit peel color was determined by considering the light transmittance (L). The average L values were ranged between 112.06 and 66.32. On the other hand among the mineral elements, potassium and manganese amounts were determined as the highest and the lowest, respectively.

Keywords Chemical composition · Gumushane · Local apple · *Malus domestica* · Pomological and morphological properties

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Bestimmung der pomologischen und morphologischen Eigenschaften sowie der chemischen Zusammensetzung lokaler Apfelsorten aus dem Gebiet Gumushane, Türkei

Zusammenfassung Die vorliegende Studie wurde durchgeführt, um die pomologischen, morphologischen sowie die chemischen Eigenschaften von lokalen Apfelsorten, die in der Provinz Gumushane angebaut werden, zu bestimmen. In der Provinz Gumushane wurden vor Ort sechszehn verschiedene Apfelsorten, namentlich der Sommerapfel, der Englische Apfel, der Grünbauchige Apfel, der Schwarzbauchige Apfel, der Gelbbauchige Apfel, der Amasya-Apfel, der Bey-Apfel (Herrenapfel), der Brustapfel, der Mahusa-Apfel, der Arabische Mädchen-Apfel, der Weideapfel, der Tavşanbası (der Hasenkopfapfel), der Gelbe Hidir, der Gumushane-Marmor-Apfel, der Brautapfel und der Dicke-Apfel zu Analysezwecken zusammengetragen. Als durchschnittliche Meßwerte der pomologischen und morphologischen Eigenschaften und der chemischen Zusammensetzung wurden festgestellt: Fruchtmasse: 127,6 g; Fruchtbreite: 65,23 mm; Fruchtlänge: 57,30 mm; Dicke des Fruchtstiels: 2,17 mm; Länge des Fruchtstiels: 17,63 mm;

Stielgrubentiefe: 12,75 mm; Kelchgrubentiefe: 10,29 mm; Fruchtfleischfestigkeit: 13,79 kg/cm^2; Kernhausbreite: 15,89 mm; Kernhauslänge: 17,39 mm; Anzahl der Kerne: 4,3; wasserlöslicher Trockenmassegehalt: 14,53 %; Aschegehalt: 1,1 %; ph-Wert: 3,8 %; titrierbare Säure: 0,69 g/l; Wassergehalt: 83,3 %; reduzierender Zucker: 5,04 g/100 g, Saccharose: 2,25 g/100 g; und die Gesamtzuckermenge von 7,29 g/100 g. Die Fruchtschalenfarben wurden unter Berücksichtigung der Lichtdurchlässigkeit (L) bestimmt. Die durchschnittlichen L-Werte lagen zwischen 112,06 und 66,32. Bei den Minearlstoffgehalten in den Früchten wurden für Kalium und Mangan der höchste und der niedrigste Mittelwert ermittelt.

Schlüsselwörter Chemische Zusammensetzung · Gumushane · Lokale Apfelsorten · *Malus domestica* · Pomologische und morphologische Eigenschaften

Introduction

The culture of fruit growing based on very old years and has made significant contributions as people's livelihood for many years in Gumushane province, located inner part of the Blacksea Region. Apple comes at the beginning of the most important fruit species those are grown in this province.

Apple is a species of the genus *Malus* belongs to the *Rosaceae* family. There are 30 apple species (*Malus domestica*) those are grown naturally in the East Asia, Central Asia, Western Asia-Europe and North America Regions, which are considered as the homeland of apple over the world. The interior parts of the Black Sea region and Taurus Mountains are the natural range of the apple and at here, *M. sylvestris* and *M. orientalis* species generally grows naturally (Ünal 2011). Apple is a mild climate fruit and its cultivation based on more than 4000 years old (Özbek 1978). The world apple production is 76 million tons and a total of 4.8 million hectares of land is used for apple cultivation. In our country, 2.8 million tons of apples are produced at 150,000 hectares of land (Anonim 2012).

Turkey is the center of gene in terms of fruit growing as in many agricultural products and it is quite rich in many fruit varieties (Özbek 1978). Because of its geographical location and ecological conditions, our country has a wealth of species. Turkey is the homeland of many types of fruits and it is also shown as the homeland of apple (Ülkümen 1938; Özbek 1978). Eight different homelands (gene centers) were determined on the world. Among these homelands, China, Central Asia and the Near East are shown as the center of the apple. It is possible to add North America, where is the range area of different types and varieties, to these gene center groups (Özbek 1978). Among these eight gene centers, Turkey has a special place since it is located within both the Near East and the Mediterranean Basin (Özcan 2012).

There are 138 fruit species grown in the world by taking culture and about 75 types of these fruits are grown in our country. Among them, 16 species are subtropical climate fruits. The values of species are revealed by pomological and morphological studies in the countries which have a wide range of fruit culture. The pomological properties of all varieties grown in our country have not been studied; therefore the values of local varieties have not been exactly revealed (Akça and Sen 1990).

Gumushane, located in the Eastern Blacksea region, constitutes the transition between the Black Sea and Eastern Anatolia Region in terms of climate characteristics. In summer; cool and in winter; cold climate is seen (Okcu 2012). Many types of fruit are grown in Gumushane and apple comes at the beginning of these fruits. In this study the local apple varieties which are grown in Gumushane have been determined and the pomological and morphological characteristics and chemical composition of these apples were determined. It is obligatory to maintain fruit trees, which are aging day by day and almost extincting, in terms of future breeding activities. For that purpose, the slips were taken from the features detected local apple varieties and grafted onto dwarf rootstock and a garden was founded from the obtained saplings. In this way, the local apple varieties were safeguarded as genetic resources.

Materials and Methods

Materials

Sixteen apples varieties have been identified by visiting the villages and districts of Gumushane province and contacting with farmers one-to-one. The detected trees were marked and the fruits were harvested at full maturity period. The harvested local varieties in the region are; Summer Apple, English apple, Green Belly, Black Belly and Yellow Belly Apples, Amasya Marble, Bey Apple, Chest Apple, Mahsusa, Arabian Girl, Willow Apple, Tavşanbaşı, Yellow Hıdır, Local Marble, Bride Apple, and Fatty Apple.

Among these varieties; Summer Apple, English Apple, Green Belly, Black Belly and Yellow Belly Apples, Amasya Marble, Bey Apple, Chest Apple, Mahsusa, Willow Apple, and Yellow Hıdır were taken from Bağlarbaşı districts, Bride Apple and Arabian Girl were taken from Mescitli, Tavşanbaşı, Local Marble, Bride Apple and Fatty Apple were taken from Hacıemin village.

Methods

The analyses were carried out for three replicates for each apple varieties and in each replicate, 10 fruits were used

and a total of 30 fruits were used for determination of the pomological and morphological characteristics and chemical composition of each apple varieties. The harvested fruits were kept at +4 °C in a refrigerator until analysis.

The fruit flavor was determined by taste analysis (degustation). The mass of harvested fruits were given in gram unit by weighing with an analytical balance. Fruit width and length, fruit stalk thickness and length, stalk pit and flower pit depth, seed width and height, seed house width and height were measured using calipers with a sensitivity of 0.01 mm. The numbers of seed of the harvested fruits were investigated after divided of the fruits into two parts with a knife. The fruit firmness values were determined with a penetrometer by removing a thin shell from the fruit surface. The water soluble dry matter (WSDM) content of the samples was determined by using a hand refractometer.

The fruit peel color was evaluated by a spectrophotometer color measurement device. For this color determination a 'mathematical structures' color identification system, created by International Commission on Illumination (Commission Internationale de l'Eclairage, CIE) was used. According to the system, there are three types conical light sensing cells in human eyes and these cells are sensitive to blue, green and red lights. As a result of this modeling, each color is expressed as three components, which are abbreviated as L, a and b (Anonim 2014).

In order to determine the water content, approximately 1.5 g of apple 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 water contents (%) were determined.

After grinded the dried apple samples, approximately 1.5 g of samples were weighted into tarred porcelain crucibles in order to determine the ash content. Then the apple samples in porcelain crucibles were heated to 550–600 °C in the muffle furnace. The samples were heated 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 (Kaya et al. 2004).

For determination of pH, freshly collected apple 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.

The solubilization process for the element analyses was carried out according to the wet digestion method. For this purpose, 0.500 g of dried and homogenized apple samples was weighted in a beaker. 15–20 mL of $HClO_4$-HNO_3 (20/80) mixture was added to the beakers. The beaker content was heated on the hotplate at low temperature until the end of the brown fumes output. Then, by raising the temperature, the burning process was continued until the solution in the beakers became clear. The resulting solution was cooled to room temperature, and then filtered to volumetric flask by passing through a glass-fibre and the final volume was completed to 25 mL. After making necessary dilutions Fe, Cu, Mn, Zn, Ca and Mg determination was performed by a Perkin Elmer AAnalyst400 model flame atomic absorption spectrophotometer. Na and K determination was carried out by a flame photometer at wavelengths of 589 and 768 nm, respectively (Kaya et al. 2004).

Sugar content was determined according to Lane-Eynon method (Pomeranz and Meloan 2002). First of all, the reducing sugar content was determined in the apple samples by applying the method, then the amount of total sugar was determined after performed the inversion of the samples. The amount of sucrose was calculated from the difference between the total sugar and reducing sugar amounts.

For titratable acidity, 25 mL of freshly prepared apple 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. Titratable acid content was determined in terms of malic acid (Campeanu et al. 2009).

Results and Discussion

Pomological and Morphological Characteristics of Local Apple Varieties

The mass of apples varied in the range of 51.00–217.43 g and the average fruit mass was found to be 127.36 g for the analyzed sixteen local apple samples. The highest fruit mass values were determined in the order of Arabian Girl (217.43 g), Bey Apple (201.40 g) and Chest Apple (187.77 g), while the lowest values were obtained for Local Marble (51.00 g) and Mahsusa (53.73 g) (Table 1). In a study, in which the pomological and morphological characteristics of 10 local apple varieties in Ahlat town center have been investigated, the average fruit mass has been recorded between 23.95 g and 168.5 g (Şen et al. 1992). The fruit mass was investigated in the range of 20.9–139.3 g for the apple samples grown in Çatak and Tatvan in 2011 (Özrenk et al. 2011). In another study conducted in Camili region of Artvin, the average fruit mass of the local apple varieties was determined in the range of 54.33–206.0 g (Serdar et al. 2007). The fruit masses of Granny Smith, Golden Delicious and Starking Delicious grown in Erzincan plain were

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

Apple Varieties	Fruit Weight (g)	Fruit width (mm)	Fruit length (mm)	Fruit stalk thickness (mm)	Fruit stalk length (mm)	Stalk pit depth (mm)	Flower pit depth (mm)	Fruit firmness (kg/cm^2)	Seed house width (mm)	Seed house length (mm)	Numbers of seed	WSDM[a] (%)	Fruit flavor
Black Belly Apple	123.10±3.79^{fg}	67.50±0.80^{defg}	54.64±0.89^{g}	2.26±0.05^{bcd}	16.08±0.60^{ghi}	12.86±0.39^{efg}	9.76±0.29^{d}	14.32±0.13^{cd}	12.86±0.54^{jk}	14.76±0.32^{g}	2.90±0.19^{fg}	15.00±0.28^{c}	Slightly tart
Yellow Belly Apple	138.20±4.26ef	69.26±0.78^{def}	57.27±0.98^{def}	2.30±0.04^{bcd}	21.24±0.55^{a}	17.51±0.30^{a}	13.47±0.32^{a}	15.02±0.11^{bc}	19.46±0.31^{b}	21.52±0.35^{a}	2.63±0.21^{fg}	14.00±0.16^{de}	Sweet
Green Belly Apple	118.43±5.63^{g}	66.60±0.73^{efg}	56.32±0.84^{efg}	2.26±0.05^{bcd}	18.51±0.74^{cde}	14.53±0.42^{bc}	13.27±0.38^{a}	14.92±0.15^{bc}	15.05±0.43^{fgh}	17.75±0.39^{de}	3.13±0.26^{f}	14.00±0.16^{de}	Sweet
Amasya Marble	127.63±3.68^{fg}	64.96±0.68^{g}	63.64±0.89^{bc}	2.27±0.08^{ef}	21.48±0.55^{a}	12.44±0.59^{fg}	13.70±0.37^{a}	14.80±0.27^{bc}	16.14±0.48^{def}	19.28±0.54^{bc}	5.03±0.38^{cd}	15.00±0.28^{c}	Sweet
Arabian Girl	217.43±5.90^{a}	77.19±0.76^{ab}	66.91±1.31^{a}	2.59±0.14^{a}	20.20±0.44^{ab}	16.53±0.31^{a}	11.05±0.37^{bc}	15.03±0.17^{bc}	17.60±0.44^{c}	20.17±0.38^{ab}	3.00±0.22^{f}	15.00±0.00^{c}	Sweet
Bey Apple	201.40±8.54^{b}	80.47±1.11^{a}	60.22±0.93^{c}	2.61±0.07^{a}	13.79±0.48^{j}	12.28±0.43^{g}	11.31±0.33^{b}	13.20±0.30^{fg}	14.30±0.46^{hij}	15.30±0.33^{fg}	4.13±0.28^{de}	14.50±0.16^{cd}	Tart
Bride Apple	96.17±2.85^{h}	54.73±1.41^{i}	55.29±1.43^{fg}	2.20±0.09^{cde}	13.62±0.68^{j}	13.15±0.36^{efg}	10.31±0.25^{bcd}	11.73±0.12^{j}	14.38±0.52^{hi}	15.58±0.47^{fg}	3.07±0.24^{f}	13.00±0.16^{f}	Slightly sweet
English Apple	144.90±2.52^{de}	72.73±0.61^{c}	56.45±0.81^{efg}	2.41±0.08^{abc}	20.00±0.49^{abc}	15.05±0.28^{b}	11.35±0.39^{b}	13.15±0.17^{fg}	19.13±0.40^{b}	21.24±0.44^{a}	3.27±0.14^{ef}	15.00±0.16^{c}	Sour
Mahsusa	53.73±2.46^{j}	48.62±0.76^{j}	46.87±0.90^{i}	1.56±0.05 ^{g}	16.91±0.49^{efgh}	7.61±0.16^{i}	5.40±0.15^{g}	17.08±0.22^{a}	12.17±0.34^{k}	15.12±0.33^{fg}	6.50±0.45^{a}	14.00±0.16^{de}	Sour
Chest Apple	187.77±5.09^{c}	77.43±0.75^{b}	63.53±0.91^{bc}	2.56±0.08^{a}	18.73±0.70^{bcd}	13.44±0.34^{cdef}	10.19±0.37^{cd}	15.08±0.22^{b}	17.24±0.60^{cde}	17.28±0.33^{e}	5.47±0.45^{bc}	13.00±0.28^{f}	Sour
Yellow Hıdır	131.83±4.14^{efg}	69.16±0.96^{de}	58.43±0.79^{de}	1.84±0.05^{f}	16.42±0.58^{gh}	13.77±0.43^{cde}	10.56±0.28^{bcd}	11.38±0.15^{j}	14.22±0.43^{hij}	14.50±0.36^{g}	6.53±0.45^{a}	17.50±0.16^{a}	Sweet
Willow Apple	59.47±2.72^{ij}	48.69±0.72^{j}	49.78±0.91^{h}	1.57±0.05^{g}	18.20±0.51^{def}	9.61±0.28^{h}	6.22±0.22^{fg}	14.67±0.32^{bc}	13.48±0.34^{ijk}	15.17±0.36^{fg}	3.37±0.31^{ef}	16.50±0.16^{b}	Tart
Tavşanbaşı	155.13±5.13^{d}	69.80±1.09^{d}	67.64±0.10^{a}	2.16±0.09^{de}	15.21±0.35^{hij}	13.39±0.42^{defg}	10.14±0.46^{cd}	13.32±0.22^{ef}	13.17±0.32^{ijk}	16.19±0.41^{f}	2.03±0.23^{g}	14.00±0.28^{de}	Sour
Fatty Apple	135.07±3.14^{ef}	69.07±0.51^{de}	59.41±0.82^{d}	2.41±0.09^{abc}	16.68±0.66^{fgh}	16.25±0.29^{a}	10.79±0.34^{bcd}	11.78±0.15^{ij}	23.04±0.64^{a}	18.63±0.33^{cd}	6.10±0.33^{ab}	15.00±0.16^{c}	Acrid
Summer Apple	71.43±2.16^{i}	57.27±0.65^{h}	46.72±0.59^{i}	2.47±0.12^{ab}	17.53±0.49^{defg}	7.28±0.21^{i}	7.60±0.39^{e}	12.42±0.46^{hi}	15.88±0.70^{efg}	18.54±0.37^{cd}	4.97±0.28^{cd}	10.00±0.16^{g}	Sweet
Local Marble	51.00±2.39^{j}	49.27±0.83^{j}	45.11±0.77^{i}	1.51±0.03^{g}	14.52±0.39^{ij}	6.70±0.21^{i}	6.80±0.22^{ef}	12.60±0.20^{gh}	14.62±0.36^{ghi}	15.46±0.31^{fg}	6.40±0.26^{a}	15.00±0.28^{c}	Acrid
Average	127.36±2.37	65.23±0.48	57.30±0.38	2.17±0.24	17.63±0.17	12.75±0.16	10.29±0.13	13.79±0.09	15.89±0.16	17.39±0.13	4.30±0.10	14.53±0.22	

[a]Water soluble dry matter content

determined as 187.39 g, 152.11 g and 130.41 g, respectively (Güleryüz et al. 2001). On the other hand in the present study, 217.43 g of fruit mass was obtained hence it is concluded that the local apple varieties grown in Gumushane can compete with standard varieties in terms of fruit mass without taking any cultural precautions.

In this study, the average fruit width was obtained as 65.23 mm for all apple varieties. The highest fruit width was determined as 80.47 mm for Bey Apple, while Mahsusa (48.62 mm) and Willow Apple (48.69 mm) have the lowest values and there was not any statistically significant difference between these two types (Table 1). By considering the fruit length, it was seen that the average fruit length was 57.30 mm. Tavşanbaşı (67.64 mm) and Arabian Girl (66.91 mm) have the highest values and no statistically significant difference were found between these two local apple varieties. In other respects, the lowest fruit lengths were obtained for Local Marble (45.11 mm) and Summer Apple (46.72 mm). In a study conducted in Ünye, the fruit lengths of apple varieties were determined in the range of 48.85–74.61 mm, while the fruit widths were between 53.40 and 86.80 mm (Bostan and Acar 2009). In another study, the fruit widths and fruit lenghts of local apple varieties, grown in Çatak ve Tatvan, were reported in the range of 35.4–60.3 mm and 32.8–54.3 mm, respectively (Özrenk et al. 2011). When compared to the literature, it is seen that the values of fruit width and fruit length obtained in the present study are high enough.

When we examined the local apple varieties in terms of fruit stalk thickness and length, we concluded that the average stalk thickness is 2.51 mm while the average stalk length is 17.63 mm. Bey Apple has the highest stalk thickness (2.61 mm), and Arabian Girl (2.59 mm) and Chest Apple (2.56 mm) follow this local apple. A statistically significant difference did not obtain between these three apple varieties. On the other hand the lowest stalk thickness was obtained as 1.51 mm for Local Marble. By evaluating the stalk length, the longest stalk was seen in Amasya Marble (21.48 mm). Yellow Belly Apple followed Amasya Marble with a stalk length value of 21.24 mm and there was no statistical significant difference between them. The shortest stalk length was investigated in Bride Apple as 13.72 mm (Table 1). According to the literature the stalk length of Iron Apple was reported in the range of 11.1–6.6 mm (Aygün and Ülgen 2009) and the average stalk thickness of Yomra Apples was obtained as 2.83 mm in 2009 (İslam et al. 2009).

In the presented study, the average stalk pit depth value was obtained as 12.75 mm (Table 1). Among the studied apple varieties, the highest stalk pit depth value was obtained in Yellow Belly Apple (17.51 mm), then Arabian Girl (16.53 mm) and Fatty Apple (16.25 mm) followed the order. There was no statistically significant difference between these apple varieties. The lowest stalk pit depth value was obtained as 6.70 mm in Local Marble. For all evaluated local apple varieties, the average flower pit depth value was investigated as 10.29 mm. The highest flower pit depths were seen in Amasya Marble (13.70 mm), Yellow Belly (13.47 mm) and Green Belly Apple (13.27), and there was not any statistically significant difference between them. In other respects Willow Apple has the lowest flower pit depth with a value of 5.40 mm (Table 1). Edizer and Bekar (2007) were determined the highest and the lowest stalk pit depths in Alyanak (18.18 mm) and Sour Apple (8.30 mm), respectively, while they reported the flower pit depth in the range of 25.47–6.40 mm in the local apple varieties grown in Tokat.

It was determined that the fruit firmness values varied between 11.38 and 17.08 kg/cm^2 in all studied local apple varieties, while the average value of fruit firmness was obtained as 13.79 kg/cm^2 (Table 1). Among the varieties, Mahsusa and Yellow Hıdır have the highest and the lowest fruit firmness values, respectively. Karlıdağ and Eşitken (2006) have determined the fruit firmness values of the apple varieties grown in upper Çoruh valley in the range of 3.70–5.25 kg/cm^2.

The average seed house width and height were determined as 15.89 ve 17.39 mm, respectively for all studied local apple varieties. The highest seed house width was established in Tavşanbaşı (23.04 mm), afterwards Yellow Belly Apples (19.46 mm) and English Apple (19.13 mm) followed the order. The lowest seed house width was seen in Mahsusa (12.17 mm). The descending sort of seed house height was as follows; Yellow Belly Apples (21.52 mm), English Apple (21.24 mm) and Arabian Girl (20.17 mm), while the lowest seed house height was found for Yellow Hıdır as 14.50 mm (Table 1). In a study in which the pomological properties of local apple varieties grown in Tokat were determined, the seed house width and height was reported in the range of 30.99–16.26 mm (Alyanak-Elifli) and 20.83–14.92 mm (Alyanak-sour apple), respectively (Edizer and Bekar 2007).

For evaluated local apple varieties, the average number of seed was investigated as 4.30, and the number of seed varied between 2.03 and 6.53. The highest number of seed values was found for Yellow Hıdır, Mahsusa and Local Marble as 6.53, 6.50 and 6.40, respectively and no statistically significant difference obtained between them. On the other hand the lowest number of seed value was obtained in Tavşanbaşı as 2.03 (Table 1). In literature, it is reported that the number of seed varied between 1.1 and 5.4 in Iron Apple (Aygün and Ülgen 2009).

The WSDM content showed an alteration between 10.0% (obtained for Yellow Hıdır) and 17.5% (obtained for Summer Apple), while the average WSDM content was found to be as 14.53% for all local apple varieties. Similarly, the WSDM content was determined in the ranges of

Table 2 The fruit peel color of local apple varieties grown in Gumushane

Apple varieties	L values	a values	b values
Black belly apple	98.23	−20.17	55.85
Yellow belly apple	106.43	−20.41	54.84
Green belly apple	104.09	−21.12	56.48
Amasya marble	81.62	41.40	44.53
Arabian girl	77.76	21.94	45.85
Bey apple	103.39	−18.89	57.54
Bride apple	66.32	40.42	36.07
English apple	111.72	−15.33	60.03
Mahsusa	87.68	12.81	48.80
Chest apple	109.51	−15.30	56.26
Yellow hıdır	112.06	−14.64	58.52
Willow apple	109.01	−12.54	57.45
Tavşanbaşı	98.00	−18.72	50.93
Fatty apple	93.39	−9.95	54.92
Summer apple	95.39	−14.22	42.04
Local marble	79.12	41.99	39.56

13.0–14.8% for NJ55 Apple (Goffreda et al. 1995), 9.5–13.5% for the local apple varieties grown in Ünye (Bostan and Acar 2009) and 10.6–13.0% for Iron Ipple grown in Rize (Aygün and Ülgen 2009). It is seen that the WSDM content results reported in the previous studies and obtained for local apple varieties grown in Gumushane are compatible with each other.

As a result of taste analysis, it was seen that the local apple varieties grown in Gumushane have slightly tart, tart, sweet, slightly sweet, sour and acrid tastes (Table 1).

The fruit peel color was determined in L, a and b values (Table 2). L values, show the light transmittance, were in the range of 112.06–66.32. Yellow Hıdır and Bride Apple has the highest and the lowest L values, respectively. a, -a, b and –b values show the redness, greenness, yellowness and blueness, respectively. The redness was determined for five apple varieties which are Amasya Marble, Arabian Girl, Bride Apple, Mahsusa and Local Marble. In addition to these, it was seen that the greenness is dominant in the remaining 11 apple varieties (Summer Apple, English apple, Green Belly, Black Belly and Yellow Belly Apples, Bey Apple, Chest Apple, Willow Apple, Tavşanbaşı, Yellow Hıdır, and Fatty Apple). The most dominant red, green and yellow colors were obtained for Local Marble (a: 41.99), Green Belly Apple (a: −21.12) and English Apple (b: 60.03), respectively, while the light red, green and yellow colors were determined for Mahsusa (a: 12.81), Fatty Apple (a: −9.95) and Bride Apple (b: 36.07), respectively (Table 2). From the results it was concluded that the color of the evaluated 16 local apple varieties changed from yellow to dark yellow.

Chemical Compositions of Local Apple Varieties

According to the chemical analyses results, it was seen that the Chest Apple (1.57%) has the highest and Local Marble (0.60%) has the lowest ash contents (Table 3). In a study, in which the chemical compositions of some local apples, grown as a biological product, were evaluated, the ash content was determined in the range of 1.63–2.77% (Campeanu et al. 2009).

It is known that the pH of the local apples shows an alteration by the influence of ecological conditions, soil structure, watering, and feeding (Hulme and Rhodes 1970). As a result of pH assessment of the apple samples, it was concluded that Amasya Marble and Mahsusa has the highest (4.3) and the lowest (3.4) values, respectively (Table 3).

Table 3 Chemical compositions of local apple varieties grown in Gumushane

Apple varieties	Ash content (%)	pH	Titratable acidity (g/L)	Water content (%)	Reducing sugar (g/100 g)	Sucrose (g/100 g)	Total sugar (g/100 g)
Black belly apple	0.94	4.0	0.44	83.1	5.63	1.56	7.19
Yellow belly apple	1.06	4.1	0.45	84.2	5.85	2.14	7.99
Green belly apple	1.07	4.1	0.38	86.6	4.92	1.44	6.36
Amasya marble	0.93	4.3	0.41	81.9	4.68	2.43	7.11
Arabian girl	1.25	3.6	0.71	80.0	5.16	2.52	7.68
Bey apple	0.98	3.6	0.66	82.2	4.98	2.33	7.31
Bride apple	1.53	4.0	0.37	84.5	4.20	1.83	6.03
English apple	1.50	3.5	1.22	81.9	4.12	3.53	7.68
Mahsusa	0.75	3.4	1.36	83.3	4.64	1.36	6.00
Chest apple	1.57	3.6	1.04	83.9	4.05	2.82	6.87
Yellow hıdır	0.98	4.2	0.39	80.4	4.68	2.70	7.38
Willow apple	0.86	3.8	0.51	83.1	4.95	3.07	8.02
Tavşanbaşı	1.13	3.5	1.32	90.2	4.63	1.81	6.44
Fatty apple	1.23	3.6	0.73	82.7	5.14	2.69	7.83
Summer apple	1.37	3.6	0.62	89.4	6.05	2.23	8.28
Local marble	0.60	4.0	0.40	84.1	6.99	1.55	8.54
Average	1.11	3.8	0.69	83.8	5.04	2.25	7.29

Edizer and Bekar (2007) have evaluated the pH of the local apple varieties grown in Tokat and they have reported that the Jerusalem Artichoke has the highest (4.48) and Arabian Girl has the lowest (2.39) pH values.

Titratable acidity is used as an important tool to predict the taste of the apples (Harker et al. 2002). The decrease in the titratable acidity by increasing the pH value is an expected result. The highest titratable acidity was determined in Mahsusa as 1.36 g L^{-1} while Bride Apple has the lowest value as 0.37 g L^{-1} (Table 3). In Poland, the titratable acidity of six different apple juices was obtained in the range of 2.7–7.3 g L^{-1} (Markowski et al. 2009).

The highest and the lowest water contents were obtained as 90.2% and 80.0% for Tavşanbaşı and Arabian Girl, respectively (Table 3). In Romania the water content of seven different apple varieties was determined between %76.69 and %88.37 (Campeanu et al. 2009).

Sugar content is one of the most important features which is directly effective in the purchase of fresh fruits and in the determination of fruit quality. The climate, soil structure and the type and amount of nutrients have influence on the sugar content of the fruits. The majority of sugar in the apple varieties is composed of fructose and glucose known as reducing sugar while non-reducing sucrose constitutes a very little amount (Mordoğan and Ergun 2002). In the present investigation the highest and the lowest reducing sugar amount was found to be in Local Marble (6.99 g/100 g) and Chest Apple (4.05 g/100 g), the highest and the lowest sucrose amount was found to be in English Apple (3.53 g/100 g) and Mahsusa (1.36 g/100 g) and the highest and the lowest total sugar amount was found to be in Local Marble (8.54 g/100 g) and Bride Apple (6.03 g/100 g), respectively (Table 3). Total sugar, reducing sugar and sucrose amounts of Golden Delicious, Starking Delicious and Granny Smith apple varieties of MM106, MM111 and Çöğür rootstock grown in Erzincan plain were reported in the ranges of 9.48–12.78%, 7.39–10.43% and 1.69–2.30%, respectively (Ercişli and Güleryüz 2000).

Mineral elements have very important tasks in bones and teeth structure, nerve and muscle function, blood production, and transportation of oxygen. Apple is considered as a good source of mineral elements. A and C vitamins in apples create a set of salts by combining some elements such as potassium, calcium, magnesium and sodium. When organic moieties of these salts, in other words organic acids, are oxidized to provide energy in blood, the base components will remain. Thus, apple has positive effects on acid-base balance of blood (Özbek 1978). The contents of macro elements (Na, K, Ca and Mg) and micro elements (Fe, Cu, Zn and Mn) of the local apple varieties grown in Gumushane are given in Table 4. By evaluating 16 different apple varieties in terms of mineral element contents, it was concluded that potassium has the highest average value (7.31 mg/g) and its amount is maximum in Amasya Marble (9.61 mg/g), and minimum in Willow Apple (5.70 mg/g). This is an expected result since potassium is one of the most stored mineral elements in plants regardless of the kinds. On the other hand manganese has the lowest average value (0.10 mg/100 g) and its amount is maximum in Summer Apple (0.28 mg/100 g), and minimum in Amasya Marble, Mahsusa and Local Marble (0.05 mg/100 g). Nour et al. (2010) have determined the average Na, K, Ca, Mg, Fe, Mn, Zn, and Cu amounts of 15 different apple varieties in Romania as 3.763, 112.30, 4.433, 7.99, 0.283, 0.041, 0.191, 0.046/100 mg, respectively.

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

Apple variety	Na[a]	K[b]	Mg[a]	Ca[a]	Fe[a]	Cu[a]	Mn[a]	Zn[a]
Black belly apple	3.76	6.41	24.5	26.3	0.64	0.21	0.16	0.21
Yellow belly apple	2.86	7.67	32.4	60.7	0.64	1.94	0.20	0.10
Green belly apple	3.97	6.98	22.8	33.0	1.09	0.14	0.11	0.05
Amasya marble	2.64	9.61	23.4	41.1	0.60	0.19	0.05	0.05
Arabian girl	3.99	6.61	20.2	23.8	0.58	0.19	0.07	0.10
Bey apple	3.25	6.42	18.8	13.5	0.67	0.17	0.07	0.07
Bride apple	3.35	9.34	34.2	44.2	0.74	0.39	0.06	0.11
English apple	3.33	6.23	23.8	29.1	0.63	0.13	0.10	0.08
Mahsusa	3.04	6.60	19.2	47.5	0.55	0.19	0.05	0.02
Chest apple	3.31	8.57	14.1	37.3	0.71	0.15	0.08	0.10
Yellow hıdır	3.31	6.80	19.9	22.0	0.73	0.16	0.08	0.08
Willow apple	3.39	5.70	18.6	34.9	0.72	0.08	0.10	0.08
Tavşanbaşı	3.34	7.40	21.6	35.8	0.59	0.20	0.12	0.05
Fatty apple	3.71	6.40	24.8	24.0	0.69	0.24	0.07	0.17
Summer apple	5.62	8.06	61.0	70.0	3.05	0.32	0.28	0.37
Local marble	3.55	8.24	19.4	34.5	0.73	0.19	0.05	0.05
Average	3.53	7.32	24.92	36.11	0.84	0.31	0.10	0.11

[a]mg/100 g

[b]mg/g

Conclusions

In the presented study, the pomological and morphological characteristics and chemical compositions of local apple varieties grown in Gumushane including Summer Apple, English apple, Green Belly, Black Belly and Yellow Belly Apples, Amasya Marble, Bey Apple, Chest Apple, Mahsusa, Arabian Girl, Willow Apple, Tavşanbaşı, Yellow Hıdır, Local Marble, Bride Apple and Fatty Apple were investigated.

The pomological and morphological analysis results were obtained in the following ranges: fruit mass; 51.00–217.43 g, fruit width; 48.62–80.47 mm, fruit length; 45.11–67.64 mm, fruit stalk thickness; 1.51–2.61 mm, fruit stalk length; 13.62–21.48 mm, stalk pit depth; 6.70–17.51 mm, flower pit depth; 5.40–13.70 mm, seed house width; 12.17–23.04 mm, seed house length; 14.50–21.52 mm, water soluble dry matter content; 10.0–17.50 %, number of seeds; 2.03–6.53, and fruit firmness; 11.38–17.08 kg/cm^2. The flavor of the apples ranged from sweet to tart. The highest light transmittance (L) value (112.06) was observed in Yellow Hıdır. The most dominant red, green and yellow colors were obtained for Local Marble (a: 41.99), Green Belly Apple (a: −21.12) and English Apple (b: 60.03), respectively.

The chemical composition analysis results were determined in the following ranges: ash content; 0.60–1.57 %, pH; 3.4–4.2, titratable acidity; 0.37–1.36 g/L, water content; 80.0–90.2 %, reducing sugar; 4.05–6.99 g/100 g, sucrose; 1.36–3.53 g/100 g and total sugar; 6.03–8.54 g/100 g. The descending sort of the mineral element contents is K > Ca > Mg > Na > Fe > Cu > Zn > Mn.

The pomological, morphological or chemically obtained results demonstrated that the evaluated local apple varieties are important in terms of breeding. The obtained results also make essential to carry out detailed selection works of these local varieties from the point of fruit breeding. Some local apple varieties were found to be appropriate to the needs of the different markets. A variation has been observed in terms of fruit charm within the local apple varieties. The results of this study will shed light on similar future works and also will be beneficial to local communities. As a result of this study, the promising local apple varieties which begun to disappear are preserved and the most suitable varieties are offered to the farmers.

References

Akça Y, Sen M (1990) Van ve Çevresinde Yetiştirilen Mahalli Elma Çeşitlerinin Morfolojik ve Pomolojik Özellikleri Üzerinde Bir Araştırma. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Dergisi 1(1):109–128

Anonim (2012) http://faostat.fao.org

Anonim (2014) http://iys.inonu.edu.tr/webpanel/dosyalar/135/file/Gidalarda%20Renk%20Olcumu.pdf

Aygün A, Ülgen SA (2009) Rize'de Yetiştirilen Demir Elma (*Malus communis* L.) Çeşidinin Bazı Meyve Özelliklerinin Belirlenmesi. Tarım Bilimleri Araştırma Dergisi 2(2):201–205

Bostan ZS, Acar Ş (2009) Ünye (Ordu) ve Çevresinde Yetiştirilen Mahalli Elma Çeşitlerinin Pomolojik Özellikleri. Tarım Bilimleri Araştırma Dergisi 2(2):15–24

Campeanu G, Neata G, Darjanschi G (2009) Chemical composition of the fruits of several apple cultivars growth as biological crop. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 37(2):161–164

Edizer Y, Bekar T (2007) Tokat Merkez İlçede Yetiştirilen Bazı Yerel Elma (*Malus communis* L.) Çeşitlerinin Fenolojik ve Pomolojik Özelliklerinin Belirlenmesi. GOÜ Ziraat Fakültesi Dergisi 24(1):1–8

Ercişli S, Güleryüz M (2000) Farklı Anaçların Bazı Elma Çeşitlerinin Meyve Özellikleri Üzerine Etkisi. Turk J Agric For 24:533–539

Goffreda JC, Voordeckkers A, Mehlenbacker SA (1995) "NJ55" Apple. Hortic Sci 32(2):387–388

Güleryüz M, Ercişli S, Erkan E (2001) Erzincan Ovasında Yetiştirilen Bazı Elma Çeşitlerinin Meyve Gelişimi Dönemlerinde Meydana Gelen Fiziksel ve Kimyasal Değişimler ile Bunlar Arasındaki İlişkiler. Atatürk Üniversitesi Ziraat Fakültesi Dergisi 32(1):51–59

Harker FR, Marsh KB, Young H, Murray SH, Gunson FA, Walker S B (2002) Sensory interpretation of instrumental measurements 2: sweet and acid taste of apple fruit. Postharvest Biol Technol 24:241–250

Hulme AC, Rhodes JC (1970) Pome fruits. In: AC Hulme (Hrsg) The biochemistry of fruit and their products, vol 1. Academy Press, London-New York

İslam A, Bostan Z, Yılmaz E (2009) Trabzon İli Yomra İlçesinde Yetiştirilen Yomra Elmasının Pomolojik Özellikleri Üzerine Bir Araştırma. Tarım Bilimleri Araştırma Dergisi 2(2):107–110

Karaçalı İ. (1990). Bahçe Ürünlerinin Muhafazası ve Pazarlanması. *Ege Üniversitesi Ziraat Fakültesi Yayınları*, No: 494, Bornova-İzmir

Karlıdağ H, Eşitken A (2006) Yukarı Çoruh Vadisinde Yetiştirilen Elma ve Armut Çeşitlerinin Bazı Pomolojik Özelliklerinin Belirlenmesi. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi (J Agric Sci) 16(2):93–96

Kaya İ, İncekara N, Nemli Y (2004) Ege Bölgesi'nde Sebze Olarak Tüketilen Yabani Kuşkonmaz, Sirken, Yabani Hindiba, Rezene, Gelincik, Çoban Değneği ve Ebegümecinin Bazı Kimyasal Analizleri. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi (J Agric Sci) 14(1):1–6

Markowski J, Baron A, Mieszczakowska M, Płocharski W (2009) Chemical composition of French and Polish cloudy apple juices. J Hortic Sci Biotechnol, ISAFRUIT Special Issue, 68–74

Mordoğan N, Ergun S (2002) Golden ve Starking Elma Çeşitlerinin Şeker İçerikleri ve Bitki Besin Elementleri ile Olan İlişkileri. Ege Üniversitesi Ziraat Fakültesi Yayınları 39(1):103–110

Nour V, Trandafir I, Ionica ME (2010) Compositional characteristics of fruits of several apple (*Malus domestica* Borkh.) cultivars. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 38(3):228–233

Okcu M (2012) Gümüşhane İlinin Tarımsal Yapısı. Gümüşhane Üniversitesi Fen Bilimleri Enstitüsü Dergisi 2(2):93–103

Özbek S (1978). Özel Meyvecilik. *Çukurova Üniversitesi Ziraat Fakültesi Yayınları*, 128 s, Adana

Özcan M (2012). Bahçe Bitkileri Ders Notları. *Ondokuz Mayıs Üniversitesi Ziraat Fakültesi Yayınları*, 82 s, Samsun

Özrenk K, Gündoğdu M, Kaya T, Kan T (2011) Çatak ve Tatvan Yörelerinde Yetiştirilen Yerel Elma Çeşitlerinin Pomolojik Özellikleri. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi (J Agric Sci) 21(1):57–63

Pomeranz Y, Meloan CE (2002) Food analysis: theory and practice. 3rd edition

Şen SM, Bostan SZ, Cangi R, Kazankaya A, Oğuz Hİ (1992) Ahlat ve Çevresinde Yetiştirilen Mahalli Elma Çeşitlerinin Morfolojik ve Pomolojik Özellikleri. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Dergisi 2(2):53–65

Serdar Ü, Ersoy B, Öztürk A, Demirsoy H (2007) Saklı Cennet Camili'de Yetiştirilen Yerel Elma Çeşitleri. Türkiye V. Ulusal Bahçe Bitkileri Kongresi, s: 575–579, Erzurum

Ülkümen L (1938) Malatya'nın Mühim Meyve Çeşitleri Üzerinde Morfolojik, Fizyolojik ve Biyolojik Araştırmalar. Yüksek Ziraat Enstitüsü Çalışmaları, sayı: 65, Ankara

Ünal A (2011) Bahçe Tarımı-II. *Anadolu Üniversitesi, Açık Öğretim Fakültesi Yayını*, Ünite: 1,2, s:1–258