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ORIGINAL ARTICLE

Fruit Weight, Total Phenolics, Acidity and Sugar Content of Edible Wild Pear (*Pyrus elaeagnifolia* Pall.) Fruits

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Abstract Wild pear (*Pyrus eleagnifolia*) is a naturally grown species mainly in inner Anatolia and its edible small fruits are traditionally consumed by local peoples and are called "Ahlat" in Turkey. Its seedlings are also used as rootstock for commercial pear cultivars. In this study, we reported first time pomological characteristics and biochemical compositions in fruits of a wide number selected wild pears genotypes (*Pyrus eleagnifolia* Pall.) from inner Anatolia. The obtained results revealed that there were significant differences among wild pear genotypes for all analyzed parameters. Fruit weight, total phenolics, total acidity and total sugar contents of the fruits varied from 4.71 to 27.09 g, 42.79 to 119.14 mg GAE/100 g, 0.20 to 1.40 g/100 g and 8.36 to 19.31 g/100 g, respectively. Considering these values, it was concluded that naturally grown wild pears of Anatolia with their rich salubrious biochemical compounds could reliably be used as a food source for humans.

Keywords *Pyrus elaeagnifolia* · Wild pear · Sugar content · Total phenolics · Acidity

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Fruchtgewicht, Gesamt-Phenolgehalt, Säure- und Zuckergehalt zum Verzehr geeigneter Früchte der Wildbirne (*Pyrus elaeagnifolia* Pall. = Ölweidenblättrige Birne)

Zusammenfassung Die Ölweidenblättrige Birne kommt hauptsächlich im Inneren Anatoliens natürlich vor und ihre genießbaren, kleinen Früchte werden traditionell von den ortsansässigen Bewohnern verzehrt. Die Früchte werden in der Türkei „Ahlat" genannt. Ihre Sämlinge werden ebenfalls als Unterlagen für kommerziell angebaute Birnensorten verwendet. In dieser Untersuchung berichteten wir erstmals über pomologische Eigenschaften und biochemische Zusammensetzungen einer umfangreichen Anzahl an Früchten ausgewählter Wildbirnen-Genotypen (*Pyrus eleagnifolia* Pall.) aus dem Inneren Anatoliens. Die gewonnenen Ergebnisse zeigten, dass es zwischen den Genotypen der Wildbirne bei allen untersuchten Parametern signifikante Unterschiede gab. Das Fruchtgewicht, der

Gesamt-Phenolgehalt, die Gesamt-Säure und der Gesamt-Zuckergehalt der Früchte variierten jeweils zwischen 4,71 und 27,09 g, von 42,79 bis 119,14 mg GAE/100 g, von 0,20 bis 1,40 g/100 g und von 8,36 bis 19,31 g/100 g. Diese Werte lassen den Schluss zu, dass natürlich gewachsene Ölweidenblättrige Birnen aus Anatolien mit ihren gesunden, biochemischen Inhaltsstoffen zuverlässig als Nahrungsquelle für den Menschen genutzt werden könnten.

Schlüsselwörter *Pyrus elaeagnifolia* · Ölweidenblättrige Birne · Birne · Zuckergehalt · Gesamt-Phenolgehalt · Säure

Introduction

Anatolia is one of the origin centers of the wild pear (*Pyrus elaeagnifolia* Pall.) and called as 'Ahlat' in Turkish. The species shows high drought and cold resistance and therefore provides one of the most commonly used rootstocks for pear cultivars in Turkey (Ercisli 2004). The trees produce edible fruits that are eaten fresh or dried by local people's centuries. The fruits have splendid taste and aroma. Therefore, when they are placed in open cups at a corner, they give off a relieving smell with positive impacts on humans throughout the entire home. Because of the high drought resistance, the species can be used in landscape management for re-cultivation in arid regions as well (Buttner 2001). Local people in Turkey also brew the leaves. In some regions of the country, dried fruits are pestle and resultant coffee-like roasted powder is used in compote. Local people also consume wild pear fruits as syrup (Cansaran et al. 2007) and pickles (Yerliturk et al. 2008).

Recent rapid developments in food industry have oriented consumers, living in urban sections of the country and moved away from the local tastes, to look for old tastes, naturally grown fruits with intensive aroma and pleasing tastes (Ercisli and Orhan 2008; Yilmaz et al. 2009; Yildiz et al. 2010; Jurikova et al. 2011; Ercisli et al. 2012; Sengul et al. 2014). Such trends for natural products have also increased the demands for alternative medicinal plants and wild species. Therefore, biochemical compositions and health-impacts of those wild naturally grown species should reliably be determined and accurately be specified so that the people know about their positive impacts on their health. For instance, ripened wild pears constipate the consumers since the ripened fruits have a high water holding capacity. Thus, wild pears are most of the time used by the local people to combat diarrhea (Baytop 2004). Determination of biochemical compositions of edible wild species will allow the food industry to use such species as additives to develop new foodstuff. Information about their bioactive compounds will also let the consumers to know whether they can be used as direct foodstuff (Yilmaz et al. 2009; Jurikova et al. 2012).

Modern objectives in plant breeding may be achieved by the evaluation of traits amongst genetic resources. Molecular markers are used already but these methods are expensive and needs sophisticated laboratory facilities. More over in wild pear, because of sufficient varieties and easy application, morphological and biochemical indexes might be appropriate for classification. Morphological and biochemical characters are the first choice used for describing and classifying the germ plasm. In addition, morphological characteristics sometimes have correlation or are associated with characteristics that are difficult to evaluate such as disease susceptibility. Therefore, they may be useful as markers in breeding programs (Koc and Bilgener 2013; Keles et al. 2014; Radivojevic et al. 2014).

There is no study on morphological and chemical characterization of wild pear genotypes (*Pyrus eleagnifolia* Pall.) in literature. Therefore, in this study, pomological and biochemical properties of 31 wild pear genotypes grown in Kayseri province are characterized and compared.

Material and Methods

Fruit samples were collected from 31 genotypes of wild pears representing the local populations and naturally grown in Kayseri and surrounding districts. Initially the sites with widespread wild pears were determined through site visits to Kayseri Central District, Talas, Kocasinan, Melikgazi, Hacilar, Develi, Yesilhisar, Yahyali, Tomarza, Sariz, Pinarbasi, Akkisla, Sarioglan, Ozvatan, Felahiye and Incesu districts. The districts and altitudes of sampling sites are provided in Table 1. (Fig. 1)

Beside some pomological characteristics (fruit weight and soluble solid content), some important biochemical analyses (total phenolics, total acidity and total sugars) were also performed in fruits of wild pear samples within the scope of this study. For all analysis, a total of 40 fruits per genotype were used. Fruit weight were measured by using a digital balance with a sensitivity of 0.001 g. Soluble solid content (SSC) of fruit juice were recorded with a hand-refractometer.

Total phenolics of different wild pear samples were determined by subjecting the fruit extracts to 1 h reaction in an alkaline ambient with Folin Ciocalteau reactive and reading the absorbance of colorful solution at 765 nm wave length. Total phenolics was expressed in mg gallic acid equivalent/100 g sample in fresh weight base (Singleton and Rossi 1965).

Fruit extracts were taken in a magnetic stirrer with water. The extract was then filtered and subjected to potentiometric acid-base titration with adjusted NaOH solution. Titra-

Table 1 Location and altitude where wild pear genotypes found

Genotypes	District	Altitude (m)
38-AK-001	Akkisla	1620
38-AK-002	Akkisla	1511
38-AK-003	Akkisla	1422
38-DE-001	Develi	1885
38-DE-003	Develi	1828
38-DE-004	Develi	1829
38-DE-005	Develi	1766
38-SA-001	Sariz	1526
38-SA-002	Sariz	1531
38-SA-004	Sariz	1545
38-SA-005	Sariz	1541
38-SA-006	Sariz	1541
38-SA-008	Sariz	1545
38-SA-009	Sariz	1553
38-SA-011	Sariz	1574
38-SA-013	Sariz	1562
38-SA-015	Sariz	1553
38-TA-002	Talas	1516
38-TA-004	Talas	1727
38-TA-005	Talas	1826
38-TA-008	Talas—Koscagiz	1568
38-TA-010	Talas—Koscagiz	1611
38-TA-011	Talas—Koscagiz	1611
38-TA-012	Talas—Koscagiz	1598
38-TA-014	Talas—Koscagiz	1549
38-TA-015	Talas	1447
38-TA-016	Talas	1455
38-TO-001	Tomarza	1458
38-TO-002	Tomarza	1447
38-TO-003	Tomarza	1488
38-TO-004	Tomarza	1465

tion acidity of wild pear samples was expressed in g mallic acid equivalent/100 g sample (Cemeroglu 2007).

Total sugar contents of fruit samples were determined in accordance with Lane—Eynon method. Samples were subjected to acid hydrolysis and acid neutralization and then clarified with Carrez solution. The resultant clear solution was subjected to titration with Fehling solution. Glucose solution was used as the standard and sugar contents of the samples were expressed in g glucose equivalent/100 gr samples (Cemeroglu 2007).

All analyses were performed four times and the results are mean ± SD of 40 fully matured wild pear fruit samples. The results were expressed on a fresh weight basis. Analysis of variance (ANOVA) was performed to compare the sample analysis at 5% confidence level.

Results and Discussion

Results revealed that wild pear genotypes had a wide range of variation in various characteristics.

Pomological Characteristics

Pomological analyses over the fruits of 31 genotypes of wild pears revealed the highest fruit weights were observed in genotypes of 38-AK-003 (27.09 g), 38-TO-004 (25.04 g) and 38-SA-005 (16.15 g) and the lowest fruit weights of genotypes were in 38-TA-002 (4.71 g), 38-SA-013 (5.84 g) and 38-SA-009 (6.38 g) genotypes, respectively (Table 2). Since wild pears have a narrow spreading area over the world, there is no study about wild pears related to fruit weight. Therefore, it was not came across with any studies in literature investigating pomological characteristics of wild pears. Such a case makes the present study as the first study worldwide about *Pyrus eleagnifolia*.

With regard to soluble solid content (SSC), the highest values were obtained in fruits of genotypes 38-TA-016 and 38-SA-009 (20.00%) and the lowest values were observed in 38-TA-004 and 38-TO-001 genotypes (12.00%). Rest of the genotypes had a SSC between 13.00 and 18.00% (Table 2). Chemical properties of fruits such as total soluble solids may provide proximal information to the consumers in terms of recognizing a more nutritious fruit. Our results are well supported by the findings of Sanchez et al. (2003), Chen et al. (2007) and Hussain et al. (2013) who reported the SSC of pear cultivars from 6 to 18%. Fourie et al. (1991) found SSC between 13.98 and 17.63% among 6 pear cultivars grown in South Africa.

Total Phenolics

Total phenolics of the fruits samples of 31 wild pear genotypes was determined and results are provided in Table 2. With regard to total phenolics, the highest values were observed in 38-TA-016 (119.14 mg GAE/100 g), 38-SA-001 (109.53 mg GAE/100 g) and 38-AK-001 (108.02 mg GAE/100 g) while the lowest values were observed in fruits of 38-DE-005 (42.79 mg GAE/100 g), 38-TO-001 (47.45 mg GAE/100 g), 38-TO-002 (49.43 mg GAE/100 g) and 38-TA-015 (53.99 mg GAE/100 g) genotypes respectively (Table 2). Marinova et al. (2005) investigated the total phenolics of some fruits grown in Bulgaria and reported the total phenolics as 124 mg/100 g in pear and 99–125 mg GAE/100 g in apple, 50 mg GAE/100 g in apricot, 78 mg GAE/100 g in sweet cherry and 59 mg GAE/100 g in fig. Our total phenolics results ranged within these commercial important fruits and we can conclude that wild pear is also a rich source of total phenolics. Hussain et al. (2013) reported total phenolics among pear cultivars between 29 and 38 mg GAE/100 g. Recent attention should also be paid to the phenolics compounds of fruits because a higher absorption of phenols leads, among other effects, to a reduction in heart disease and lower cholesterol levels (Craig and Beck 1999). Phenolics also reported had preventive impacts on gene

Fig. 1 Wild pear (*Pyrus eleagnifolia* Pall.) trees (*top left and right*), non mature (*bottom left*) and mature fruits (*bottom right*)

mutation and formation of cancer cells (Tanaka et al. 1998). Considering the positive impacts on nutritional physiology, phenolics compounds are also called as bioflavonoids and considering the regulatory impacts on permeability of micro circulation system and blood pressure and they are also called as P factor (Permeability Factor) or P vitamin [Cemeroglu 2007, Saldamli 2007].

Recent studies have shown that the skin of pears contains at least three to four times as many phenolics phytonutrients as the flesh. These phytonutrients include antioxidant, anti-inflammatory flavonoids, and potentially anti-cancer phytonutrients like cinnamic acids. The skin of the pear has also been shown to contain about half of the pear's total dietary fiber (Schieber et al. 2001; Sanchez et al. 2003; Chen et al. 2007; Salta et al. 2010). Hussain et al. (2013) reported total phenolics among pear cultivars between 29 and 38 mg GAE/100 g. Ozturk et al. (2009) reported total phenolics in the fruits of cv. Santa Maria (43.8 mg GAE/100 g) and cv. Deveci (39.3 mg GAE/100 g). In another study, total phenolics content in pear cultivars was reported from 32.6 to 47.3 mg/100 g in inner Anatolia (Karadeniz et al. 2005). Comparing with these studies, we can conclude that most of the wild pear genotypes had higher total phenolics content than commercial pear cultivars.

Titratable Acidity

Relatively high variations were observed in titratable acidity values of the wild pear fruits. The highest values were observed in fruits of 38-SA-013 (1.40 g/100 g) and followed by 38-TA-008 (1.10 g/100 g) and 38-TA-010 (1.02 g/100 g) genotypes; the lowest values were observed in fruits of 38-AK-001 (0.20 g/100 g), 38-TA-016 (0.25 g/100 g) and 38-TA-002 (0.30 g/100 g) genotypes (Table 2). Pears are known as natural non-acidic foods and include malic, citric, tartaric and oxalic acids. Acidity of fruits plays a vital role in health as well as canning industry. Chen et al. (2007) reported titratable acidity between 0.10 and 0.46 pear cultivars grown in China which indicating higher values than wild pears. Hussain et al. (2013) reported titratable acidity among pear cultivars between 0.12 and 0.26 %.

Total Sugar Contents

Total sugar contents of the fruit samples varied between 8.36 g/100 g (38-DE-005) and 19.31 g/100 g (38-TA-016) among the genotypes. The rest of the genotypes had total sugar contents between 9 and 14 g/100 g (Table 2). Sugar contents of fruits are also significant attributes in human

Table 2 Pomological and characteristics of *P. eleagnifolia* genotypes

Genotypes	Fruit weight (g)	SSC (%)	Total phenolics (mg/100 g)	Total acidity (g/100 g)	Total sugar (g/100 g)
38-AK-001	7.57±0.98	17.00±0.46	108.02±6.24	0.20±0.00	10.98±0.52
38-AK-002	7.69±1.67	14.00±0.60	67.53±11.45	0.61±0.01	13.78±0.60
38-AK-003	27.09±6.57	14.00±0.24	56.82±11.09	0.53±0.01	11.67±0.28
38-DE-001	10.96±2.33	12.00±1.00	101.24±5.10	0.36±0.02	8.68±0.01
38-DE-003	15.15±2.77	16.00±0.45	98.74±4.77	0.77±0.08	12.66±0.25
38-DE-004	7.95±1.40	15.00±0.24	103.82±3.95	0.59±0.01	11.85±0.72
38-DE-005	7.06±1.50	15.00±1.10	42.79±8.40	0.80±0.21	8.36±0.02
38-SA-001	7.89±1.73	18.00±0.29	109.53±12.16	0.84±0.27	11.09±0.45
38-SA-002	8.38±0.01	18.00±0.71	71.70±7.28	0.64±0.01	14.95±0.92
38-SA-004	9.83±1.68	17.00±0.38	63.87±3.53	0.53±0.02	14.89±0.10
38-SA-005	16.15±4.09	15.00±0.51	107.32±8.92	0.61±0.03	12.66±0.34
38-SA-006	11.47±1.72	17.00±0.73	59.67±7.39	0.82±0.01	14.06±0.15
38-SA-008	7.26±1.46	16.00±0.76	70.75±0.88	0.56±0.03	14.07±3.07
38-SA-009	6.38±1.24	20.00±0.61	89.94±0.40	0.71±0.01	13.82±1.06
38-SA-011	9.99±1.80	16.00±0.65	65.92±0.80	0.58±0.01	12.63±0.04
38-SA-013	5.84±0.71	18.00±0.26	74.67±10.12	1.40±0.01	13.05±0.06
38-SA-015	10.72±2.52	15.00±0.45	60.86±1.53	0.62±0.01	11.32±0.32
38-TA-002	4.71±0.86	18.00±0.60	73.18±7.60	0.30±0.02	12.89±0.21
38-TA-004	8.85±1.90	12.00±0.80	56.43±8.93	0.32±0.01	9.81±0.25
38-TA-005	11.62±1.57	15.00±0.34	93.80±7.20	0.51±0.00	11.20±0.35
38-TA-008	10.05±2.08	16.00±0.20	66.28±11.48	1.10±0.01	12.86±1.58
38-TA-010	10.26±2.12	13.00±0.26	94.59±7.24	1.02±0.04	9.02±0.08
38-TA-011	13.46±2.21	14.00±0.32	92.55±3.31	0.84±0.01	11.57±0.17
38-TA-012	13.07±2.91	13.00±0.42	63.75±9.05	0.61±0.08	13.37±0.51
38-TA-014	10.07±1.03	13.00±0.30	102.14±11.24	0.51±0.02	9.63±0.11
38-TA-015	7.90±1.70	18.00±0.58	53.99±0.96	0.50±0.00	14.64±2.46
38-TA-016	6.57±0.82	20.00±0.86	119.14±0.40	0.25±0.00	19.31±2.47
38-TO-001	6.72±0.63	12.00±0.40	47.45±7.97	0.33±0.00	11.43±0.73
38-TO-002	7.44±1.72	15.50±0.24	49.43±11.38	0.48±0.06	13.18±0.08
38-TO-003	11.49±2.28	18.00±0.70	83.63±8.25	0.70±0.05	12.99±0.49
38-TO-004	25.04±3.77	15.00±0.14	65.99±8.51	0.49±0.01	10.27±1.03

nutrition. Fourie et al. (1991) found total sugar between 8.62 and 12.09% among 6 pear cultivars in South Africa. In this case, wild pears exhibited higher sugar contents than commercial pears. Karadeniz (1999) showed total sugar contents between 4.94 and 10.91 among 7 commercial pear cultivars grown in Turkey.

Conclusion

The present study was the first report on wild pears and found to be significant in providing the important pomological and biochemical compositions of naturally grown wild pears, *Pyrus eleagnifolia* commonly consumed by local people and putting forward the nutritional values and the positive impacts of such attributes on human health. Significant variability was found for overall fruit characteristics tested in the study. The present study indicated that the wild pear is rich source of phenolics demonstrating its potential use as functional foods.

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