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Determination of some chemical characteristics and total antioxidant capacity in apple varieties grown in Posof/Ardahan region

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Abstract

In this study, total phenolic content, antioxidant capacity, total anthocyanin content and total ascorbic acid content (in flesh+peel) of the 7 apple cultivars grown in Posof/Ardahan were measured. The total phenolic content of the three apple cultivars was higher than other cultivars. “Posofkırmızısı”, “Sarı safran” and “Paşa” apple cultivars had the highest total phenolic contents (239.22, 228.81 and 222.71 mg of gallic acid equivalents/100 g of flesh+peels, respectively). Results showed that fresh apple had the highest levels for antioxidant capacity (90.32 and 114.23 μ mol of vitamin C equivalents/g of flesh+peel) and total anthocyanin content (30.07 to 71.49 mg/100g), whereas lower levels were found for ascorbic acid in flesh+peels. Results covered a narrow range: 17.18–26.83 mg/100g for ascorbic acid content in flesh+peels weight of apple cultivars. As a result, that these apple cultivars have high total phenolic value and antioxidant capacity in flesh+peels. For this reason, it is suggested for consume with their peels.

Keywords: Apple, Total phenolic, Total antioxidant, Anthocyanin, Ascorbic acid

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Introduction

Apple is a member of the *Malus* genus of the family of Rosaceae. Anatolia is one of the natural spread area of apples informed the 48 species that spread the different gene centers (Europe, the Himalayas, China, Japan, Korea and North America) (Dziubiak 2004; Ercişli 2004; Arabacı and Sevindik 2014). The apple varieties given our research are local apple varieties that propagated with grafting by local people in Posof/Ardahan region. Apple is an important fruit in terms of human health is rich in phenolic compounds and antioxidant substances (Arabacı and Sevindik 2014; Chen and Chen 2013; Vauzouret al. 2010; Williams et al. 2004). Apples are quantitatively the most consumed fruits in several countries in Europe and America. (Claire Kevers at al 2011). Apples are a good source of phenolic compounds because their consumption is widespread, and they are available in the market throughout the year. (Claire Kevers at al 2011, Wolfe et al. 2003, Eberhardt et al. 2000). In a fruit, the amount of phenolic contents can vary according to the growth period, the year of harvest, the geographic location, the storage conditions, and most importantly, genetic variation. (Claire Kevers at al 2011; Jiang et al. 2006; McGhie et al. 2005; Rossle et al. 2010; Wojdylo et al. 2008). The total extractable phenolic content has been ranged from 110 to 357 mg/100 g of fresh apple (Eberhardt et al. 2000; Podsedek et al. 2000; Wolfe et al. 2003).

One of the antioxidant is ascorbic acid, the most abundant in fruits and vegetables. Ascorbic acid in the apple is lower compared with other fruits (Arabacı and Sevindik 2014). Ascorbic acid content is reported as 2-30 mg / 100g,

varies according to the cultivars of apple (Fisher 1999; Mapson 1970; Schuphan 1956). The phenolics were higher responsibility than Vitamin C for the antioxidant activity (Wolfe et al. 2003). At the same time, the content of total phenolics or others often do not directly reflect the total antioxidant capacity in fruits (Lee et al. 2003)

The aim of this research was determination of the total phenolics, total anthocyanins ascorbic acid content and total antioxidant activity of local apple varieties in Posof/Ardahan region. The obtained results can be used in the registration process of these local varieties and may be taken into consideration in the selection of parents in breeding programs.

Materials and Methods

Fruit Material

Seven varieties of apples (“Posof kırmızısı”, “Sarı safran”, “Paşa”, “Kaburgalı”, “Uruset”, “Sütelnası” and “Beyazalma”) were obtained from the Posof/Ardahan region. The fruits were collected on the harvest time and used for analysis. For the study apple fruits were not stored. Samples were transported to Isparta in icebox for analysis after harvested and the apples were analyzed directly.

Methods

In experiment, 3 samples were prepared for each cultivar. Total phenolic were detected with Folin-Ciocalteu assay. 10 g flesh+peels were centrifuged at 6000 rpm after homogenized in 40 ml ethanol solution. After, diluted (1/10) 1000 μ l folin-ciocalteu and 800 μ l Na_2CO_3 solution was

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added upon supernatant. After 2 h incubated examples were read at 750 nanometer wavelength in spectrophotometer. Water-ethanol mixture was used as blank. Gallic acid is used as a standard in the calculation (Arabacı and Sevindik 2014)

For total anthocyanin analysis, 10 g flesh+peels were homogenized in methanol solution that 1% HCL included. Samples were filtered with filter paper after a night standing. Supernatant were incubated in tampon solution (pH 1.0 and pH 4.5). Samples were read against the blank at 530 and 700 nanometer wavelengths. Results were calculated using siyanidin- 3-galactoside molar absorbtivit coefficient (Arabacı and Sevindik 2014)

For ascorbic acid analysis, fruit juice samples were obtained by pureed and filtered. Samples were homogenized by centrifuge. 400 µL oxalic acid (0.4% 0.4) and 4.5 ml 2,6-diklorofenolindofenol solution were added upon supernatant. Data were read against the blank at 520 nanometer wavelength in spectrophotometer (Arabacı and Sevindik 2014).

Antioxidant capacity was determined using DPPH method. Fruit juice samples were obtained by pureed and filtered. Samples were homogenized by centrifuge. 950 µl 0.1 N DPPH (1,1-diphenyl-2-picrylhydrazyl) solution was added upon 50 µl supernatant. Then it was read against the blank at 515 nm wavelength spectrophotometer (Suils et al. 2000, Bakhshian and Arakawa 2006; Rezaei et al. 2013, Arabacı and Sevindik 2014).

Statistical Analysis

In this research, Data were checked for normal distribution that is the precondition of parametric tests. Normal distribution and homogeneity of variance were checked by Anderson-Darling test and Bartlett's Chi-square test respectively. The difference between the average rank of the varieties were analyzed with the Kruskal-Wallis test due to abnormal distribution. Differences between varieties were analyzed by Bonferroni-Dunn multiple comparison test. Statistical analyzes were performed using Minitab 16 software package.

Results and Discussion

In this research, the total phenolic, anthocyanin and ascorbic acid contents and antioxidant activity of the flesh+peel of the seven apple varieties were determined

(Table 1). The Kruskal-Wallis test was applied to data. The differences between the average rank of the varieties are statistically significant ($p < 0.01$). The Bonferroni-Dunn test was applied to differences between the average ranks of the varieties and shown in Table 1. The phenolic content was found to vary from 126.42 to 239.22 mg/100 g according to the variety.

The total phenolic contents of “Posofkirmızısı” and “Sarı şafran” varieties were highest at 239.22 and 228.81 mg of gallic acid equivalents/100 g respectively (Table 1, Figure 1). These values were significantly different. Other cultivars were followed by 222.71 mg/100g for “Paşa”, 190.56 mg/100g for “Kaburgalı”, 155.66 mg/100g for “Uruset”, 140.20 mg/100g for “Sütelması” and 126.42 mg/100g for “Beyazelma” cultivars (Table 1, Figure 1). The total phenolic contents of the “Beyazelma” were significantly lowest than the other all varieties. Different researchers were informed the results for total phenolic in apple. Our data was similar this results (Vrhovsek et al. 1996; 66-212 mg/100 g, Kevers et al. 2011; 140 to 447 mg/100 g, Wolfe et al. 2003; 159 to 119.0 mg/100g, Arabacı and Sevindik 2014; 46.9 to 112.2 mg/100g).

Total anthocyanin contents of “Kaburgalı” were highest at 71.50 mg/100g, followed by “Beyazelma” and “Uruset” varieties (63.21 mg/100g and 58.28 mg/100g respectively) (Table 1, Figure 2). These value differences between “Kaburgalı” were significant. “Sarı şafran”, “Paşa” and “Posofkirmızısı” varieties were followed by others (34.56 mg/100g, 33.32 mg/100g and 32.44 mg/100g respectively) (Table 1, Figure 2). The differences between these three varieties were significant. Different researchers were found results that wide ranged. Arabacı and Sevindik 2014 were informed from 0.5 to 49.1 mg/100g for total anthocyanin amount of apple peels but, only one apple variety has anthocyanin (35.9 mg/100g for red colored flesh Uruset). Wolfe et al. (2003) was reported from 2.1 to 26.8 mg of cyanidin 3-glucoside equivalents/100 g of peels. Rababah et al. (2005) was determined as 9.2 mg/kg of apple. Our data was similar this results. According to some researchers, the amount of anthocyanin is varies according to peel color of fruits. And this depends on the presence of cyanidin 3-galactoside that makes the peel red color (Wolfe et al. (2003); Awad and Jager 2000).

Table 1. Total phenolic and anthocyanin, ascorbic acid and free radical activity of apple cultivars

Variable	Total Phenolic (mg of gallic acid equivalents/100 g)		Total Anthocyanin (mg/100g)		Antiokeidant Activity (µmol of vitamin C equivalents/g)		Ascorbic Acid (mg/100g)	
	Mean	Rank means	Mean	Rank means	Mean	Rank means	Mean	Rank means
Kaburgalı	190,56±0,12	11 D	71,50±0,18	20A	90,32±0,00	2 G	17,18±0,13	2 F
Posofkirmızısı	239,22±0,10	20 A	32,44±0,10	5F	114,23±0,01	20 A	19,93±0,07	12,3 C
Uruset	155,66±0,12	8 E	58,28±0,15	14 C	110,72±0,01	17 B	17,69±0,14	5 E
Paşa	222,71±0,21	14 C	33,32±0,05	8E	104,41±0,03	5 F	19,77±0,04	8 D
Sütelması	140,20±0,26	5 F	30,07±0,09	2G	106,32±0,04	8 E	19,88±0,01	12,7 C
Beyazelma	126,42±0,03	2 G	63,21±0,05	17B	107,80±0,03	11 D	26,83±0,11	20 A
Sarı şafran	228,81±0,08	17 B	34,56±0,03	11 D	109,68±0,00	14 C	24,40±0,03	17 B

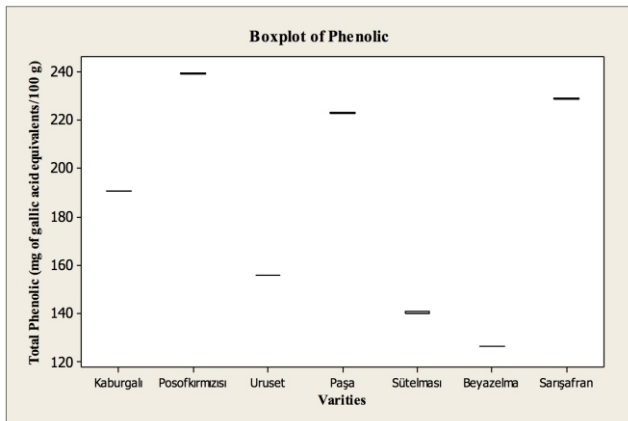


Figure 1. Boxplot of Phenolic (Means and SE Mean)

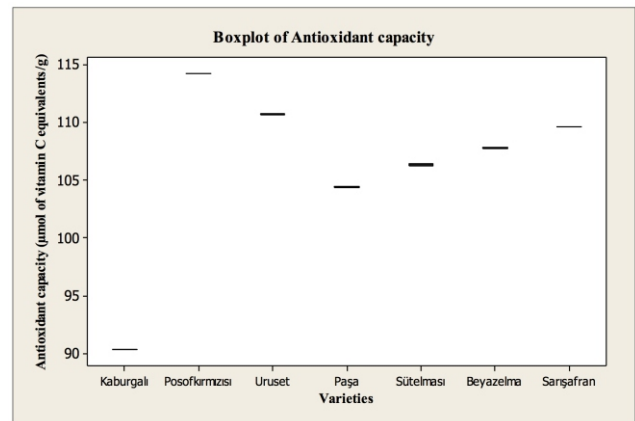


Figure 3. Boxplot of Antioxidant capacity (Means and SE Mean)

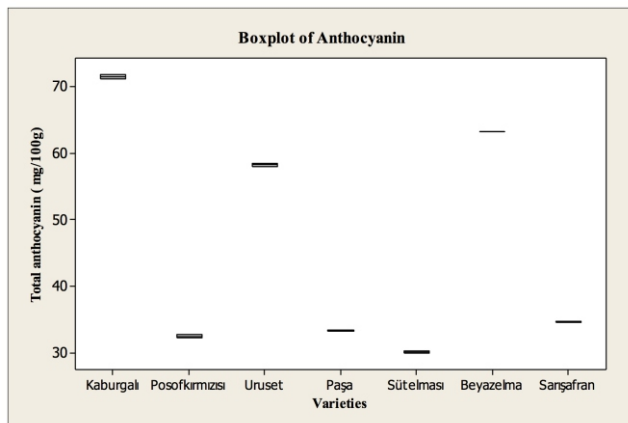


Figure 2. Boxplot of Anthocyanin (Means and SE Mean)

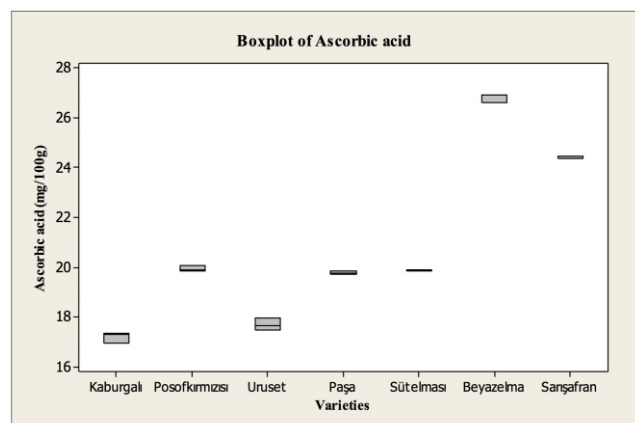


Figure 4. Boxplot of Ascorbic acid (Means and SE Mean)

In this research, ascorbic acid contents of apple varieties were shown in Table 1 and Figure 3. “Beyazelma” and “Sarı şafran” varieties were highest amount of ascorbic acid (26.83mg/100g and 24.40 mg/100g respectively). These values were significantly different. Other cultivars were followed by 19.93 mg/100g for “Posofkirmızı”, 19.88 mg/100g for “Sütelaşı”, 19.77mg/100g for “Paşa”, 17.69 mg/100g for “Uruset” and 17.18mg/100g for “Kaburgalı” (Table 1, Figure 3). The differences between these four varieties were significant and significant differences are between these four varieties and the varieties which has the highest value (“Beyazelma” and “Sarı şafran”). Different researchers were informed the results for total phenolic in apple. Our data was similar this results (Szeto et al. 2002; 60 mg/100g, Arabacı and Sevindik 2014; 5.2 to 17.2 mg/100g, Kevers et al. 2011; 11.6 to 35.3 mg/100g, Gardner et al. 2000; 3.9 mikrom, Lee et al. 2003; 9.0 to 16.6 mg/100g, Miller et al 1997; 51 µmol/litre of juice). At the same time, our data were higher than many other researchers reported. The reason for this is believed to be genetic variations and effects of growth area conditions.

The antioxidant activity of “Posofkirmızı” was highest

at 114. µmol of vitamin C equivalents/g, followed by “Uruset”, “Sarı şafran”, “Beyazelma”, “Sütelaşı” and “Paşa” varieties (110.72, 109.68, 107.80, 106.32 and 104.41 µmol of vitamin C equivalents/g respectively) (Table 1, Figure 4). These values were significantly different. The antioxidant activity of the “Kaburgalı” (90.32 µmol of vitamin C equivalents/g) were significantly lowest than the other all varieties. Different researchers were informed the results for total phenolic in apple. Our data was similar this results (Szeto et al. 2002; 6300 4200 µmol/kg fresh wet wt, Arabacı and Sevindik 2014; 21.7-57.8%, Kevers et al. 2011; 1101-4917 µmolTE/100 g FW, Van der Sluis et al. 2001; IC50: 5.8-8.0 g of fw/L, Lee et al. 2003; 116.22 mg of VCEAC/100 g, Rababah et al. 2005; 17.7 mM TE/kg).

Conclusion

As a result, that these local apple cultivars have high total phenolic, anthocyanin and antioxidant capacity in flesh+peels. It is known, positive effect on human health of these substances. For this reason it is suggested for consume with their peels.



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