IJAFLS
e-ISSN: 2602-4381

International Journal of Agriculture, Forestry and Life Sciences

Original Article | Open access | Int J Agric For Life Sci (2021) 5(2): 184-188

Fruit morphological and nutritional characteristics of different *Rosa pimpinnelifolia* genotypes

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Abstract

Wild edible fruits have been gained more popularity more recently due to their higher human health related compounds and unique aroma characteristics. The genus *Rosa* includes over 30 species and among them *Rosa pimpinellifolia* has distinct plant and fruit traits and the studies on this specie in literature is very limited. In this study, some fruit morphological and nutritional characteristics of six *R. pimpinellifolia* plants naturally grown in Ilica district of Erzurum province have been studied. Results exhibited that genotypes differed each other for most of the morphological and nutritional characteristics. The six genotypes showed fruit weights and flesh ratio between 1.88-2.21 g and 81.10-90.83%, respectively. Total anthocyanin, vitamin C and total phenolic content of the six *R. pimpinellifolia* genotypes ranged from 3.74-5.02 mg cyanidin-3-glucoside, 37-53 mg per 100 g fresh weight, 1018-1407 mg gallic acid equivalent (GAE) per 100 g fresh weight, respectively. Antioxidant activity was found between 10.11-13.86 µmol Fe (II)/g fresh weight among genotypes. Results indicate potential use of fruits of *R. pimpinellifolia* in food industry in future.

Keywords: *Rosa pimpinellifolia*, morphological and biochemical content, diversity

Introduction

Plants in particular wild edible ones are genetically very diverse group and found different parts of the World and accepted an important part of human history used for nutrients and health care for centuries. They have been using currently mainly as food, herbal medicine and ornamental (aesthetic) purposes (Kaliora and Dedoussis, 2007). The use of wild edible plants including *Rosa pimpinellifolia* have been promoting by World Health Organization due to their local availability, cheapness and effectiveness. During last decade scientific studies have been increased to determine nutritional composition and therapeutic activity of different wild edible plants (Sommano et al., 2013; Alam et al., 2020). The studies showed that consumption of those plants had positive effect on human diet and health indicating wild edible plants rich sources of antioxidant compounds such as phenolics, anthocyanins, ascorbic acid etc. (Sommano et al., 2013; Alam et al., 2020).

Rosa pimpinellifolia is one of the most important rosehip species whose awareness and importance has increased in recent years in Turkey (Ercisli, 2005, Kan, 2021). It is widely found in Eastern and Northeastern Anatolia region in Turkey and had distinct variable black fruit color. It is more populated in particular in area of Bayburt, Erzurum and Gümüşhane in Eastern and Northeastern Anatolia (Ercişli 2005). In these regions *Rosa pimpinellifolia* is known by different local names. For example, it is called "Şilan" in Siirt, "Sarıgül" in Konya, "Kara kuşburnu" in Erzurum and "Koyun gözü" in Bayburt, Gümüşhane and Erzincan provinces (Korkmaz and Ozcelik, 2015). Due to its black color, it is generally known as black rosehip among the people in the other growing areas in Turkey (Macit and Köse, 2015).

Cite this artile as:
Karatas, N. (2021). Fruit morphological and nutritional characteristics of different Rosa pimpinnelifolia genotypes. Int. J. Agric. For. Life Sci., 5(2): 184-188.
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Received: 24.10.2021 **Accepted:** 22.12.2021 **Published:** 25.12.2021
Year: 2021 **Volume:** 5 **Issue:** 2 (December)
Available online at: http://dergipark.gov.tr/ijafls

For a long time, fruits and roots of *Rosa pimpinellifolia* have been used in traditional medicine in the treatment of digestive and stomach ailments or bloating, hemorrhoids, cough and urinary infections. Its roots are also used as a natural dye (Ercisli 2005).

Rosa pimpinellifolia differs from the other rosehip species in terms of fruit characteristics and root structure. In general marmalade and jam obtained from fruits of different *Rosa* species but marmalade and jam cannot be obtained from the fruit of this species. Instead of marmalade and jam, its fruits and roots commonly used as herbal tea (Ercişli 2005). Compared to the other *Rosa* species, it spreads in a narrower area and resistant to pest and diseases. The distribution of the species in Turkey is 1200-2750 m (Ercişli 2005; Korkmaz et al. 2013). *Rosa pimpinellifolia* is also an aesthetic *Rosa* species with narrow spread and white flowers.

The aim of this study to determine some important fruit morphological and nutritional characteristics of six *R. pimpinellifolia* plants.

Materials and Methods

Plant material

The plant material naturally found in Ilica district of Erzurum province at the altitude of 1800 m. Fully maturated fruits were harvested at 2018 year from different parts of shrubs in *R. pimpinellifolia*. Harvested fruits were brought to laboratory in cold chain.

Morphological characteristics

Fruit weight and fruit flesh ratio are important fruit morphological characteristics of *Rosa* species. Fruit weight of six genotypes was measured by using 0.01 g electronic balance on 50 fruit per genotype. Fruit flesh ratio was determined on 50 fruits per genotype as well by using fruit weight-seed weight/fruit weight x 100 formula.

Nutritional composition

Sample preparation and extraction

The harvested fruits of six genotypes *R. pimpinellifolia* stored at -80 ºC until further analysis. During the analysis, the frozen fruits were taken and thawed to 24-25 ºC. Later, fruit samples were homogenised and a single extraction procedure (taking 3 g aliquots transferred inside tubes and extracted for 1 hour with 20 mL buffer including acetone, water (deionized), and acetic acid (70:29.5:0.5 v/v) (Singleton and Rossi, 1965).

Extraction of sugars

For individual sugar determination a mix (five grams of samples plus metaphosphoric acid, 2.5%) used. After that homogenates centrifuged at 10000 rpm for 10 min then filtered into HPLC vials. All samples and corresponding standard injection were repeated three times. The sugar content expressed as g/100 g fresh weight.

Total phenolic contents

The total phenolic content (TPC) of the fruit samples of *Rosa pimpinellifolia* was determined by Singleton and Rossi (1965) and results expressed mg of gallic acid equivalents (GAE) per 100 g fresh sample.

Total anthocyanin content

pH differential method of Giusti and Wrolstad (2005) was used to determine total anthocyanin content. And results expressed as mg of cyanidin-3-glucoside equivalent in 100 g of fresh sample.

Ferric Reducing Antioxidant Power Assay

FRAP (Ferric reducing antioxidant power) method was used for antioxidant capacity analysis according to Benzie and Strain (1996). The FRAP was expressed as µmol Fe (II)/ g fresh weight.

Statistical Analysis

For statistical analysis, SPSS software and procedures were used. For replicate was used each analysis The data subjected to Duncan multiple range tests at the significant level of $p<0.05$. , Data were processed according to principal component analysis (PCA) using SPSS for Windows Version 15.0, SPSS Inc. (Chicago, IL, USA).

RESULTS AND DISCUSSION

Morphological traits

Fruit weight, fruit flesh ratio and external (peel) color of six *R. pimpinellifolia* genotypes are shown in Table 1. As indicated in Table 1, fruit weight and flesh ratio were found to significant at $p<0.05$ level among six *Rosa pimpinellifolia* genotypes. The highest fruit weight was obtained from RP1 genotype as 2.21 g and followed in descending order RP2 (2.10 g)>RP5 (2.07 g)>RP6 (2.02 g)> RP4 (1.94 g)>RP3 (1.88 g), respectively. In addition, RP5 and RP6 genotypes placed same statistical group for fruit weight (Table 1). The fruit weight of selected rose hip genotypes belongs to different species varied between 0.61-4.95 g in different regions of Turkey (Yamankaradeniz, 1983; Balta and Cam, 1996; Kazankaya et al., 2005).

The fruit flesh ratio of six *Rosa pimpinellifolia* genotypes were found between 81.10 % (RP4) and 90.33% (RP1) and RP3 and RP6 genotypes were found at same statistical group. Among six genotypes the majority had black fruit peel color (RP1, RP3, RP4 and RP6) and one genotype had light black and one genotype had dark black fruit peel color (Table 1). Kan (2021) indicated that average fruit weight of *R. pimpinellifolia* is 1.77 g which is close value with our samples. Fruit weight of *Rosa* is specie and genotype dependent and ecological and geographical conditions are also effects fruit weight values of the rose hips (Yamankaradeniz, 1983; Yoruk, 2006; Ercisli, 2007). Ercisli (1996) reported a wide variation among *Rosa* species for fruit flesh ratio which ranged from 54.88% to 91.86% with average of 67.30%. In another study, Karakuş ve Bostan (2017) found fruit flesh ratio of a large number of *Rosa* genotypes between 63.89-75.01%. Özen (2013) found fruit flesh ratio between 61.69% and 82.83% among *Rosa* genotypes. According to those results it is possible to say that *R. pimpinellifolia* had higher fruit flesh ratio than the other *Rosa* species due to lower number of seeds.

Table 1. Fruit weight, flesh ratio and peel color of *Rosa pimpinellifolia* genotypes

Genotypes	Fruit weight (g)	Flesh ratio (%)	Peel color
RP1	2.21a	90.33a	Black
RP2	2.10b	87.06b	Light Black
RP3	1.88cd	85.80bc	Black
RP4	1.94c	81.10cd	Black
RP5	2.07bc	83.38c	Dark Black
RP6	2.02bc	85.40bc	Black

*Different letters indicate the statistical difference within the same column among genotypes and species at 5% level.

Ascorbic Acid (Vitamin C), Total phenolic, total anthocyanin and total antioxidant capacity

Vitamin C (Ascorbic acid), total phenol, total anthocyanin content, and total antioxidant capacity of the six *R. pimpinellifolia* genotypes are given in Table 2. As seen in Table 2, there were statistically significant differences (p<0.05) among genotypes in terms of vitamin C, total phenol, total anthocyanin and antioxidant capacity.

Vitamin C content were found between 37-53 mg per 100 g fresh fruit. Kan (2021) showed that *R. pimpinellifolia* had 59 mg vitamin C in 100 g fresh fruit. Previous studies indicated that *Rosa* species exhibits variable vitamin C content. In Romania, Roman et al. (2013) reported that *Rosa* genotypes had vitamin C between 112-360 mg per 100 g of fresh rose hips. Celik et al. (2009) showed vitamin C content in fruits of different *Rosa* species between 604 and 1032 mg/100 g. Vitamin C content of rose hips also varies with geographical and climatic conditions (Ercisli, 2005). The results indicated that fruits of *Rosa pimpinellifolia* had the lowest vitamin C content among *Rosa* species.

Total phenol content of *R. pimpinellifolia* genotypes ranged from 1018-1407 mg GAE per 100 g. This result revealed that *R. pimpinellifolia* had high total phenolic content among *Rosa* species. Montazeri et al. (2011) reported average 424 mg GAE/100 g total phenol content in *Rosa canina* fruits. Phenolic compounds are mainly responsible for total antioxidant capacity in plants (Javanmardi et al. 2003). Koczka et al. (2018) found that fruits of *Rosa pimpinellifolia* (*R. spinosissima*) grown in Hungary had higher total phenol content than the other *Rosa* species and total phenolic content were in decreasing order *Rosa pimpinellifolia* > *R. canina* > *R. rugosa* > *R. gallica*. The total phenol differences among genotypes could be explained by genetic background and also growing and cultivated conditions.

Total anthocyanin content of *R. pimpinellifolia* genotypes were in range of 3.74-5.02 mg cyanidin-3-glucoside equivalent per 100 g of fresh fruit and the genotypes statistically differed each other for total anthocyanin content (p<0.05) (Table 2). Kan (2021) found that *R. pimpinellifolia*, *R. canina* and *R. villosa* had total anthocyanin content 3.72 mg, 2.75 mg and 2.80 mg cyanidin-3-glucoside equivalent per 100 g fresh weight, respectively. The present results implied that *R. pimpinellifolia* had the highest total anthocyanin content than the other *Rosa* species. Previous study showed that fruits of *Rosa* species mainly had cyanidin-3-glucoside (Guimaraes et al., 2013) and cyanidin-3-glucoside was reported to have the highest oxygen radical scavenging effect (Wang et al., 1997).

The antioxidant capacity of six *R. pimpinellifolia* genotypes determined by FRAP assay has been shown in Table 2. Statistically significant differences (p<0.05) were evident among six genotypes in the total antioxidant capacities. FRAP values ranged from 10.11 μmol Fe (II)/g (RP2) to 13.86 μmol Fe (II)/g (RP5) (Table 2). Previously Demir et al. (2014) reported differences on total antioxidant capacity of *Rosa* species. Cunja et al. (2015) reported that the highest antioxidant capacity was observed in *R. canina* fruit. Koczka et al. (2018) in their study conducted in Hungary determined that the antioxidant activity of *Rosa* species and the fruits of the *Rosa pimpinellifolia* (*R. spinosissima*) was found to be higher antioxidant capacity than the other *Rosa* species. They found a direct high correlation between the total phenol content and antioxidant activity. These results reveal that the fruits of *R. pimpinellifolia* can be used as a natural antioxidant source.

Table 2. Vitamin C, total phenol, total anthocyanin and antioxidant capacity of *Rosa pimpinellifolia* genotypes

Genotypes	Vitamin C (mg/100 g)	Total phenol (mg GAE/100 g)	Total anthocyanin (mg cy-3-gluc/100 g)	FRAP (μmol Fe (II)/g)
RP1	37b	1090ab	4.33bc	10.96cd
RP2	48ab	1018cd	3.74c	10.11d
RP3	53a	1164b	4.12bc	11.60c
RP4	50ab	1333c	4.78ab	12.44b
RP5	44b	1407a	5.02a	13.86a
RP6	40bc	1227c	4.55b	11.89bc

*Different letters indicate the statistical difference within the same column among genotypes and species at 5% level

Individual sugars

Sugar content in fruits of six *R. pimpinellifolia* genotypes is shown in Table 3. Sugar and organic acid contents are in general determining fruit quality and taste (Kobus et al., 2005). As presented in Table 3, there were significant differences (p<0.05) among genotypes for glucose, sorbitol

and fructose content. For all genotypes glucose was the main sugar (5.74-6.55 g/100 g) and followed by sorbitol (4.67-5.11 g/100 g) and fructose (3.98-4.35 g/100 g). Sucrose content was the lowest (0.18-0.44 g/100 g) and found insignificant among genotypes (Table 3). Kan (2021) reported glucose, sorbitol, fructose and sucrose in *R. pimpinellifolia* fruits as 6.88, 4.82, 4.23 and 0.36 g/100 g fresh weight base. Previous studies indicated that glucose was the major sugar in rose hips, ranged between 7.45–12.94 g/100 g and followed by fructose (Yoruk et al., 2008; Barros et al., 2011; Rosu et al., 2011; Ozrenk et al., 2012; Demir et al., 2014). Ozrenk et al. (2012) reported sucrose content in *Rosa* species between 0.17-0.88%.

Table 3. Specific sugars (g/100 g) in fruits of *Rosa pimpinellifolia* genotypes

Genotypes	Glucose	Sorbitol	Fructose	Sucrose
RP1	6.07c	5.03ab	4.07ab	0.27^{NS}
RP2	6.55a	5.11a	4.35a	0.44
RP3	5.85cd	4.88ab	4.24ab	0.23
RP4	5.97cd	4.95ab	4.18ab	0.30
RP5	5.74d	4.67b	3.98b	0.18
RP6	6.33b	4.80ab	4.02ab	0.35

*Different letters indicate the statistical difference within the same column among genotypes and species at 5% level. NS: Non Significant

Conclusion

Total phenol, anthocyanin content and antioxidant activities of the fruits belonging to the *R. pimpinellifolia* were found to be quite high. Due to the high content of anthocyanins and antioxidants, the fruits of this species could be able to be used as a natural source of anthocyanins and antioxidants. The fruits of this specie have aromatic feature and plants resistance to diseases and pests that could be important for organic agriculture. Considering the limiting feature of the climate and its distribution in a narrow area, it is necessary to ensure the reproduction of the species in order to spread it.

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