ACTA SCIENTIARUM POLONORUM

Acta Sci. Pol. Hortorum Cultus, 19(2) 2020, 123–134

www.acta.media.pl ISSN 1644-0692 e-ISSN 2545-1405 DOI: 10.24326/asphc.2020.2.12

ORIGINAL PAPER

Accepted: 8.07.2019

CHEMICAL CHANGES IN SEEDS AND FRUITS OF NATURAL GROWING ROSEHIP (*Rosa* sp.) FROM YOZGAT (TURKEY)

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ABSTRACT

Yozgat province is located on the Bozok Plateau in the middle Kızılırmak section of Turkey's Central Anatolian region. In a research carried out in 2015–2016, a total of 142 genotypes of fruit samples having superior characteristics in rosehips grown naturally were taken from Yozgat province and districts. As a result of the modified weighed results, 49 types were found in the first year as promising. In the second year of selection, the morphological and pomological characteristics of selected genotypes of the first year were examined. In this study, phenolic compounds and organic acids, macro and microelement, and fatty acid analysis were carried out in 5 genotypes which are prominent among these genotypes. When phenolic compounds of rosehip genotypes were investigated, gallic acid varied from 3.52–22.35 mg·kg^{-1}. Citric acid was observed to be the main organic acid in rosehips and it was found to be the highest (6.21 mg·g^{-1}) in the 66 SRK 12, while it was detected lowest in the 66 BGZ 11 (2.05 mg·g^{-1}). Mineral compositions of rosehip genotypes, e.g. P, K, Ca and Mg, were: 182.56–1768.97 mg·kg^{-1}, 1.06–10 450.16 mg·kg^{-1}, 27.40–17 616.59 mg·kg^{-1}, 8.55–3134.67 mg·kg^{-1}, respectively. Seven major fatty acids were determined in rosehip genotypes and palmitic acid, linoleic acid, stearic acid, and oleic acid were 3.42–5.28%, 30.32–50.22%, 3.07–6.60%, 21.58–48.31%, respectively.

Key words: rosehip, fruit and seed chemical contents, Yozgat (Turkey)

INTRODUCTION

Anatolia has form richness in terms of many fruit species. The Rosa genus, including rosehip, has more than 100 species in the temperate and subtropical regions of the northern hemisphere and 27 species are grown in our country [Nilsson 1997, Tübives 2018]. Since the roots of the rosehip plant are deeply rooted, they are resistant to stasis and cold have high adaptability and are successfully used for erosion control. Due to its tolerance to disease and harmfulness, tolerance to climate and soil conditions, roses are rootstocks and also used as a landscape plant due to bush form. The establishment of varieties and gardens, which have been registered in recent years, provide the stable fertility contribution required for the industry. The rosehip fruit that is fruit juice and marmalade are consumed because of its rich content [Honda et al. 1996, Demir and Ozcan 2001].

A characteristic of rosehip is that its chemical composition differs depending on the cultivar, growing region, climate, maturity, cultivation practice, and storage conditions. Significant variations in fatty acids, organic acids, phenolics, sugars, water-soluble vitamins, and minerals of rosehip have been reported over the years by different researchers. The fruits contain antioxidants, phenols, carotenoids, organic acids, fatty acids, and minerals [Uggla et al. 2003, 2005, Mármol et al. 2017]. Rosehip fruits also contain minerals: P, K, Ca, Fe, Cu, Mn, Zn, Na, B, flavonoids, and carotenoids such as lycopene, the pigment that gives the red–orange [Demir and Ozcan 2001, Kazaz

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et al. 2009], polyphenols [Roman et al. 2013]. The oil of dog rose seed contains fatty acids like oleic, linoleic, palmitic, stearic, and arachidonic [Ozcan 2002, Kazaz et al. 2009]. Everyday intake of fatty acids may decrease the risk of cardiovascular disease to 20–30% and outcome in almost one additional life year for a 40-year-old human [Engelfriet et al. 2010]. Essential fatty acids are fatty acids that humans need to be taken for good health, but can not synthesize them and must be obtained from food [Das 2006].

The total fat content in rosehip seeds can alter between 1.3% and 11.1% depending on environmental conditions, geographical region, season and species [Ercisli 2007, Çelik et al. 2010, Sharma et al. 2012, Güneş et al. 2017a]. The major fatty acids encountered in rosehip studies are palmitic, stearic, oleic, linoleic, linolenic and arachidic acid [Çelik et al. 2010, Adamczak et al. 2011, Barros et al. 2011, Sharma et al. 2012, Fofana et al. 2013].

The content of oleic, linoleic and linolenic acid in rosehip seeds is more stable and higher when compared with olive and blueberry [Fofana et al. 2013]. Rosehip kernel oil is rich in polyunsaturated fatty acids and is the most common source of omega-3 and omega-6 fatty acids. Omega-3 fatty acid takes on an important role in cholesterol, as well as in the repair of the nervous system and in the cancellation or slowing down of abnormal cells in some types of cancer.

Approximately 60–70% of the fresh rosehip berries are fruit flesh and 30–40% are the seeds. Rosehip fruit meat is evaluated by processing with different products. The core fraction of 30–40% is often separated as waste [Güneş et al. 2016]. However, rosehip seeds can be processed with different products in the cosmetics industry with fatty acids and can be used in public medicine. Because rosehip seed oil is used as a skin barrier, anti-aging, extreme line reducing (particularly around the eyes and mouth) as a protective and wound improvement agent in sun and hard air environments. It also has anti-spotting, pigmentation--reducing, capillary cracking and anti-acne protective properties [D'amelio 1999]. Shabykin and Godorazhi [1967] have tried the efficacy of rosehip seed oil together with oral fat-soluble vitamins on different inflammatory dermatitis [Lin et al. 2018].

The rosehip kernel has been used for many years in the treatment of various sores, wounds and skin diseases in folk medicine. Rosehip seeds may be added to enhance omega-3 and omega-6 of the food or to be fed in poultry and large/small headed animals [Macit et al. 2003]. It is also known that the antioxidant and antimicrobial effects, rich minerals, vitamins, sugars, phenolic compounds, carotenoids, tocopherols, bioflavonoids, tannins, organic acids, fruit acids, amino acids, essential oils and pectin in rosehip fruits are high [Özkan et al. 2004, Uggla et al. 2005, Ercisli et al. 2007].

In this study we used five rosehip genotypes originating from Turkey which have not been studied in detail before. The aim of our study is to reveal the chemical composition of these five rosehips genotypes such as mineral elements, phenolic compounds and organic acids in its fruit, fatty acids in its seeds.

MATERIAL AND METHODS

Plant materials. Previous research, aimed at the selection of superior properties in naturally growing rosehips, conducted in Yozgat province of central Turkey during 2015–2016. In this study, fruit samples were taken from a total of 142 the rosehip genotypes. First year, 49 types were found to be promising as a result of weighted grading which was modified. In the second year of the selection, selected genotypes, which were chosen in the first year, were investigated morphological and pomological characteristics [Uçaral and Koç 2016]. This study was conducted on five genotypes that were selected as promising. Fruit samples were collected at the ripe stage from selected 66 CYR 03 from the plants belonging to the Rosa pimpinellifolia and others (66 BGZ 11, 66 SRG 14, 66 SRG 17 and 66 SRK 12) from the plants belonging to the *Rosa canina* species. The fruits were selected according to uniformity of shape and colour. The fruits were stored at –20°C until analysis in polyethylene bags.

Determination of mineral elements. Thermo Scientific – iCAP-Qc (ICP-MS) calibration standard solutions of elements were diluted with 5% nitric acid to draw the calibration curves. The calibration curve was constructed using eleven different concentrations (1.0 ppb, 2.5 ppb, 5.0 ppb, 10.0 ppb, 25.0 ppb, 50.0 ppb, 100.0 ppb, 250.0 ppb, 500.0 ppb, 1000.0 ppb, and 2000.0 ppb) of each element (Na, Mg, Al, P, Ca, K, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Pb). Samples

weighted into microwave Teflon tubes and digested with microwave oven (Milestone Star D) by 5 mL HNO_3 and 2 mL HCl. Then all samples diluted to 20 mL with distilled water [Türksoy et al. 2018].

Determination of phenolic compounds and organic acids. The rosehips fruit samples were to be ex-tracted according to the method described by Liu et al. [2010]. Dried, seedless rosehips fruits (*Rosa* sp.) were be milled into a fine powder. A 2.0 g of fruit powder was be extracted three times with 20 mL of aqueous ethanol (80%) in an ultrasonicator bath at 40°C, for 15 min for each extraction. The obtained extracts from three extractions were be combined. After the removal of ethanol using rotary evaporation, the extract was be dissolved in 10 mL methanol, followed by filtration through a 0.45 µm filter. After this, the clear solution was be placed in the glass vial of HPLC and the sample was be analyzed by HPLC-DAD. Phenolic acids separation was be performed using HPLC autosampler system model LC-20A, on an Inertsil C18 ODS-3 column (5 µm particle size, 4.6 mm × 250 mm, Japan) at 25°C. A binary solvent system was be employed consisting of methanol : water : formic acid (10 : 88 : 2, v/v) as solvent A and methanol : water : formic acid (90 : 8 : 2, v/v) as solvent B. The detection was be monitored at 280 nm [Ozturk and Tuncel 2011] using an SPD-M20A photodiode array (PDA) detector (Shimadzu, Japan). Organic acids (oxalic, tartaric, formic, malic, L-ascorbic, malonic, maleic, citric, succinic, fumaric) acids separation was be performed using HPLC autosampler system model -M H_2SO_4 was used as mobile phase. The detection was be monitored at 214 nm [Bhandari and Kawabata 2004] using an SPD-M20A photodiode array (PDA) detector (Shimadzu, Japan).

Determination of fatty acid contents. The extraction was carried out using a procedure described by Satil et al. [2003] and Tariq et al. [2011]. A dried and ground sample (10 g) was be extracted by petroleum ether for 6 h by Soxhlet apparatus. The solvent was be evaporated under reduced pressure using a rotary evaporator at 40°C. 5 mL of the internal standard solution (3 mg.mL^{-1} triheptadecanoin in n-hexane) was be added to residue (oil) then refluxed with potassium hydroxide solution (0.5 N) in methanol (6 : 1, v/v) at 60°C for 90 min (to ensure complete conversion of oil into fatty acid methyl esters). The refluxed mixture was be transferred into a separatory funnel, and the reflux bottle was being washed with (5 × 2 mL) of water, then 20 × 2 mL of n-hexane. The organic phase (n-hexane) was be washed three times with 20 mL of sodium chloride solution (5%) then washed with Milli-Q water until the washing water remained colorless upon addition of phenolphthalein, and the organic phase was be dried with sodium sulfate. The organic phase was to be evaporated to dryness using a rotary evaporator (LabTech-EV311, Italy) at 45°C. The concentrated extract was be topped to 10 mL with chloroform, filtered through a 0.48 µm syringe filter. A 950 µL of a concentrated extract (in chloroform) was being transferred into a silanized vial then 50 µL of BSTFA (N,O-Bis (trimethylsilyl) trifluoroacetamide) with 1% TMCS (Trimethylchlorosilane) as derivatizing and silylating reagent was be combined. The mixture was shaken well for 1 min, the sample was then incubated at 60°C for 60 min and finally analyzed by GC-MSafter cooling. The fatty acid methyl esters (FAMEs) contents were be determined using a Shimadzu–QP2010 ultra (Kyoto, Japan) gas chromatography coupled with the mass spectrometric detector as described by Tariq et al. [2011]. Autosampler system and real-time analysis software were be used for all analyses. One microliter of each sample was being injected into the gas chromatography using a split mode, with the split ratio of (1 : 10) inlet via autosampler. The separation was be performed on a capillary column DB-5MS (30 m × 0.32 mm, 0.25 µm of film thickness). The carrier gas was Helium with the flow rate of 1.5 mL.min^{-1}. The column temperature was programmed from 120 to 300°C at the rate of 10°C.min^{-1}. The temperature of both injector and detector was set at 250°C. The mass spectrometer was set to scan in the range of m/z 50–550 with electron impact (EI) mode of ionization.

Statistical analysis. All measurements were performed in triplicate and results were tested by SPSS 20.0 for Windows program. The differences between the means were compared using the Duncan test ($P < 5\%$).

RESULT AND DISCUSSION

Mineral elements. The mineral contents of genotypes were shown in Table 1. Differences among

Table 1. Mineral contents in fruits of genotypes (mg·kg^{-1})

Genotypes	Minerals							
	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Iron (Fe)	Manganese (Mn)	Copper (Cu)	Zinc (Zn)
66 BGZ 11	1665.93 a	9151.40 b	17616.59 a	2436.43 c	193.02 a	76.65 c	5.83 a	12.54 a
66 CYR 03	182.56 d	1.06 c	27.40 d	8.55 e	3.44 e	0.03 e	0.01 d	0.10 e
66 SRG 14	1768.97 a	10450.16 a	4987.53 c	1415.09 d	52.87 d	32.59 d	4.29 c	5.12 d
66 SRG 17	1435.69 b	10397.94 a	11469.21 b	2642.10 b	125.61 b	127.51 a	4.75 b	11.93 b
66 SRK 12	1144.01 c	8964.14 b	10919.31 b	3134.67 a	106.64 c	92.46 b	4.66 bc	11.21 c

Different letters in the same column show statistically significant differences by Duncan's multiple range test at $P < 0.05$

the genotypes were significantly different ($P < 0.05$) observed based on the mineral compositions (Tab. 1). The Phosphorus (P) contents of fruits of genotypes varied from 182.56 mg·kg^{-1} (66 CYR 03) and 1768.97 mg·kg^{-1} (66 SRG 14). In some previous studies, it was found that P contents of rosehips were between 1010 mg·kg^{-1} and 5360 mg·kg^{-1} [Demir and Ozcan 2001, Szentmihalyi et al. 2002, Ercisli 2007, Kazaz et al. 2009, Özrenk et al. 2012, Javanmard et al. 2018].

The Potassium (K) contents of fruits of genotypes were between 1.06 mg·kg^{-1} and 10450.16 mg·kg^{-1}. The K contents of rosehip were reported to be 4200–11900 ppm in rose species by Kovacs et al. [2000]; 890.5–1023.9 mg·kg^{-1} by Demir and Ozcan [2001]; 3786 ±23 µg.g^{-1} by Szentmihalyi et al. [2002]; 5467–7700 ppm by Ercisli [2007]; 5316.8 mg·kg^{-1} by Ozcan et al. [2008]; 2243–12454 mg·kg^{-1} in *Rosa damascena*, and 3231–14545 mg·kg^{-1} in *Rosa canina* by Kazaz et al. [2009]; 3113.31 ppm by Türkben et al. [2010]; 11152–45405 ppm by Özrenk et al. [2012]; 429 mg 100 g^{-1} by Phillips et al. [2014]; 4458–7917 mg·kg^{-1} by Javanmard et al. [2018]; 6258 mg·kg^{-1} by Kizil et al. [2018]; and 5181.53–5779.45 mg·kg^{-1} by Popovic-Djordjevic et al. [2018]. According to our data, the Calcium (Ca) and Magnesium (Mg) contents of fruits of genotypes varied between 27.40–17616.59 mg·kg^{-1} and 8.55–3134.67 mg·kg^{-1}. The Ca and Mg contents of rosehip were reported to be 1100–3090 ppm and 11.4–45.9 ppm by Kovacs et al. [2000], 133.3–146.7 ppm and 162.7–183.9 ppm by Demir and Ozcan [2001], 7948 µg.g^{-1} and 1193 µg.g^{-1} by Szentmihalyi et al. [2002], 1220–2867 ppm and 990–1254 ppm by Ercisli [2007], 3479.3 mg·kg^{-1} and 1018.2 mg·kg^{-1} by Ozcan et al. [2008], 3416.48 ppm and 932.77 ppm by Türkben et al. [2010], 169 mg.100 g^{-1} and 69 mg.100 g^{-1} by Phillips et al. [2014], 3234–5766 mg·kg^{-1} and 806–1610 mg·kg^{-1} by Javanmard et al. [2018], 869.74–1120.59 mg·kg^{-1} and 344.11–395.68 mg·kg^{-1} by Popovic-Djordjevic et al. [2018], 3351 mg·kg^{-1} and 1435 mg·kg^{-1} by Kizil et al. [2018]. Kazaz et al. [2009], Calcium contents of *Rosa damascena* and *Rosa canina* fruits and fruit parts were found between 3885–11162 mg·kg^{-1} and 3800–8442 mg·kg^{-1}, respectively. Mg contents were determined as 441–1501 mg·kg^{-1} in *Rosa damascena* and 965–2175 mg·kg^{-1} in *Rosa canina*. The Iron (Fe), Manganese (Mn), Copper (Cu) and Zinc (Zn) contents were between 3.44–193.02 mg·kg^{-1}, 0.03–127.51 mg·kg^{-1}, 0.01–5.83 mg·kg^{-1} and 0.10–12.54 mg·kg^{-1}, respectively. In some previous studies, it was found that Fe contents of rosehips were between 0.1 ppm and 117.5 mg·kg^{-1} [Kovacs et al. 2000, Demir and Ozcan 2001, Nowak 2006, Ercisli 2007, Kazaz et al. 2009, Türkben et al. 2010, Özrenk et al. 2012, Javanmard et al. 2018, Kizil et al. 2018, Popović-Djordjevic et al. 2018]. The Mn contents of rosehip were reported to be 1.1–140.01 ppm [Kovacs et al. 2000, Demir and Ozcan 2001, Nowak 2006, Ercisli 2007, Ozcan et al. 2008, Kazaz et al. 2009, Özrenk et al. 2012, Javan-

mard et al. 2018]. The Cu contents of fruits of genotypes varied between 0.710–1800 mg·kg^{-1} [Kovacs et al. 2000, Nowak 2006, Ercisli 2007, Ozcan et al. 2008, Kazaz et al. 2009, Türkben et al. 2010, Özrenk et al. 2012, Javanmard et al. 2018, Kizil et al. 2018, Popović-Djordjevic et al. 2018]. The Zn contents of rosehip were determined as 2.70–42 mg·kg^{-1} [Kovacs et al. 2000, Demir and Ozcan 2001, Nowak 2006, Ercisli 2007, Ozcan et al. 2008, Kazaz et al. 2009, Türkben et al. 2010, Özrenk et al. 2012, Javanmard et al. 2018, Popović-Djordjevic et al. 2018]. In our study, all mineral contents of 66 CYR 03 genotype belonging to *Rosa pimpinellifolia* was found to be lower than genotypes belonging to other *Rosa canina* genus and studies conducted to date. Other four genotypes were similar to mineral contents of previous studies.

Phenolic compounds and organic acids. The phenolic compounds and organic acids contents of rosehips genotypes were given in Table 2 and Table 3. Differences among the genotypes were significantly different ($P < 0.05$) observed based on the phenolic compounds and organic acids (Tabs. 2, 3). The gallic acid contents of fruits of genotypes varied from 3.52 mg·kg^{-1} (66 BGZ 11) and 22.35 mg·kg^{-1} (66 SRK 12). The Protocatechuic acid was found to be the highest (100.84 mg·kg^{-1} and 99.81 mg·kg^{-1}) in the 66 SRG 14 and 66 SRK 12, while it was found to be lowest in the 66 BGZ 11 (42.46 mg·kg^{-1}). Gallic acid, chlorogenic acid, 4–hydroxybenzoic acid, vanillic acid, and syringic acid contents of 66 SRK 12 were found the highest among genotypes. Therefore it was statistically separated from other genotypes. 66 SRG 14 and 66 SRK 12 genotypes were determined to be statistically significant according to caffeic acid and ferulic acid contents (Tab. 2).

In a study in rosehips identified eleven phenolic acids containing high amounts of phenolic acid and the number of compounds between 0.2 mg·g^{-1} to 303.2 mg·g^{-1} [Nowak 2006]. Nowak stated that the conjugated phenolic acid forms in the fruit were dominated and mainly hydrolyzed in gallic acid (93–303 mg·g^{-1} in dry plant material). In consequence of this alkaline and acid hydrolyzes from gallotannins and galloyl esters are released gallic acid. Demir et al. [2014] pointed out that the gallic acid in samples of *R. dumalis*, *R. gallica* and *R. dumalis* subsp. *boissieri* were 7.70, 7.88 and 8.29 mg·g^{-1} dry weight, respectively, while other samples including *R. canina* and *R. hirtissima* (12,67 and 12.93 mg·g^{-1} dry weight) contained almost the same levels. The phenolic acid contents of rosehips were in confirmed with studies by Öztürk et al. [2007] who reported that the amounts of gallic acid, protocatechuic acid, vanillic acid, chlorogenic acid, p-coumaric acid, ferulic acid and t-cinnamic acid 2.3, 1.4, 6.9, 3.1, 8.5, 24.9, 23.9 and 1.7 mg 100 g^{-1}, respectively. Changes in caffeic acid, gallic acid, and ferulic acid were observed depending on the harvesting time by Elmastaş et al. [2017]. The amount of

Table 2. Phenolic compounds of rosehip genotypes (mg·kg^{-1})

Phenolic compounds	Genotypes				
	66 BGZ 11	66 CYR 03	66 SRG 14	66 SRG 17	66 SRK 12
Gallic acid	3.52 e	8.30 c	15.50 b	5.42 d	22.35 a
Protocatechuic acid	42.46 d	47.21 c	100.84 a	59.85 b	99.81a
Chlorogenic acid	82.62 c	78.79 d	219.23 b	67.37 e	256.82 a
4-hydroxybenzoic acid	14.01 d	22.04 c	66.40 b	21.86 c	92.04 a
Vanillic acid	6.08 d	11.98 c	26.64 b	7.65 d	40.70 a
Caffeic acid	0.79 d	5.87 b	9.59 a	2.86 c	9.43 a
Syringic acid	1.95 c	9.37 b	9.60 b	3.55 c	12.58 a
Ferulic acid	1.34 c	4.16 b	7.28 a	2.67 bc	7.27 a
Propylparaben (I.S) (ppm)	111.00 d	128.08 a	122.05 b	112.17 d	117.40 c

Different letters in the same line show statistically significant differences by Duncan's multiple range test at $P < 0.05$

Table 3. Organic acids contents of rosehip genotypes (mg·g^{-1})

Organic Acid	Genotypes				
	66 BGZ 11	66 CYR 03	66 SRG 14	66 SRG 17	66 SRK 12
Citric	2.05 e	2.23 c	5.11 b	2.11 d	6.21 a
Oxalic	0.10 d	0.11 c	0.21 b	0.09 e	0.31 a
Tartaric	0.11 d	0.10 e	0.28 b	0.13 c	0.34 a
Formic	ND	ND	ND	ND	ND
Malic	1.28 c	1.33 b	0.99 d	1.35 a	0.95 e
L-ascorbic	0.23 c	0.20 d	0.26 b	0.11 e	0.27 a
Malonic	ND	ND	ND	0.01 b	0.02 a
Maleic	ND	ND	ND	ND	ND
Succinic	0.02 c	ND	0.10 a	0.01 d	0.08 b
Fumaric	ND	0.00078 a	0.00037 c	0.00035 d	0.00054 b

Different letters in the same line show statistically significant differences by Duncan's multiple range test at $P < 0.05$. ND: not detected

Table 4. Fatty acids composition of genotypes of rosehips (%)

Fatty acids		Genotypes				
		66 BGZ 11	66 CYR 03	66 SRG 14	66 SRG 17	66 SRK 12
Palmitic acid	C16:0	4.19 b	5.28 a	4.00 b	3.42 c	4.00 b
Linoleic acid	C18:2	37.6 d	30.32 e	46.33 b	42.05 c	50.22 a
Oleic acid	C18:1	45.39 bc	46.77 ab	43.98 c	48.31 a	21.58 d
Stearic acid	C18:0	6.60 a	3.13 b	3.68 b	3.07 b	3.21 b
Gondoic acid	C20:1	1.05 a	0.86 b	0.44 d	0.67 c	0.29 e
Arachidic acid	C20:0	3.17 a	0.61 c	1.06 bc	1.58 b	1.09 bc
Behenic acid	C22:0	0.73 a	0.44 b	0.15 e	0.22 c	0.18 d
Σ		98.73	87.41	99.64	99.32	80.57

Different letters in the same line show statistically significant differences among sampling dates by Duncan's multiple range test at $P < 0.05$

caffeic acid in *R. dumalis*, *R. canina* and *R. villosa* were between 24.17–77.0 mg·kg^{-1}, 6.50–18.50 mg·kg^{-1}, 11.92–19.0 mg·kg^{-1} respectively. The gallic acid contents in *R. dumalis*, *R. canina* and *R. villosa* were found between 13.08–57.5 mg·kg^{-1}, 3.08–6.83 mg·kg^{-1}, 1.17–13.42 mg·kg^{-1} respectively. The ferulic acid concentration tended to increase with harvest time and peaked at the sixth harvest time in all studied species (2.25–8.42 mg·kg^{-1}, 1.92–7.17 mg·kg^{-1}, 2.83–11.33 mg·kg^{-1} respectively). The phenolic acid contents of rosehips are in accordance with studies in previous studies. Our findings are in agreement with these reports.

Organic acid values of genotypes were given in Table 3. Fruit acidity is owing to the existence of a few organic acids, and play an important role in deciding fruit quality and its nutrient value. Citric acid is a natural protection and used to serve a sour taste to foods. Malic acid is a natural component of fruits that controls metabolism and rises energy manufacture [Xie et al. 2011, Wu et al. 2012].

During ripening, acid content generally decreases as the organic acids are used up or converted to sugars. The citric acid was found to be the highest (6.21 mg·g^{-1}) in the 66 SRK 12, while it was

found to be lowest in the 66 BGZ 11 (2.05 mg·g^{-1}). The amounts of oxalic acid were between 0.09–0.31 mg·g^{-1}, while the tartaric acid was 0.10–0.34 mg·g^{-1}. The malic acid content varies from 0.95 to 1.35 mg·kg^{-1} and the L-ascorbic acid content varies from 0.11 to 0.27 mg·g^{-1}. The formic acid and maleic acid contents were not detected in any genotype. Citric acid has been found to be the main organic acid in rosehips [Kovacs et al. 2000, Öztürk et al. 2007, Adamczak et al. 2012, Cunja et al. 2015]. According to Adamczak et al. [2012], citric acid content showed the high content of citric acid (3.48 g.100 g^{-1} DM). Özrenk et al. [2012] were detected that citric acid, oxalic acid, tartaric acid, malic acid, and succinic acid contents ranged in 1.56–3.15%; 0.32–0.62%; 0.073–0.155%; 0.76–4.39% and 0.028–2.465% respectively. Malic acid was determined as the highest of the organic acids. Demir et al. [2014] reported the citric acid content of 4.76 to 9.12 g 100 g^{-1} DW, and malic acid content varies from 0.45 to 1.10 g 100 g^{-1}. Cunja et al. [2015] reported citric acid (15.0–18.6 g 100 g^{-1} DW) and malic acid (5.8–8.5 g 100 g^{-1} DW) contents in *R. canina* hips during ripening. Abaci et al. [2016] pointed out that the major acids in *R. iberica* Stev. hips were determined to be citric acid (0.62 g 100 g^{-1} FW) and malic acid (0.49 g 100 g^{-1} FW), while other detected acids included succinic acid (0.012 g 100 g^{-1} FW) and fumaric acid (0.016 g 100 g^{-1} FW).

Fatty acids composition. Thousand seed weight of genotypes (66 BGZ 11, 66 CYR 03, 66 SRG 14, 66 SRG 17, 66 SRK 12) were recorded as 26.0, 72.5, 18.4, 31.7, and 14.9 g, respectively. The fatty acids composition of these genotypes of rosehips in seeds were given in Table 4. Seven major compounds of them were found in high amounts as a result of the fatty acid analysis in genotypes. Fatty acid analysis showed that a great variation of fatty acids was found among genotypes. The palmitic and linoleic acid contents of all genotypes were between 3.42% to 5.28% and 30.32% to 50.22%. The proportions of palmitic, stearic, oleic, linoleic, and α–linolenic acids obtained from the seed oils of rosehip by diverse extraction methods were noticed to be 3.60–7.87%, 2.45–3.27%, 16.25–22.11%, 35.94–54.75%, and 20.29–26.48%, respectively [Szentmihalyi et al. 2002]. The fatty acid composition was determined in the seed oils by Ozcan [2002]. The major fatty acids identified by gas chromatography of rose seed oils growing wild in the Hadim, Taskent, and Ermenek regions in Turkey were, respectively, as follows: palmitic (3.17%, 1.71%, and 2.14%), stearic (2.47%, 2.14%, and 1.69%), oleic (16.73%, 18.42%, and 14.71%), linoleic (54.41%, 51.71%, and 48,64%), linolenic (17.14%, 16.42% and 18.41%), and arachidic (2.11%, 1.87%, and 2.61%).

The fatty acid profile of a number of Polish wild species of rose fruits were examined by Nowak [2005] linoleic acid (44.4–55.5%), α–linolenic acid (18.6–31.4%), oleic acid (13.5–20.3%), palmitic acid (2.3–3.3%), stearic acid (1–2.5%), octadecenoic acid (0.38–0.72%), eicosenoic acid (0.3–0.7%), eicosadienoic acid (0–0.16%), erucic acid (0.03–0.17%) and minör fatty acids. Concha et al. [2006] reported that palmitic acid, stearic acid, oleic acid and linoleic acid contents in *Rosa aff. rubiginosa* oil extracted through different processes were found between 3.33–4.97%, 0.11–1.75%, 12.36–14.82% and 42.20–47.87%, respectively. Machmudah et al. [2007] determined that the seed oil extracted mainly contained linoleic acid as the most abundant followed by linolenic, palmitic and stearic acid. Fatty acid analysis showed rose species studied contained nine major compounds and a great variation of fatty acids was found among species by Ercisli [2007]. Palmitic acid in samples of *R. canina*, *R. dumalis* subs. *boissieri*, *Rosa dumalis* subsp. *antalyensis*, *R. villosa*, *R. pisiformis* and *R. pulverulenta* were 16.4–26.6% whereas linoleic acid of these species were 0–17.5%. Ercisli et al. [2007] showed that examined *Rosa* species included eleven main compounds and that there were statistically more fatty acid variations. The main fatty acid for *Rosa villosa*, *Rosa pulverulanta*, *Rosa dumalis* subsp. *boissieri*, *Rosa pisiformis*, and *Rosa canina* was linoleic acid (46.31–54.03%). Yoruk et al. [2008] reported that fruits of *Rosa iberice*, *Rosa canina*, *Rosa villosa*, *Rosa dumalis* and *Rosa pisiformis* were collected from Lake Van basin, Turkey. The oleic and linoleic acid levels were determined to be different in each species and also in fruits and seeds. The highest linoleic acid level in fruits was found in *Rosa dumalis* (3.150 µg.g^{-1}) while the highest oleic acid level was detected in *Rosa canina* (0.57 µg.g^{-1}). In seeds, the highest linoleic and oleic acid levels were determined in *R. canina* (3.95 µg.g^{-1}) and *R. dumalis* (10.50 µg.g^{-1}), respectively. Kazaz et al. [2009] pointed out that Palmitic acid content of

R. damascene was found to be 5.30% whereas *R. canina* was observed to be 5.26%. The stearic acid contents of *R. damascena* and *R. canina* were 2.02% and 3.13%. The oleic and linoleic acid contents of *R. canina* were found 22.14% and 48.84% while they were found 23.91% and 54.18% in *R. damascena.* The seed oil contents of five rosehip species were searched growing in Hakkâri by Çelik et al. [2010]. Seeds contained 4.25–5.15% of palmitic acid, 0.22–0.89% of palmitoleic acid, 1.80–2.43% of stearic acid, 20.35–23.03% of oleic acid, 41.14–51.06% of linoleic acid, 19.66–23.83% of linolenic acid, and 0.94–1.29% of arachidic acid depending on the species. Adamczak et al. [2011] reported that a wide range of differentiation was found in terms of the level of fatty oil and the main fatty acids in the hips of rose species of the section *Caninae*. The palmitic acid content of *Rosa* species was found to be 2.72–4.08% while the linoleic acid content was found to be 33.54–47.01%. Oleic and stearic acids contents were also between 11.12–17.03% and 1.41–2.37%. The arachidic acid content of *Rosa* species were 0.20–0.51%. Ripened hips seeds were searched by Barros et al. [2011]. Seeds contained 10.13% of palmitic acid, 4.64% of stearic acid, 18.96% of oleic acid, 43.48% of linoleic acid, 1.41% of arachidic acid, 0.30% of gondoic acid and 1.25% of behenic acid. Fromm et al. [2012] pointed out that the major acids in rosehip were determined to be palmitic acid (3.1%), stearic acid (2.2%), oleic acid (18.8%), linoleic acid (36.7%), arachidic acid (1.3%), gondoic acid (0.8%), and behenic acid (0.5%). Sharma et al. [2012] determined that the major fatty acids present in the seed oil were characterized as linoleic acid (45.38 to 54.58%), linolenic acid (13.67 to 24.75%), oleic acid (11.97 to 21.08%) and palmitic acid (6.54 to 12.97%). Ilyasoğlu [2014] investigated the nutritional composition and phytochemical composition of the rosehip seed, and the fatty acid and sterol compositions of the seed oil. The main fatty acids detected in the seed oil were palmitic acid (3.34%), stearic acid (1.69%), linoleic acid (54.05%), linolenic acid (19.37%), arachidic acid (1.0%), and oleic acid (19.50%). Grajzer et al. [2015] showed that the fatty composition of rosehip oil was determined to be palmitic acid (4.8%), stearic acid (3.0%), oleic acid (16.3%), linoleic acid (51.7%). Murathan et al. [2016] intended to compare fatty acid compounds of four rosehip species, these are *Rosa pimpinellifolia*, *R. villosa*, *R. canina*, and *R. dumalis*. Fatty acid composition (%) of four rosehip species reported that palmitic acid, stearic acid, oleic acid, linoleic acid, arachidic acid, gondoic acid, and behenic acid contents were found between 5.50–8.27%, 0.09–8.81%, 26.75–44.63%, 27.97–41.21%, 0.78–1.90%, 0.83–1.72%, and 0.60–1.05%, respectively. Güneş et al. [2016] reported that oleic, linoleic and linolenic acid contents were higher when compared to others in all the genotypes. As it is in *R. canina*, linolenic acid ratio has been determined between 11.79–14.25%, palmitic acid ratio has been determined between 3.70–9.21%, stearic acid ratio has been determined between 2.03–4.98%, arachidic acid ratio has been determined between 0.12–1.54%; cis-11.14-eicosadienoic acid ratio has been determined between 0.10–0.55%, behenic acid ratio has been determined between 0.01–0.20% and lignoceric acid ratio has been determined between 0.01–0.32%. Güneş et al. [2017a] have determined that the fatty acid ratios of some rosehips have changed at different harvest times. Eleven fatty acids in the analyzed rosehip seeds were detected. These were palmitic, stearic, oleic, linoleic, linolenic, gamma-linolenic, arachidic, cis–11, 14–eicosadienoic, behenic, lignoceric and nervonic acid. According to harvest time, the same genotype's oleic acid percentage was between 37.07–40.26%, the linoleic acid ratio was between 38.90–43.13% and the linolenic acid ratio was between 13.65–15.33%. Güneş et al. [2017b] were used fruits and seeds of five promising genotypes belonging to *Rosa dumalis*, *R. canina*, and *R. villosa*. The ratio of linoleic, oleic and linolenic acids was between 39–53%, 13–36%, and 15–24%, respectively. Heat treatment did not influence the oleic acid rate of any species, but notably impressed the rates of linoleic acid of *R.dumalis* spp. *boissieri* (MR-46), the linolenic acid of *R. dumalis* (MR-12) and *R. dumalis* ssp. *boissieri* (MR-46). Javanmard et al. [2018] investigated biochemical characteristics of five dog rose ecotypes (Kopehjamshid, Zarneh, Miyankish, Aghcheh and Sadeghiyeh), that were collected from the central part of Iran (Isfahan province). Miyankish had topmost oil content (11.43%), and was abundant in saturated fatty acids. Unsaturated fatty acids, such as oleic acid and linolenic acid were high in Sadeghiyeh. In this study, twenty seven fatty acids were detected that the most unsat-

urated fatty acids were linoleic acid (43.10–55.00%), linolenic acid (18.34–28.38%) and oleic acid (17.18–22.58%). Palmitic acid, the most significant saturated fatty acid was found between 3.69–5.05%. Linoleic acid was determined maximum in Kopehjamshid. Furthermore, Zarneh and Sadeghiyeh, had the highest level of linolenic and oleic acids, among the regions. The level of linolenic acid was higher than oleic acid in Kopehjamshid, Zarneh and Sadeghiyeh ecotypes. In another study, wild rosehip (*Rosa canina* L.) clone samples were collected from Dicle, district of Diyarbakir by Kizil et al. [2018]. Wild and cultivated rosehip seed oil possess major fatty acids like oleic, linoleic, stearic, and arachidic acid contents of 40.66%, 34.43%, 6.03%, and 0.39%, respectively. The highest oil component was found to be oleic acid in wild (40.66%) and cultivated plant seeds (38.83%).

When we compare our work with previous studies, the palmitic acid value was found to be between 1.71–26.6% in the other studies while it was found between 3.42–5.28% in our genotypes. Linoleic acid value was between 16.42–55.5% in different studies and 30.32–50.22% in our genotypes. The stearic acid value was found to be 0.09–8.81% in other studies while genotypes were found to be between 3.07–6.60%. The results we have found with studies are similar. The oleic acid value was found between 11.12–44.63% in the previous studies, while the values we determined in our genotypes ranged from 21.58% to 48.31%. Some genotypes [66 BGZ 11 (45.39%), 66 CYR 03 (46.77%) and 66 SRG 17 (48.31%)] were found to be higher of oleic acid content. Our results of palmitic, linoleic and stearic acids determination were in agreement with the results obtained from other studies while oleic acid was detected to be available at a higher level.

CONCLUSION

In the present study, phenolic compounds and organic acids, macro and microelement, and fatty acid analysis were carried out in five genotypes which are prominent among selected genotypes. Whole mineral contents of genotype belonging to *Rosa pimpinellifolia* was observed to be lower than genotypes belonging to other *Rosa canina* genus and studies conducted to date. Other four genotypes were similar to mineral contents of previous studies. The phenolic compounds and organic acids contents of rosehips are in accordance with studies in previous studies. Seven major fatty acids were determined in rosehip genotypes. Our results of palmitic, linoleic and stearic acids determination were in agreement with the results obtained from other studies while oleic acid was noticed to be existent in the bigger level.

Compared to previous reports, most of our findings are in agreement with these reports. Different could be due to variation between species, maturity of the fruit, climatic and environmental conditions (e.g. light, temperature, soil nutrients) and altitude at which the hips were grown. As a result of this study provides important information on the composition of rosehips for plant breeders.

ACKNOWLEDGEMENTS

This study was financially supported by Yozgat Bozok University Scientific Reseach Projects Division (Project number: 6602c-ZF/17-131). I thank Yozgat Bozok University Scientific Reseach Projects Division for its additions.

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