Variations in Chemical Compositions of *Rosa damascena* Mill. and *Rosa canina* L. Fruits

Soner KAZAZ[1], Hasan BAYDAR[2] and Sabri ERBAS[2]

[1]Department of Landscape Architecture, Faculty of Forestry, University of Suleyman Demirel, Isparta, Turkey; [2]Department of Field Crops, Faculty of Agriculture, University of Suleyman Demirel, Isparta, Turkey

Abstract

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In this study, fruits, fruit flesh and seeds of damask rose (*Rosa damascena* Mill.) and rose hip (*Rosa canina* L.) were assayed for the composition of fatty acids, ascorbic acid, α-tocopherol, β-carotene, and mineral elements. The content of linoleic acid in seed oil of *Rosa damascena* (54.18%) was found to be higher than in that of *Rosa canina* (48.84%). α-Tocopherol contents were found to be 7.10 μg/g and 34.20 μg/g for *Rosa damascena* and *Rosa canina* fruits, respectively. Ascorbic acid content was determined as the highest in the fruit flesh (546 mg/100 g in *Rosa damascena* and 2200 mg/100 g in *Rosa canina*), and as the lowest in the seeds of both species. *Rosa damascena* fruits were found to be richer in minerals such as Ca, Fe, K, Mn, Na, P, and Zn than *Rosa canina* fruits. The results of the present study showed that *Rosa damascena* fruits could be used as food and food additive equally as rose hip fruits.

Keywords: *Rosa damascena*; *Rosa canina*; chemical composition; nutritional value

Rose is one of the most important crops in the floriculture industry (Senapati & Rout 2008) and is used as cut flowers, potted plant, and garden plants (Guterman *et al*. 2002). Roses have been also used in the food, perfumery, and cosmetics industries for many years (Gustavsson 1998; Uggla 2004; Kaur *et al*. 2007). Roses belong to the genus *Rosa* in the Rosaceae family. The genus *Rosa* contains over 100 species that are widely distributed in Europe, Asia, Middle East, and North America (Nilsson 1997). Approximately 25 rose species have been reported in Turkey (Kutbay & Kilinc 1996). These 25 species are widely spread throughout the country from the sea level to altitudes as high as 3000 m (Ercisli 2004). Therefore, it is possible to describe Turkey as "native rose museum" (Ercisli & Guleryuz 2005). *Rosa canina* L. (dog rose, rose hip) and *Rosa damascena* Mill. (damask rose) are among the most cultivated and economically valued species in Turkey.

The fruits of the rose species are considerably beneficial for human health since they contain organic and inorganic matters that are outstanding in quality and amounts. The fruits of the rose species, especially rose hip (dog rose), are rich in minerals, vitamins, sugars, phenolic compounds, carotenoids, tocopherol, bioflavonoids, tannins, organic acids, fruit acids, aminoacids, volatile oils, and pectin (De Vries 1980; Muhitch & Fletcher 1984; Zhao *et al*. 1988; Razungles *et al*. 1989; Biacs & Daood 1994; Chai & Ding 1995; Akyuz *et al*. 1996; Izhaki 1998; Demir & Özcan 2001; Kadakal *et al*. 2002; Cutter 2003;

Uggla *et al*. 2005; Ercisli *et al*. 2007). Moreover, antioxidant and antimicrobial effects of the rose fruits are significantly strong (Özkan *et al*. 2004). The seeds of rose hip also contain unsaturated and polyunsaturated fatty acids (Szentmihályi *et al*. 2002). Rose fruits have long been used in Turkey for food, medicinal, and many other purposes and for several special traditional products such as rose hip fruit juice, rose hip jam, rose hip marmalade, rose hip pestil and rose hip syrup (Ercisli & Guleryuz 2005). Additionally, rose hip tea is made with both their fruits and roots (Kurt & Yamankaradeniz 1983; Ercisli & Guleryuz 2005).

There are mainly four species of roses that are used for the oil production (Tucker & Maciarello 1988). *Rosa damascena* Mill. (commonly known as damask rose) is the most important species used to produce rose oil for the perfumery industry (Guterman *et al*. 2002). The main growing areas of *Rosa damascena* are Turkey, Bulgaria, Southern Russia, and Morocco (Weiss 1997). On the other hand, the world-wide production is currently centered in Turkey (Isparta province) and Bulgaria (Kazanlik Valley). 10 000 tons of fresh rose flowers of *Rosa damascena* grown on 2000 ha are processed annually in rose oil factories in Turkey; and especially rose oil, rose water, rose concrete, and rose absolute are obtained.

Many works have been published on the nutritional value and chemical composition of some rose species fruits, especially *Rosa canina*, but no detailed study concerning the fruits, fruit flesh, and seeds of *Rosa damascena* has been performed so far. Most of the studies related to the damask rose have focused on the growing techniques, harvest time, and physical and chemical properties of rose oil. Therefore, the purpose of this study was to determine the variations in chemical compositions of *Rosa damascena* and *Rosa canina* fruits and to estimate the possibility of utilising damask rose fruits, similarly to rose hip fruits, in food and food additive sectors, as well as of using its flowers for the production of rose oil, rose water, rose concrete, and rose absolute.

MATERIALS AND METHODS

Materials. Damask rose fruits were collected from plantations located in Isparta province (Turkey) whereas rose hip fruits were collected from the bushes widely growing in Gumushane province (Turkey) in September 2007. All fruits were collected commercially at the stage of ripeness. Fruits were selected with respect to uniformity of shape and colour and were kept at –20°C in polyethylene bags until the use.

Methods. Chemical properties of the samples were determined according to AOAC (1984).

Determination of oil content and fatty acid compositions. 10 g of a dried and ground sample was extracted with petroleum ether for 6 h in Soxhlet apparatus (Büchi Universal Extraction System B-811, Germany) and the crude oil content in percentage was determined (Anonymous 1993). GC/MS analysis of the oil samples was performed on QP5050 GC/MS equipped with a Quadrapole detector. GC/MS analysis was implemented under the following conditions: capillary column CP-Wax 52 CB (50 m × 0.32 mm i.d.; 1.2 μm); injector temperature 240°C; detector (70 eV) temperature 250°C; flow rate for helium 40 ml/minute. Oven temperature was kept at 200°C for 1 min and raised to 240°C at a rate of 20°C/min, and then kept at 240°C for 20 minutes. 50 μl of sample was first derivatised with methanol under catalysis with sodium methoxide for one night (Marquard 1987); then 1 ml *n*-hexane was added and the phase containing *n*-hexane was injected into GC/MS. The contents of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2), and α-linolenic acids (C18:3) were determined using a computing integrator on a percentage basis.

Determination of ascorbic acid content. 5 g sample was homogenised with 25 ml of 2% H_3PO_4 and subsequently filtered. 1 ml extraction solution (0.01M KH_2PO_4, pH 8) was added to 1 ml of the filtrate. 1 ml of this solution was withdrawn from the cartridge (C_{18} Sep-Pak) and the cartridge was then washed with 2 ml extraction solution. The extraction solutions were combined and then 20 μl of the sample was injected into HPLC (high performance liquid chromatography) (Shimadzu). The working conditions of HPLC were as follows: HPLC detector: SPD-10AVvp UV-VIS detector ($\lambda_{max.}$: 254 nm); System control: SCL-10Avp; Pump: LC-6AD, Colon: ACE C18 (250 × 4.6 mm, 5 μm); Mobile phase: H_2O (pH 3 with H_3PO_4); Flow rate: 0.8 ml/minute. Ascorbic acid amount was determined as mg/100 g.

*Determination of α-tocopherol and β-carotene contents***.** 2 g of the sample were extracted with 5 ml *n*-hexane using homogenisation with vortex

followed by centrifugation. The upper phases dissolved in *n*-hexane were taken and *n*-hexane was completely evaporated using a rotary evaporator at 40°C. The solid residues accumulated in the balloon were then obtained by dissolution in the mobile phase, and after filtering through Sartorius filter (0.45 μm), 20 μl of the residue was withdrawn and injected into HPLC (Shimadzu). The working conditions of HPLC: HPLC detector: SPD-M10Avp DAD detector (for α-tocopherol λ =295 nm and for β-carotene λ = 450 nm); Degasser: SCL-10Avp; Pump: LC-10ADvp; Colon oven: CTO-10ACvp; Colon: YMC Pack ODS-AM (250 × 4.6 mm, 5 μm); Colon temperature: 40°C; Mobile phases: methanol/ACN/THF (73:20:7); Flow rate: 1 ml/minute. The amounts of α-tocopherol and β-carotene were determined as μg/g.

Determination of mineral elements. Dried and ground samples were put into a burning cup and 1 ml H_20_2 + 5 ml HNO_3 were added. The samples were incinerated in Milestone microwave oven and the solution was diluted with distilled water to make the volume (of 25 ml), and were analysed with an inductively coupled plasma optical emission spectrometry (ICP-OES) (Perkin-Elmer). The measurements were performed for 14 elements determination (P, K, Ca, Mg, Na, Fe, Cu, Mn, Zn, B, Mo, Ag, Cd, and Cr).

RESULTS AND DISCUSSION

Crude oil and fatty acids in damask rose and rose hip seeds

The oil contents of the rose species (Table 1) were found to be 7.15% (*Rosa canina*) and 2.75% (*Rosa damascena*). This result showed that the rose hip seeds contained 2.6 times more oil than those of damask rose. On the other hand, fatty acid compositions of both seed oils were found to be similar.

It was found that damask rose and rose hip seed oils were significantly rich in unsaturated fatty acids (omega fatty acids). The proportions of all three fatty acids in damask rose and rose hip were found to be 93.18% and 91.63%, respectively. Accordingly, the result showing that the unsaturation ratio was high (> 90%) and the saturation ratio low (< 10%) is an indicator that the nutritional, fitotherapic, and aromatherapic values are significantly high for both seed oils. It is especially noteworthy that the oils are rich in ω-3 fatty acid (α-linolenic acid) that is contained in other plant oils not at all or in very small amounts.

The previous studies concentrated on seed oils of other rose species, *Rosa canina* being foremost, but no detailed study appeared on the seed oil of *Rosa damascena*. Ercisli *et al*. (2007) reported the oil content of *Rosa canina* seeds to be 5.37% while Demir and Özcan (2001) found the crude seed oil contents of two different species belonging to *Rosa canina* as 1.2% and 1.6%. Additionally, Yoruk *et al*. (2008) suggested that rose seeds should be utilised instead of being wasted because of their rich sugars and fatty acid contents. Seed oil of *Rosa canina* was demostrated to contain high amounts of linoleic and α-linolenic acids (Ercisli 2007), and the contents of saturated and unsaturated fatty acids were found to vary between 7.75–14.68% and 77.80–91.86% for different rose species, respectively (Ercisli *et al*. 2007). The proportions of crude oil and of palmitic, stearic, oleic, linoleic, and α-linolenic acids obtained from the seed oils of rose hip by different extraction methods were reported to be 4.85–6.68%, 3.60–7.87%, 2.4–3.27%, 16.25–22.11%,35.94–54.75%, and 20.29–26.48%, respectively (Szentmihalyi *et al*. 2002). Our results of linoleic, α-linolenic, stearic, and oleic acids determination are in agreement with the

Table 1. Oil contents and fatty acids compositions in seeds of rose species (in %)

Oil and fatty acids	Carbon length	*Rosa damascena*	*Rosa canina*
Total oil content	–	2.75	7.15
Palmitic acid	C16:0	5.30	5.26
Stearic acid	C18:0	2.02	3.13
Oleic acid (ω-9)	C18:1	23.91	22.14
Linoleic acid (ω-6)	C18:2	54.18	48.84
α-linolenic acid (ω-3)	C18:3	15.09	20.65

Table 2. Ascorbic acid, α-tocopherol and β-carotene contents in fruits, fruit flesh, and seeds of rose species

Species	Organs	Ascorbic acid (mg/100 g)	α-tocopherol (μg/g)	β-carotene (μg/g)
	fruit	332.0	7.10	3.70
Rosa damascene	fruit flesh	546.0	5.35	3.50
	seed	145.0	5.25	2.95
	fruit	411.0	34.20	2.60
Rosa canina	fruit flesh	2200.0	21.62	3.25
	seed	306.0	8.05	0.18

results obtained by Nowak (2005) while palmitic acid was found to be present at a higher level.

Ascorbic acid, α-tocopherol, and β-carotene in rose fruits

Ascorbic acid contents in the fruit flesh were higher than in the fruits and seeds of both rose species (Table 2). In concrete terms, the rose hip contained 2.11 times more ascorbic acid in the seeds, 4.03 times more in the fruit flesh, and 1.23 times more in the fruit than the respective damask rose products. Ascorbic acid of different rose species was reported to amount to 106–2712 mg/100 g in the studies conducted in different agro-climatic regions of Turkey (Demir & Özcan 2001; Gunes & Sen 2001; Ercisli *et al*. 2007; Yoruk *et al*. 2008). Our results, in general, were within the limits of these studies. Halasova and Jicinska (1988), Nojavan *et al*. (2008) reported that ascorbic acid amount in rose hip varied between 629–967 mg/100 g and 211–417.5 mg/100 g, respectively. The differences in ascorbic acid contents might result from the variations in altitude, species, variety, ecological factors, and harvest time (Kurt & Yamankaradeniz 1983; Akyuz *et al*. 1996; Celik *et al*. 2006; Dogan & Kazankaya 2006).

α-Tocopherol content in the fruit was observed to be higher than those in the fruit flesh and seeds of both rose species (Table 2). β-Carotene contents of damask rose were found to be 2.95 μg/g in the seeds, 3.50 μg/g in the fruit flesh, and 3.70 μg/g in the fruits whereas β-carotene contents were observed to be 0.18 μg/g in the seeds, 3.25 μg/g in the fruit flesh, and 2.60 μg/g in the fruits of rose hip. The highest β-carotene content was found in the fruits of damask rose, and in the fruit flesh of dog rose. The β-carotene contents in the seeds of both species were found low compared to those in the fruits and fruit flesh (Table 2). Our results on α-tocopherol and β-carotene contents provided higher values than those of Yoruk *et al*. (2008).

Mineral elements in rose fruits

The results of the analyses give the nutrient values per 100 g of the used portion of dried weight (Table 3). Mineral element contents in the fruit flesh of both species were found higher than those in the fruits and seeds. The measurements were performed with 14 elements but since the concentrations of Mo, Ag, Cd, and Cr were very low in both damask rose and rose hip, these elements are not shown in Table 3.

Phosphorus contents were found in this study, to amount to 1224 mg/kg in damask rose fruits and 1010 mg/kg in rose hip fruits. Our findings were lower than the P contents given by some references (Demir & Özcan 2001; Ercisli 2007). The P contents varied between 67–1459 mg/kg in the fruit flesh and seeds of both species. The P content in rose hip seeds was reported to be 1781 μg/g, Szentmihalyi *et al*. (2002). Potassium contents in the fruits and fruit parts varied between 2243–12 454 mg/kg in damask rose, and between 3231–14 545 mg/kg in dog rose. The K contents in the fruits of rose hip were reported to be 890.5–1023.9 mg/kg by Demir and Özcan (2001), 5467 ppm by Ercisli (2007), and 4200–11 900 ppm in various rose species by Kovacs *et al*. (2004). Calcium contents of damask rose and rose hip fruits and fruit parts were found between 3885–11 162 mg/kg and 3800–8442 mg/kg, respectively. Demir and Özcan (2001) reported the Ca contents in rose hip fruits to range between 133.3–146.7 ppm whereas Ercisli (2007) reported it as 2867 ppm.

Magnesium contents in the fruits and fruit parts (441–1501 mg/kg in damask rose, 965–2175 mg/kg

Table 3. Mineral contents in fruits, fruit flesh, and seeds of the rose species (mg/kg)[a]

Minerals	*Rosa damascena*			*Rosa canina*		
	fruit	fruit flesh	seed	fruit	fruit flesh	feed
Phosphorus (P)	1224.0 ± 29.3	1459.0 ± 28.1	720.0 ± 10.4	1010.0 ± 28.2	673.0 ± 12.8	1282.0 ± 39.0
Potassium (K)	10256.0 ± 84.2	12454.0 ± 141.0	2243.0 ± 66.3	9140.0 ± 143.6	14545.0 ± 164.6	3231.0 ± 73.4
Calcium (Ca)	9440.0 ± 214.6	11162.0 ± 153.5	3885.0 ± 136.6	6301.0 ± 123.3	8442.0 ± 158.8	3800.0 ± 100.5
Magnesium (Mg)	1226.0 ± 27.6	1501.0 ± 24.0	441.0 ± 12.3	1652.0 ± 53.5	2175 ± 18.2	965.0 ± 23.5
Sodium (Na)	158.0 ± 3.2	163.0 ± 3.1	98.0 ± 3.4	149.0 ± 5.3	110.0 ± 0.7	98.0 ± 3.1
Iron (Fe)	11.0 ± 2.7	118.0 ± 2.2	110.0 ±0.3	27.0 ± 0.9	25.0 ± 0.6	15.0 ± 0.2
Copper (Cu)	4.0 ± 0.1	4.0 ± 0.1	4.0 ± 0.2	4.0 ± 0.1	3.0 ± 0.1	6.0 ± 0.2
Manganese (Mn)	59.0 ± 1.2	73.0 ± 1.1	24.0 ± 0.6	32.0 ± 0.1	43.0 ± 0.6	19.0 ± 0.5
Zinc (Zn)	13.0 ± 0.3	13.0 ± 0.6	10.0 ± 0.2	10.0 ± 0.3	7.0 ± 0.3	14.0 ± 0.3
Boron (B)	3.0 ± 0.5	5.0 ± 0.4	1.0 ± 0.1	13.0 ± 0.6	21.0 ± 0.9	2.0 ± 0.3

[a]all data represent the mean of three determinations

in rose hip) were close to the findings of Demir and Özcan (2001), and Kovacs *et al.* (2004). Sodium contents ranged from 98 to 163 mg/kg in damask rose and 98–149 mg/kg in rose hip. Na content of rose hip seeds was found to be higher than that given by Szentmihályi *et al.* (2002). Copper contents were determined to be 4 mg/kg with damask rose and between 3–6 mg/kg with rose hip. The Cu contents in the fruits of both rose species were low in comparison with the results of Ercisli (2007). The Cu contents obtained from the seeds of both rose species in this study were in accordance with the data of Szentmihályi *et al.* (2002). The iron contents in the fruits, fruit flesh, and seeds were determined to lie between 11–118 mg/kg in damask rose and 15–27 mg/kg in rose hip in this study. The Fe content in the rose hip fruits was very similar to that given by Ercisli (2007) but lower than that given by Demir and Özcan (2001). Also, the Fe content in rose hip seeds was close to the result of Szentmihályi *et al.* (2002) which was 20.15 ppm.

Manganese contents were determined as 24 mg/kg to 73 mg/kg and 19–43 mg/kg in damask rose and rose hip, respectively. The findings of the this study, regarding the Mn content in the fruits of dog rose, were lower than those reported by Ercisli (2007) but the results were similar to those reported by Demir and Özcan (2001). In another study, the content of P in rose hip seeds was determined as 22.54 µg/g (Szentmihályi *et al.* 2002). The zinc contents in the fruits, fruit flesh, and seeds of both rose species were found to range between 7–14 mg/ kg. The results obtained in the present study on the Zn content were in agreement with those of Ercisli (2007) and Szentmihályi *et al.* (2002), however, they are higher than those of Demir and Özcan (2001) which give the value of 3.69–4.51 ppm. The highest boron content in the rose species studied was found in the fruit flesh of rose hip (21 mg/kg) while the lowest one was determined in the seeds of damask rose (1 mg/kg). The B contents in the fruits of the rose species were found to be 3 mg/kg (damask rose) and 13 mg/kg (dog rose). The B content in the seeds of rose hip was reported as 7.54 ppm by Szentmihályi *et al.* (2002). In other study, the B content in the fruits of *Arbutus unedo* L. was determined as 16.03 mg/kg (Özcan & Haciseferogullari 2007).

The contents of mineral elements were found in this study, to differ greatly between the rose species as well as various parts of fruits. The difference in the mineral compositions of the fruits could be caused by the species, variety, ecological factors, and fruit size (Demir & Özcan 2001; Ercisli 2007). Moreover, the harvest time and altitude could also affect the mineral composition. The results in this study related to damask rose could only be compared with the reports on rose hip fruits, since almost no detailed studies on the chemical composition of damask rose fruits have been reported.

CONCLUSION

The results obtained in this study are considered significant for having shown that damask rose, although it contains oil, linolenic acid, β-carotene, and ascorbic acid in lower proportions than rose hip, can be utilised for similar purposes since it is richer than the latter one in α-tocopherol, oleic and linoleic acids, and minerals such as Ca, Fe, K, Mn, Na, P, and Zn. Decreased toxic elements contents such as Ag, Cd, and Cr is an important advantage. In conclusion, it would be possible to derive benefit from damask rose fruits, similarly as with rose hip fruits, in food and food additive sectors, as well as from using their flowers for the production of rose oil, rose water, rose concrete, and rose absolute.

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Corresponding author:

Ast. Prof. Soner Kazaz, Department of Landscape Architecture, Faculty of Forestry, University of Suleyman Demirel, Isparta 32260, Turkey

tel.: + 90 246 211 44 88, fax: + 90 246 237 18 10, e-mail: sonerkazaz@orman.sdu.edu.tr