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Functional Compounds and Antioxidant Activity of *Rosa* Species Grown In Turkey

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Abstract
Rose hips differ from other fruits with their high vitamin C, vitamin E, phenolic, and antioxidant content, making it an economical source of antioxidants. Exploring the fruit and seed components of different *Rosa* species could enable better use of their potential for various industries. Thus, rose hips of *Rosa corymbifera*, *Rosa rugosa* (Thunb.), *Rosa alba* L., and *Rosa canina* L. cultivated in the same growing conditions were analyzed. Their antioxidant activity and capacity, vitamin C, total carotenoids and phenolics, tocopherols and seed oils, as well as their fatty acid composition were determined. In addition to having highly polyunsaturated fatty acids, *R. canina* was also found to have noticeably high antioxidant components. In the overall evaluation (both fruit and oil characteristics), *R. canina* was found to have the most favorable content, while *R. rugosa* has the most desirable oil characteristics. As a result of the evaluation of fruit (excluding oil), *R. corymbifera* and *R. canina* were determined as prominent species. Despite medium level oil content, *R. rugosa* can be recommended for seed oil uses. *R. corymbifera* and *R. canina* are recommended for the food and food supplement industry. Production of rose hip species that contain the remarkable functional components of fruits and the health-promoting fatty acids of seeds may be used in combination as a marketing tool. In this way, the medicinal plant market share and profitability rate of rose hip will increase.

Keywords *R. canina* · *R. corymbifera* · *R. rugosa* · Tocopherols · Fatty acids

Introduction

In Turkey, rose species grow naturally, and it was only in the last few years that rose hip plants were cultivated on a commercial level. In fact, *Rosa canina* L. and *Rosa corymbifera* Borkh. are mainly used as ornamental plants or rootstocks for other cultivated species and varieties in Turkey.

R. corymbifera is a deciduous shrub plant that can grow to around 3 m. It is in the same taxonomic group as *R. canina*, and its morphological features are similar to the dog rose (D'Angiolillo et al. 2018). *Rosa rugosa* (Thunb.) is native to the northern coast of Japan and the Korean Peninsula, and is widely distributed in Northeast China and the northern hemisphere (Bruun 2005). *R. rugosa*, which is traditionally consumed as fruit juice, tea, jam, and marmalade, is a type of rose hip with high phytochemical and biological potential. *R. rugosa* seeds (achenes) are an important by-product of rose hip production (Patel 2013). *Rosa alba* L. is a large, down-curved, and thorny tree or shrub measuring up to 1.8 m in height with excellent velvety white roses that can grow in cold and unsuitable soils (Da Silva et al. 2014; Chaturvedi et al. 2009). *R. alba* is commonly known as white oil rose. It is widely cultivated in Europe, Asia, North America, and Northwest Africa for both ornamental and medicinal purposes due to the aromatic components in its fragrance (Verma et al. 2020).

Today, interest in the consumption of medicinal plants has increased. In particular, their immune-promoting effect has become even more important due to the COVID-19 epidemic that emerged in 2020 (Heiat et al. 2021; Sytar et al. 2021). The consumption of rose hip products is expected to increase in the future parallel to interest in medicinal plant consumption. The interest in rose hip is related to its pharmacologically effective components, especially its antioxidant components (Al-Yafeai et al. 2018). However, other components that confer functional properties on rose hip should be examined in more detail (Akram et al.

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2020). Many studies have reported—depending on the components in rose hip varieties—gastro-protective (Gurbuz et al. 2003), antiulcer (Lattanzio et al. 2011), hepatoprotective, and neuroprotective effects, as well as the ability to reduce the risk of cardiovascular diseases, prevent epithelitis after radiotherapy, antiarthritis, chronic musculoskeletal pain, while anticarcinogenic effects have also been reported (Chrubasik-Hausmann et al. 2014).

Rose hips, which are the fruit of the rose bush (*Rosa* genus), are valued for their flavor, taste, color, and aroma, in accordance with their recognition as one of richest sources of pro-health compounds. Screening, preservation, and propagation of the most valuable local populations of rose hip are carried out for food, pharmacological, and cosmetic applications (Okatan et al. 2019).

Rose hip is one of the important products in terms of quantity in world production and marketing of organic plants collected from nature (Pećinar et al. 2021). Rose hip plantations, which were rarely seen in the past, are now frequently encountered. Variety is reported to be an effective factor in the components of the rose hip (Nađpal et al. 2016; Shameh et al. 2019). Against this background, it is believed that the correct and suitable species and variety selection are important in newly established rose hip plantations. Rose hip is used for various purposes in the food industry, such as jam, marmalade, fruit juice, dried fruit, etc., as well as in the pharmaceutical industry and the food supplement industry, especially to reduce joint pain and strengthen immunity (Ayati et al. 2018). Therefore, determining the components of rose hip varieties and planning production and marketing according to the specified area of use of these components or the appropriate type of industry can lead to commercially successful results. The aim of this study was to determine some of the components and antioxidant activities of four rose hip species grown under the same growing conditions and with the same cultural practices. Depending on the defined components, some species will be recommended to farmers and producers.

Material and Methods

Material

In this study, rose hips of *R. corymbifera, R. rugosa, R. alba*, and *R. canina* cultivated in the rose orchard of the Ataturk Horticultural Central Research Institute, Yalova, Turkey, were used as plant material. Rose hips were hand-harvested when skin color turned a full red color in 2018 and 2019. They were stored at –18 °C until analysis.

A total of 3 g of dried and ground samples were taken and homogenized with 25 mL of pure methanol for 2 min and kept at +4 °C overnight. This was then centrifuged at 10,000 rpm for 20 min in a centrifuge. The supernatant was stored at –20 °C until analysis. These prepared extracts were used for the determination of total phenolic substance content and antioxidant activity, as well as for antioxidant capacity analysis (Apak et al. 2004; Thaipong et al. 2006).

Chemical Analyses

The total phenolic contents were determined using the Folin-Ciocalteu method (Thaipong et al. 2006). Antioxidant activity based on electron transfer was determined with the DPPH (2,2-diphenyl-1-picryl-hydrazyl-hydrate) method (Thaipong et al. 2006). Total phenol content and antioxidant activity were expressed as gallic acid equivalent. Antioxidant capacities were determined using the cupric ion reducing antioxidant capacity (CUPRAC) method and expressed as Trolox equivalent (Apak et al. 2004). The DCPIP (2,6-dichlorophenol indophenol) method was used for ascorbic acid content determination (AOAC 1990). Total sugar contents were determined with the Lane and Eynon method (Ranganan 1991). For seed oil determination, rose hips were cut into quarters and the seeds split with tweezers. The oil content of seeds was determined using a Soxhlet extractor (ISO 1988). Total sugar and seed oil content were expressed as percentages (%). Fatty acid composition of seed oils was determined according to the official method (TFC 2014) using a gas chromatography device. Each fatty acid was reported as a percentage of total fatty acids. Total carotenoid content was determined with a spectrophotometric method (Fascella et al. 2019). The official High-performance liquid chromatography (HPLC) method was used for α-tocopherol and γ-tocopherol content determination (FAO 2000).

Fatty Acid Composition Analysis

Quality index (QI), polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), saturated fatty acids (SFA), MUFA to PUFA ratio, and iodine number (IN) of seed oils were calculated (Kyriakidis and Katsiloulis 2000).

These formulas are as follows:

- SFA (%) = palmitic acid + stearic acid + arashidic acid + behenic acid
- MUFA (%) = palmitoleic acid + oleic acid + eicosenoic acid
- PUFA (%) = linoleic acid + linolenic acid
- IN = 0.93 × (oleic acid + eicosenoic acid) + 1.35 × (linoleic acid) + 2.62 × (linolenic acid)
- QI = Oleic acid/(palmitic acid + linoleic acid)

All of the analyses were repeated three times for each sample. Research was established according to a two factorial (year and species), completely randomized plot design to determine season and species differences. Statistical analysis was performed with the SAS statistical software package program with 0.05 significance value.

Results and Discussion

The flow chart of the study examining the functional properties of *R. corymbifera, R. rugosa, R. alba*, and *R. canina* cultivars grown in Turkey is given in Fig. 1.

Both high vitamin C and high total phenolic content are responsible for the high antioxidative activity of rose hip (Larsen et al. 2003). Vitamin E and carotenoids are also reported to be components that contribute to the antioxidative activity (Gruenwald et al. 2019). Vitamin C and total sugar content of rose hip and oil content of seeds are presented in Table 1. Vitamin C and oil content were reported as variable components in rose hip species (Roman et al. 2013). Ercisli and Esitken (2004) as well as Roman et al. (2013) reported the vitamin C content of rose hip to be between

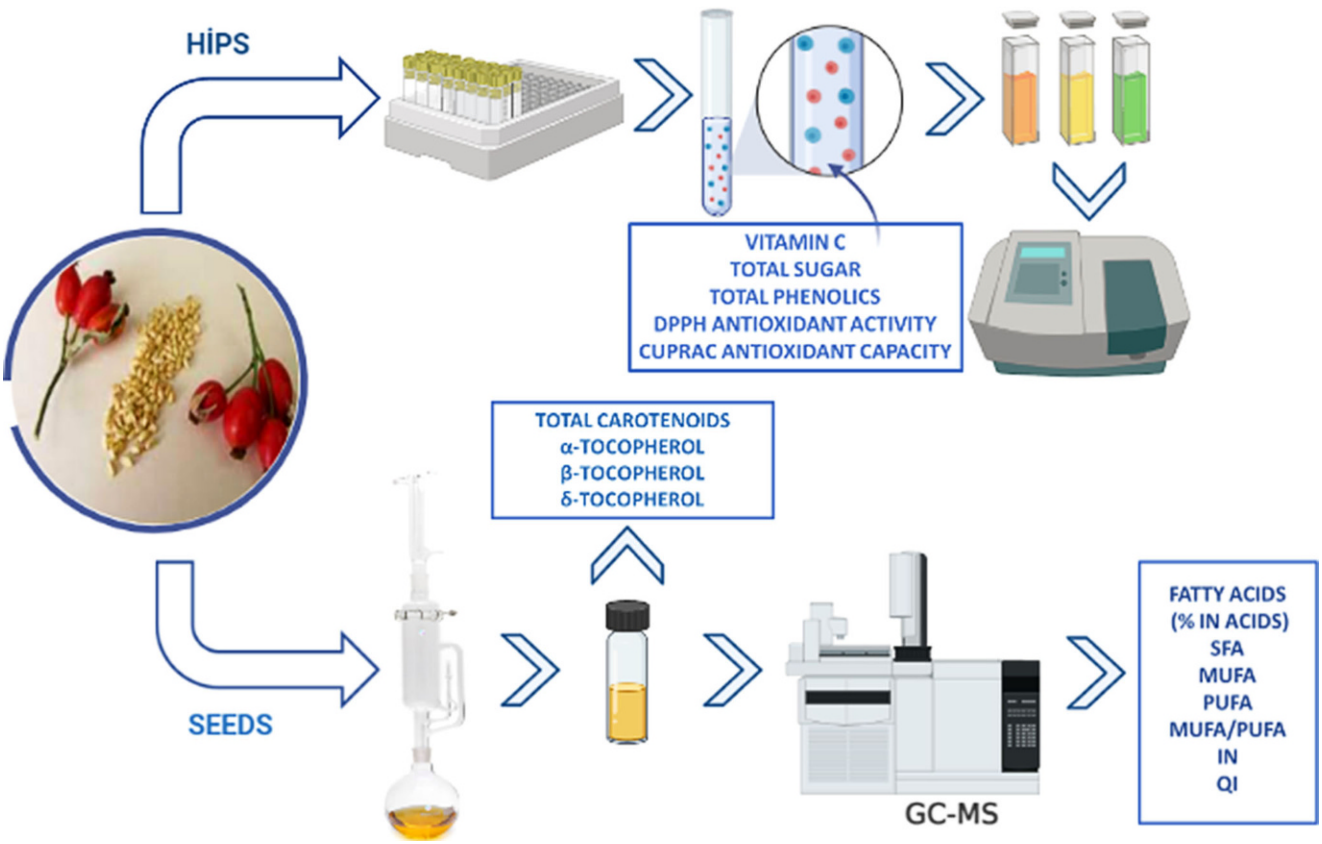

Fig. 1 Flow chart examining the functional properties of rose hip varieties. *GC-MS* gas chromatography-mass spectrometry, *SFA* saturated fatty acids, *MUFA* monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids, *IN* iodine number, *QI* quality index

Table 1 Vitamin C and total sugar content of rose hips as well as oil content of their seeds

Components	Year	*R. corymbifera*		*R. rugosa*		*R. alba*		*R. canina*		Average
Vitamin C (mg/100 g)	2018	760.52 ± 61.34	–	577.13 ± 9.04	–	733.86 ± 9.22	–	628.11 ± 4.05	–	784.00 A
	2019	900.65 ± 6.15	–	573.28 ± 53.26	–	900.22 ± 3.68	–	763.42 ± 29.37	–	674.75 B
	Average	830.54	A	575.21	C	816.50	A	695.50	B	–
Total sugar (%)	2018	6.63 ± 0.34	a	2.05 ± 0.08	d	6.18 ± 0.32	a	5.00 ± 0.43	b	4.49A
	2019	4.10 ± 0.60	c	2.16 ± 0.37	e	3.82 ± 0.36	c	4.98 ± 0.30	b	3.73B
	Average	5.36	A	2.10	B	4.99	A	4.99	A	–
Oil content in seed %	2018	16.07 ± 0.62	a	7.26 ± 0.07	Cd	5.89 ± 0.13	d	15.18 ± 0.97	a	–
	2019	16.19 ± 0.27	a	10.14 ± 0.47	b	7.71 ± 0.13	c	7.38 ± 0.26	Cd	11.10
	Average	16.12875	A	8.69875	C	6.7965	D	11.28	B	10.35

a–e represent the interaction of factors, while A–C represent one factor ($p < 0.05$)

Table 2 Total carotenes, α-tocopherol, and γ-tocopherol content of rose hips

Components	Year	*R. corymbifera*		*R. rugosa*		*R. alba*		*R. canina*		Average
Total carotenoids (mg/100 g dw)	2018	1258.36 ± 22.1	d	1310.08 ± 9.9	b	950.09 ± 9.3	h	1356.73 ± 27.2	a	1218.81A
	2019	1290.78 ± 26.2	c	1180.21 ± 9.83	f	1024.45 ± 1.08	g	1249.17 ± 13.2	e	1186.15B
	Average	1274.57	B	1245.14	C	987.27	D	1302.94	A	–
α-Tocopherol (µmol/100 g)	2018	7.87 ± 0.1	e	9.775 ± 0.18	b	9.275 ± 0.04	c	10.47 ± 0.11	a	9.35
	2019	8.2 ± 0.11	d	10.36 ± 0.06	a	9.475 ± 0.18	c	10.24 ± 0.05	a	9.57
	Average	8.03	–	10.07	–	9.38	–	10.36	–	–
γ-Tocopherol (µmol/100 g)	2018	1.63 ± 0.07	b–d	1.87 ± 0.06	a	1.68 ± 0.09	a–d	1.72 ± 0.14	a–c	1.73
	2019	1.48 ± 0.11	d	1.53 ± 0.02	Cd	1.81 ± 0.05	Ab	1.73 ± 0.15	a–c	1.64
	Average	1.55	–	1.71	–	1.75	–	1.725	–	–

a–e represent the interaction of factors
A–C represent one factor ($p < 0.05$)

180 and 965 mg/100 g. Dąbrowska et al. (2019) reported the oil content of rose hip seed to be between 7.5 and 8.8%. The total sugar contents of different rose hip genotypes were reported to be 7.95–16.65% (Bilgin et al. 2020) and 15.32–21.57% (Erogul and Oguz 2018). In this study, the vitamin C and total sugar contents of rose hip were determined to be 573.28–900.65 mg/100 g and 2.05–6.63%, respectively. Oil content of rose hip seeds ranged between 5.89 and 16.19%. In general, the oil content of rose hip seeds was higher than other fruits seeds, but lower than oil seeds such as flax (linseed) and sunflower (Wittkop et al. 2009). This result is in agreement with the results of Erogul and Oguz (2018), Roman et al. (2013), and Bilgin et al. (2020). Species differences had a strong effect on the vitamin C and oil contents of rose hips.

Although rose hips do not have high oil content seeds, their oil is rich in terms of bioactive components such as tocopherols, carotenoids, and sterols, which increase the potential medicinal uses of rose hips (Fromm et al. 2012). The total carotene, α-tocopherol, and γ-tocopherol contents of rose hips are presented in Table 2. Total carotenoid contents of different rose hip species were reported as between 1204.5 (*R. canina*) and 1235.7 (*R. sempervirens*) by Fascella et al. (2019), and 1072.7 (*R. corymbifera*) and 1061.7 mg/100 g dry weight (*R. micrantha*) by Andersson et al. (2011). The authors also indicated the statistically significant differences in carotenoid contents, which were caused by genetic, climatic, and ripening stage. This study found similar results (950.09–1356.71 mg/100 g dry weight) to these researchers.

The tocopherol content of rose hip is reported to mainly consist of α-tocopherol (~88%) and γ-tocopherol (~12%). On the other hand, β-tocopherol and δ(delta)-tocopherol were reported in trace amounts (Kazaz et al. 2009; Westphal et al. 2018). Total tocopherols were reported for in *R. dumalis* (10.12 µg/g) and *R. pisiformis* (17.60 µg/g) by Yoruk et al. (2008). The α-tocopherol and γ-tocopherol contents of *R. canina* rose hip were reported to be 12.4 µmol/100 g and 1.7 µmol/100 g, respectively, by Westphal et al. (2018). Similar results (15.9 µmol/100 g total tocopherol) were also reported for *R. canina* by Al-Yafeai et al. (2018). In this study, statistically significant differences were not determined between species for α-tocopherol and γ-tocopherol contents ($p < 0.05$). However, cultivation years were found

Table 3 Total phenolics, antioxidant activity, and antioxidant capacity of rose hips

Analysis	Year	*R. corymbifera*		*R. rugosa*		*R. alba*		*R. canina*		Average
Total phenolics (mg gallic acid/100 g)	2018	1335.70 ± 15.6	–	764.01 ± 49.54	–	1186.07 ± 34.29	–	1561.83 ± 55.84	–	1211.9
	2019	1336.37 ± 92.95	–	1029.05 ± 94.62	–	1259.21 ± 72.99	–	1515.53 ± 40.59	–	1285.04
	Average	1336.04	B	896.53	C	1222.64	B	1538.68	A	–
DPPH Antioxidant activity (mg gallic acid/100 g)	2018	7949.24 ± 48.20	b	566.67 ± 97.13	d	2695.45 ± 75.70	c	9786.37 ± 96.40	a	5249.43
	2019	9949.25 ± 74.21	a	1263.64 ± 75.75	Cd	2585.61 ± 46.20	c	9081.82 ± 93.34	Ab	5720.08
	Average	8949.24	A	915.15	C	2640.53	B	9434.09	A	–
CUPRAC Antioxidant capacity (mg Trolox/100 g)	2018	3190.75 ± 125.55	–	5377.75 ± 94.09	–	3234.50 ± 53.31	–	1932.50 ± 47.31	–	3433.88
	2019	2865.75 ± 145.11	–	5574.50 ± 101.54	–	3341.50 ± 28.56	–	1269.00 ± 119.00	–	3262.69
	Average	3028.25	B	5476.13	A	3288.00	B	1600.75	C	–

a–e represent the interaction of factors
A–C represent one factor ($p < 0.05$)

to be important for these contents. The highest carotenoids (1249.17–1356.71 mg/100 g dry weight) were found in *R. canina,* followed by *R.rugosa* and *R. corymbifera*.

Total phenolic content and antioxidant characteristics are presented in Table 3. Total phenolic compounds were 4500 mg gallic acid/100 g (PaunoviĆ et al. 2019) and 1900 mg gallic acid/100 g (Mihaylova et al. 2015). Antioxidant activity was 28.4–56.8 µmol TE/g (Erogul and Oguz 2018), and antioxidant capacity of was 35.53 mmol TE/g dry weigh (Demir et al. 2014). Total phenolic compounds of *R. canina* and *R. pimpinellifolia* were reported from the same regions and were not significantly different (Fattahi et al. 2012). However, in this study, statistically significant differences were found between species ($p<0.05$). Total phenolic content and antioxidant characters were determined to be lower than reported in the literature, but they are still remarkable compared to other fruits with their high antioxidant characteristics. Functional components such as phenolics and carotenoids are quality indicators of foods (Girón et al. 2019). Thus, the production of foods that have a high content of bioactive components can increase the profits of farmers and producers.

The fatty acid composition of rose hip seed is presented in Table 4. Statistically significant differences were not seen for butyric, palmitic, and arachidic acid contents of rose hip cultivars ($p<0.05$). *R. rugosa* has the highest linolenic acid and *R. alba* the highest oleic acid content, whereas *R. alba* has the lowest linoleic acid. Linoleic acid (54.80%) and linolenic acid (23.47%) were reported as the major fatty acids in rose hip seed oil (Turan et al. 2018). In this study, linoleic acid, oleic acid, and linolenic acid were determined as the main fatty acids. Similar to our study results, linoleic acid (36–55%) was reported as the most abundant fatty acid, followed by linolenic (17–27%) and oleic acid (15–22%) (Mannozzi et al. 2020).

R. rugosa and *R. canina* had a higher PUFA content than others, while *R. alba* had the highest MUFA content. *R. canina* had the lowest MUFA/PUFA ratio favorable for health nutrition. Calculated fatty acid characteristics are presented in Table 5. Rose hip oil contains more than 77% PUFA and therefore the oil is susceptible to oxidation (Concha et al. 2006). PUFA, MUFA, and SFA ratios of the *R. dumalis* (MR-12) were reported as 54.65–57.31%, 37.09–40.31%, and 5.56–5.71%, respectively (Gunes et al. 2017). High omega-6 and omega-3 group fatty acids of rose hip seed oil

Table 4 Fatty acid composition of rose hip seeds

Fatty acids (% in acids)	Year	*R. corymbifera*		*R. rugosa*		*R. alba*		*R. canina*		Average
Butyric acid	2018	7.28 ± 1.32	Ab	2.61 ± 0.07	c	3.92 ± 0.06	Bc	4.38 ± 0.06	Bc	4.55
	2019	4.39 ± 0.21	Bc	6.04 ± 0.01	a–c	8.43 ± 0.97	a	3.77 ± 0.89	c	5.66
	Average	5.84	–	4.33	–	6.18	–	4.08	–	–
Palmitic acid	2018	2.06 ± 0.04	–	2.70 ± 0.21	–	2.31 ± 0.65	–	1.93 ± 0.06	–	2.25
	2019	2.99 ± 0.19	–	2.10 ± 0.02	–	2.60 ± 0.13	–	2.44 ± 0.07	–	2.53
	Average	2.53	–	2.40	–	2.46	–	2.18	–	–
Stearic acid	2018	2.05 ± 0.10	–	0.89 ± 0.01	–	1.82 ± 0.11	–	0.87 ± 0.01	–	1.41
	2019	2.17 ± 0.14	–	0.88 ± 0.07	–	1.50 ± 0.26	–	1.79 ± 0.12	–	1.59
	Average	2.11	A	0.88	C	1.66	AB	1.33	BC	–
Oleic acid	2018	21.11 ± 0.30	c	18.74 ± 0.63	Cd	33.03 ± 0.10	a	15.73 ± 0.07	d	22.15
	2019	20.79 ± 0.14	c	16.59 ± 0.32	d	26.97 ± 1.97	b	20.99 ± 0.15	c	21.34
	Average	20.95	B	17.67	C	30.00	A	18.36	C	–
Linoleic acid	2018	51.52 ± 0.90	–	52.23 ± 0.56	–	43.97 ± 3.45	–	59.08 ± 0.51	–	51.70
	2019	53.71 ± 0.43	–	53.74 ± 0.43	–	40.51 ± 0.48	–	54.41 ± 0.87	–	50.59
	Average	52.61	A	52.98	A	42.24	B	56.74	A	–
Linolenic acid	2018	14.72 ± 0.12	d	21.66 ± 0.01	a	16.92 ± 0.86	c	17.40 ± 0.05	Bc	17.67A
	2019	15.04 ± 0.07	d	19.18 ± 0.22	b	18.12 ± 0.31	Bc	15.12 ± 0.27	d	16.87B
	Average	14.88	D	20.42	A	17.52	B	16.26	C	–
Arachidic acid	2018	0.33 ± 0.08	–	0.48 ± 0.24	–	0.71 ± 0.03	–	0.21 ± 0.01	–	0.43
	2019	0.26 ± 0.07	–	0.70 ± 0.03	–	0.61 ± 0.09	–	0.34 ± 0.02	–	0.48
	Average	0.29	–	0.59	–	0.66	–	0.28	–	–
Gadoleic acid	2018	0.71 ± 0.4	–	0.34 ± 0.03	–	0.32 ± 0.01	–	0.40 ± 0.01	–	0.44
	2019	0.66 ± 0.07	–	0.33 ± 0.01	–	0.27 ± 0.05	–	0.66 ± 0.02	–	0.48
	Average	0.68	A	0.33	C	0.30	C	0.53	B	–

a–e represent the interaction of factors

A–C represent one factor ($p<0.05$)

Table 5 Calculated fatty acid characteristics

	Year	*R. corymbifera*	*R. rugosa*	*R. alba*	*R. canina*
SFA	2018	11.72	6.68	8.76	7.39
	2019	9.81	9.72	13.14	8.34
MUFA	2018	21.82	19.08	33.35	16.13
	2019	21.45	16.92	27.24	21.65
PUFA	2018	66.24	73.89	60.89	76.48
	2019	68.75	72.92	58.63	69.53
MUFA/PUFA	2018	0.33	0.26	0.55	0.21
	2019	0.31	0.23	0.46	0.31
IN	2018	127.76	144.69	134.41	139.97
	2019	131.25	138.22	127.24	132.59
QI	2018	1.26	0.77	1.72	0.81
	2019	1.15	0.78	1.30	1.19

SFA saturated fatty acids, *MUFA* monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids, *IN* iodine number, *QI* quality index

are effective in anti-aging and health promotion (Dąbrowska et al. 2019). *R. rugosa* has a remarkably low QI, whereas *R. alba* has the highest. The IN of rose hip oil was reported to be 152–169 (Krist 2020) and 179 (Dąbrowska et al. 2019), which is higher than that found in this study. The higher SFA and lower MUFA and PUFA contents were responsible for this difference.

Conclusion

Rose hips are raw materials used in the cosmetics, medicinal, and food industries. The use of functional components of rosehip species in these industries may provide added value. It is important to produce varieties with characteristics specified to meet the growing interest in and specific expectations on rose hip species. The most commonly commercially used rose hip strain is *R. canina*. The most important quality parameters in *R. corymbifera, R. rugosa, R. alba,* and *R. canina* were compared. Thus, this study evaluated a number of functional characters of *R. corymbifera, R. rugosa, R. alba,* and *R. canina* to evaluate their potential. Genetic differences were determined as statistically important factors in rose hips, excluding tocopherol, butyric, palmitic, and arachidic acid content ($p<0.05$). In the overall evaluation (both fruit and oil characteristics), *R. canina* were determined as having the most favorable content, followed by *R. corymbifera* and *R. rugosa*, while *R. rugosa* has the most desirable oil characteristics. In addition to having the fatty acids required in terms of health, *R. canina* also has noticeably higher antioxidant components. When excluding the evaluation of fatty acid compositions and comparing fruit characteristics, *R. corymbifera* and *R. canina* were determined as prominent, while *R. rugosa* and *R. alba* lagged behind. Despite medium level oil content, *R. rugosa* can be recommended for oil uses in the skin care, cosmetic, and dermatology industry. Of the rose hip species, the highest vitamin C was observed in *R. corymbifera* and *R. alba* species, and a significant difference to *R canina* was observed. The highest total phenolics and DPPH antioxidants were seen in *R canina*, followed very closely by *R. corymbifera*. Therefore, *R. corymbifera* and *R alba* could be recommended as a raw material for vitamin C supplement production; on the other hand, *R canina* and *R. corymbifera* could be favorable raw materials for phenol supplement production. The *R. Rugosa* variety showed the highest activity in terms of CUPRAC antioxidant activity. In addition to the high vitamin C, antioxidant, and phenolic components, rose hips are also an important raw material resource for many sectors, since they have a very valuable fatty acid composition and tocophenol content. As a result of this study, it has been found that the *R. corymbifera* variety has superior properties in terms of its content, and it is an alternative to the commercial variety *R. canina*. Use of the rose hips *R. corymbifera* and *R. canina* can be recommended for the food, food supplement, and drug industry. The functional components and fatty acid composition can be used in tandem as a marketing tool for rose hip, thereby increasing the profitability rate of rose hip farmers.

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Author Contribution F.G. cultivated, followed the maturation levels of, and harvested the rose hips. S.K. determined the total phenolic and ascorbic acid, as well as total sugar contents, antioxidant activity/capacity, and fatty acid compositions. Y.O. determined the oil content of seeds as well as the total carotenoid, α-tocopherol, and γ-tocopherol content of rose hips. All authors participated in the preparation of this paper.

Conflict of interest S. Kayahan, Y. Ozdemir, and F. Gulbag declare that they have no competing interests.

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