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Fatty acids and mineral composition of seed oils extracted from different *Rosa* L. taxa

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SUMMARY: In the study, the macro and micro elements and fatty acid contents in rose seeds, which are generally evaluated in the waste category, were determined. Among the plants belonging to these taxa, only the registered varieties belonging to four taxa were used, while the others were genotypes. The plant materials of the study include rosehip (*R. canina* L.), Yildiz variety of rosehip (*R. canina* L. cv 'Yildiz'), Syrup rose (*R. heckeliana* Tratt. subsp. *vanheurckiana*), Austrian briar (*R. foetida* Herrm.), lax rootstock [*R. caesia* Sm. (Syn: *R. laxa* Retz.)], wild rose [*R. montana* subsp. *woronovii* Chaix subsp. *woronovii* (Lonacz) Ö. Nilsson L.], hybrid landscape roses (*R.* x *hybrida*) and Hosap rose [*R. pisiformis* (Christ) D.] taxa. It was determined that the contents of nitrogen, potassium, phosphorus, magnesium and calcium of the macro elements examined in the seed samples differed statistically from each other. The seeds of different *Rosa* L. species examined within the scope of the research can be considered as one of the fruit oil sources with its 3.71-10.01% oil content. The fatty acid contents were determined as follows: linoleic acid (ω6) contents in the taxa ranged from 41.63 to 50.11% with an average of 44.88%; oleic acid (ω9) ranged from 20.80 to 30.27% with an average of 24.95%; linolenic acid (ω3) varied between 14.00-28.51% with an average of 19.20%; arachidic acid ranged from 0.75-1.63% and the average was 1.97%; eicosenoic acid ranged between 0.13-0.65% and averaged 0.33%; palmitoleic acid contents ranged from 0.08-0.60; behenic acid varied between 0.08-0.19% with 0.11% average. It was observed that the (ω3/ω6 ratio of the hybrid rose, which is especially used as a landscape rose and whose fruits are not evaluated, had an average value. *R. canina* 'Yildiz' cultivar showed a high (ω3/ω6 ratio, which is important in health terms. The high oleic acid contents found in these taxa are important results.

KEYWORDS: *Element contents; Fatty acids; Oil extraction;* Rosa *L.; Rosehip oil.*

RESUMEN: ***Composición en ácidos grasos y minerales de aceites de semillas extraídos de diferentes taxones de* Rosa L**. En este estudio se determinaron los contenidos de macro y microelementos y ácidos grasos de las semillas de *Rosas*, que generalmente se clasifican en la categoría de residuos. Entre las plantas pertenecientes a estos taxones, solo se utilizaron las variedades registradas pertenecientes a cuatro taxones, mientras que las demás fueron genotipos. Los materiales vegetales del estudio incluyen rosa mosqueta (*R. canina* L.), variedad de rosa mosqueta Yildiz (*R. canina* L. cv 'Yildiz'), rosa de jarabe (*R. heckeliana* Tratt. subsp. *vanheurckiana*), brezo austríaco (*R. foetida* Herrm.), patrón laxo [*R. caesia* Sm. (Syn: *R. laxa* Retz.)], rosal silvestre [*R. montana* subesp. *woronovii* Chaix subsp. *woronovii* (Lonacz) Ö. Nilsson L.], rosas híbridas de paisaje (*R.* x *hybrida*) y rosa Hosap [*R. pisiformis* (Cristo) D.] taxones. Se determinó que los contenidos de nitrógeno, potasio, fósforo, magnesio y calcio entre los elementos examinados en las semillas diferían estadísticamente entre sí. Las semillas de diferentes especies de *Rosa* L. pueden considerarse como una de las fuentes de aceite de frutas con un contenido de 3,71-10,01%. El contenido de los ácidos linoleico (ω6) de los taxones de las rosas varió de 41,63 a 50,11 % con un promedio de 44,88 %, el oleico (ω9) varió de 20,80 a 30,27 % con un promedio de 24,95 %, el linolénico (ω3) varió entre 14,00 y 28,51 % con un promedio de 19,20 %, el araquídico osciló entre 0,75 y 1,63 % y 1,97 % de promedio, el eicosenoico osciló entre 0,13 y 0,65 % y promedio de 0,33, el behénico varió entre 0,08-0,19% con un promedio de 0,11%. Se ha observado que la relación ω3/ω6 de la rosa híbrida, que se utiliza especialmente como rosa de paisaje y cuyos frutos no se han evaluado, tienen un valor medio. El cultivar de *R. canina* 'Yildiz' tiene un alto valor de omega ω3/ω6 importante en términos de salud. El alto contenido de ácido oleico de estos taxones son unos resultados muy importantes.

PALABRAS CLAVE: *Aceite de rosa mosqueta; Ácidos grasos; Contenido de elementos; Extracción de aceite;* Rosa *L.*

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1. INTRODUCTION

The Rosales order includes nine families of economic and ecological importance. The Rosaceae family, which generally consists of trees and shrubs for landscaping and fruit growing, includes 90 genera and 3000 species. The members of the family have worldwide distribution but are more concentrated in the northern temperate regions. The family is extremely economically important as a source of many fruits, essential oils, and countless varieties of landscape and ornamental plants (Simpson, 2019).

Horticulture is basically a discipline concerned with the cultivation of plant materials by humans for food supply, medicinal use, or functional and aesthetic purposes. Roses are a genetically diverse group and play an important role in the economy of modern society but are also central to the healthy diets of urban populations. From this point of view, they are an extremely important garden plant because they contain these features. *R. canina*, *R. rugosa* and *R. montana* taxa are the most commonly used species in industry and are known as 'rosehip'.

The most important characteristics affecting the quality of the fruits of these species are taste and aroma. The soluble solid content of fruits is directly related to taste, and sugars make up a large part of the water-soluble dry matter. Rosehip has always been appreciated as a cheap source of vitamin C in times of war and economic depression due to its biological and nutritional values. Rosehip fruits contain vitamins A, B1, B2, E, C, P, and K (Roman *et al.*, 2013; Oz *et al.*, 2018; Fascella *et al.*, 2019; Fetni *et al.*, 2020). In this context, the rosehip (*Rosa* L.) plant has maintained its importance in folk medicine and medicine since historical times. Rosehip seed oil is a valuable raw material for the development of herbal cosmetics and skin care products such as lotions and creams.

The seeds of many products containing bioactive compounds such as rosehip are classified as waste during the processes in the factory, and it has been stated that the effective use of these waste products is limited (Szentmihályi *et al.*, 2002; Vasic *et al.,* 2020; Saygi, 2021). The seeds in question contain unsaturated fatty acids such as linoleic acid (C18:2n6c), oleic acid (C18:1n9c) and α-linolenic acid (C18:3n3) (McGaw *et al.*, 2002; Nowak, 2005; Ercisli, 2007; Machmudah *et al.*, 2007; Kazaz *et al.*, 2009; Kizil *et al.*, 2018; Vasic *et al.*, 2020; Mannozzi *et al.*, 2020).

The originality of this article is that many of the taxa examined have not been studied in this respect before. It can be said that the reasons for this are that it is difficult to reach the regions where it is located, the number of seeds varies and most of them are collected as *R. canina*. As a result of the research, it was determined that the species that were not evaluated before (with waste seeds) also had important characteristics. Zero waste is an important phenomenon for today. In the research, it was determined that different properties of rose oils, which are used in landscape architecture studies and whose fruits (seeds) are in the waste category, are also important.

The fatty acids extracted from *Rosa* L. seeds show significant antibacterial, antioxidant, anti-inflammatory, and anti-cyanobacterial activity (McGaw *et al.*, 2002). Considering both the phytochemical contents of these oils for human health from research in medicine pharmacy and chemistry (Guven *et al.*, 2021) and the positive effects of using them as feed in agricultural production and aquaculture studies (Dyck and Evans, 2021), there are many promising factors. Therefore, their separation from the waste category is an important phenomenon. Within the scope of the study, fixed oil contents and compositions and macro and micro element contents of seeds belonging to 8 different *Rosa* L. taxa were determined.

2. MATERIALS AND METHODS

2.1. Materials

The plant materials in the study include rosehip (*R. canina* L.), Yildiz variety of rosehip (*R. canina* L. cv 'Yildiz'), Syrup rose (*R. heckeliana* Tratt. subsp. *vanheurckiana*), Austrian briar (*R. foetida* Herrm.), lax rootstock [*R. caesia* Sm. (Syn: *R. laxa* Retz.)], wild rose [*R. montana* subsp. *woronovii* Chaix subsp. *woronovii* (Lonacz) Ö. Nilsson L.], hybrid landscape roses (*R.* x *hybrida*) and Hosap rose [*R. pisiformis* (Christ) D.] taxa. The taxa names are written in full at this stage, and in other parts of the research, they are given in a short form without authorization.

Cuttings belonging to the taxa were taken from Van Yüzüncü Yıl University Faculty of Architecture and Design, Landscape Architecture Department Research Fields and Tokat Gaziosmanpaşa University Faculty of Agriculture Department of Horticulture

Research Field. The literature of Brummitt and Powell (1992) was taken as a reference for the standard spelling of scientific names of species and subspecies, including the authors (abbreviations), and was examined by considering the UPOV (2010) criteria.

Among the plants belonging to these taxa, only the registered varieties belonging to four taxa were used, while the others were genotypes. In the study carried out under greenhouse conditions, the greenhouse temperature was measured with an Onset Computer H21-001 HOBO brand thermometer and the average annual temperature was determined as 24.73 °C. This value was determined as a result of measurements made for 24 months. It was determined that the pH of the growing medium in which the study was carried out was 7.14 and had a clay/loamy structure. The lime content was determined as 6.14% and the salt content was 0.04 %.

2.2. Methods

2.2.1. Determination of oil yield from seeds

The seeds of the specified taxa were dried in an oven at 65 °C for 72 hours. The experiment was established with 3 replications and 12 grams of seed in each replication. The seeds were ground in a coffee grinder (Sinbo SCM-2934 110 W). The cartridge was placed on the hangers in the extraction beaker of the instrument and programmed to extract for 4 hours in the Soxhlet extractor (Gerhardt®) by adding 150 ml of solvent (ether with a boiling point of 40-60 °C) into the extraction beaker. At the end of the program, the hanging cartridges were taken and the extraction beakers were dried at 103 °C for 1 hour and cooled in the desiccator, then weighed with an accuracy of 0.001 g. The drying-cooling and weighing process continued until the difference between the two weights was less than 0.1%. The amount of oil in the sample after weighing was calculated as a weight percent (Gokturk Baydar and Akkurt, 2007; Sabir *et al.*, 2012; Canbay and Bardakci, 2011). At the end of the process, the flasks were kept in an oven at 60 °C for 24 hours to evaporate the hexane from the mixture, and the fixed oil content was determined as the weight of the oil yield (%w/w) (Ercisli, 2007; Celik *et al.*, 2010; Lachmann *et al.*, 2015). 130 ml of hexane were added to the ground rose seeds (35 g) and kept in a circular shaker at 180 rpm for 2 hours. At the end of the period, the content was filtered coarsely and the hexane in the filtrate was removed in a rotary evaporator at 40 °C to obtain oil.

2.2.2. Determination of fatty acid content and composition

Fatty acid methyl esters were formed as indicated for the determination of fatty acid quantities. For this, 4 g of the oil sample were weighed and kept in the dark for 6 minutes with isooctane and methanolic KOH. Then, 2-3 drops of methyl orange and 1 N HCl were added, and phase separation was observed. At the end of the process, 1 ml of the clear phase formed in the phase separation was taken and injected into the device. The oils extracted in the Soxhlet extractor were stored in 10 mL hexane in screw-capped tubes at 4 °C until the fatty acids were determined. Before analysis, the hexane in the tubes was separated from the oils in an oven at 60 °C for 4 hours (Yakar *et al.*, 2021). In order to determine the fatty acid composition, a Thermo brand, TraceGC Ultra model, FID (Flame Ion Dedector) detector gas chromatography device was used. A 60 m HP-88 column was used for the separation of fatty acids. The temperature of the injector block was set at 280 and 250 °C. It was adjusted to reach 180 °C with an increase of 20 °C/min after waiting for 2 minutes at 50 °C. With an increase of 5 °C/min from this value, it reached 230 °C and was held at this temperature for 5.5 minutes. The split ratio was 1/50. Hydrogen was used as the carrier gas, and the determination was made with 3 replications.

2.2.3. Determination of elements in seeds

Rose seeds, which were dried in an oven at 65 °C for 72 hours, were ground in a coffee grinder until they turned into powder. The core samples were then pulverized in 3 replications, with 0.5 g of sample burnt in each replication using the wet burning method. The % of N was determined according to the Khejdal method (Kacar, 1972). Plant elements such as P, K, Ca, Mg, Fe, Mn, Cu, Zn, B, Na were determined in the ICP device by dissolving them in a 1 N HCl acid solution (Ryan *et al.*, 2001).

2.3. Statistical analysis

The data from analysis and measurements were subjected to Analysis of Variance (ANOVA) in the Minitab 18 computer package program. Differences between means were expressed by grouping according to ANOVA and compared among themselves according to the LSD 5% level.

3. RESULTS AND DISCUSSION

3.1. Oil contents of Rosa seeds

In this study, the seed fatty acid compositions of *Rosa* L. taxa (*R. montana* subsp. *woronovii*, *R. foetida*, *R. laxa*) which had not been studied before were determined. In addition to these taxa, the seed oil contents of previously studied taxa *R. canina*, *R. heckeliana*, *R. pisiformis* and hybrid landscape rose seeds were also investigated (Szentmihalyi *et al.,* 2000; Nowak 2005; Ercisli 2007; Machmudah *et al.,* 2007; Kazaz *et al.*, 2009; Celik *et al.,* 2010; Prescha *et al.,* 2014, İlyasoğlu, 2014; Turan *et al.,* 2018; Kizil *et al.,* 2018; Vasic *et al.,* 2020). As a result of the study, the different values for *R. canina* and *R. canina* 'Yildiz' seeds obtained under the same ecological conditions and from the same species show that the fatty acid compositions may vary not only on the basis of species, but also according to varieties. In this context, the oil content in the seeds of the *Rosa* L. taxa, which is the subject of this research, was determined and statistical evaluations were made for the years 2020, 2021 and the average of the two years (Table 1).

According to the average values of the two-year data, although the seed oil contents varied according to the species and subspecies, the difference between the years was found to be statistically insignificant ($p > 0.05$).

Considering the descriptive statistics, the seed oil contents from 2020 varied between 3.79 and 10.06% and the average value of the investigated taxa was 6.83%. The seed oil contents from 2021 ranged between 3.64 and 9.96% and the average value of the investigated taxa was 6.78%. According to the data obtained, *R. montana* subsp. *woronovii* seeds had the lowest seed oil content in 2020 and 2021, and the *R. heckeliana* species had the highest seed oil content.

Ercisli (2007) studied six taxa and found that the oil content was between 4.60 and 5.37%. In this context, when the seed oil contents of the *Rosa* L. taxa used in this research were taken into account, it was determined that the data obtained were comparable to the literature data. When the relevant literature is examined, it is possible that the differences in fatty acid composition may be related to environmental conditions (climate and altitude, etc.), which are known to have an effect on fatty acid composition (Ilyasoglu, 2014). The subspecies were determined to have a value above the average (10.01%).

In recent years, research on different fruit oils in the cosmetic and food industries has increased and alternative products have begun to be examined in more detail. The seeds from different rose species examined within the scope of this research can be considered as a fruit oil source with its 3.71-10.01% oil content.

3.2. Fatty acid composition of seed oil

According to the analyses made on the eight *Rosa* L. taxa investigated, these taxa contain an

Table 1. Total oil contents in Rosa seeds (%)

Taxa	2020	2021	Average
R. canina	8.48±0.07[c]	8.40±0.04[c]	8.44±0.05
R. canina 'Yildiz'	9.07±0.05[b]	9.04±0.07[b]	9.05±0.05
R. foetida	3.99±0.02[h]	3.84±0.10[h]	3.91±0.03
R. heckeliana subsp. *vanheurckiona*	10.06±0.05[a]	9.96±0.05[a]	10.01±0.08
R. laxa	8.14±0.02[d]	8.22±0.02[d]	8.18±0.06
*R. montana*subsp.*woronovii*	3.79±0.11[i]	3.64±0.03[i]	3.71±0.04
R. pisiformis	7.78±0.02[e]	7.69±0.03[e]	7.73±0.05
R. x hybrida	4.70±0.02[g]	4.80±0.03[g]	4.75±0.04
LSD (%5)	0.090[a]	0.095[a]	1.375[b]

[a]At the 5% level, taxa were found to be statistically significant. (The data obtained were compared among themselves according to the LSD 5% level)
[b]The difference between years at the level of 5% was found to be statistically significant. Each application was analyzed in triplicate.

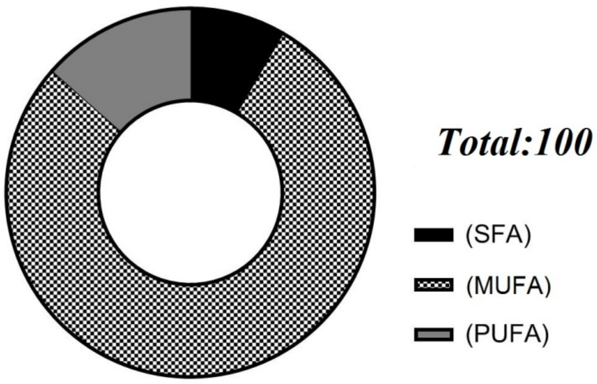

Figure 1. Percent oil content in Rosa L. seeds

average of 91.62% unsaturated fatty acids and 8.38% saturated fatty acids (Figure 1). These rates are 96.17 - 3.83%, respectively, in the studies by Nowak (2005), 85% and 15% according to Macmudah *et al.* (2007), and in the studies by Kazaz *et al.* (2009), they were determined as 91.1% and 8.90%. Therefore, it has been concluded that the results obtained in this research are comparable to the literature data in question.

Unlike data from the literature (McGaw *et al*., 2002; Nowak, 2005; Ercisli, 2007; Machmudah *et al*., 2007; Kazaz *et al*., 2009; Kizil *et al*., 2018; Vasic *et al*., 2020), it was determined that the *Rosa* L. taxa contained low levels of lauric acid. In accordance with the results from the statistical analysis of the saturated fatty acid contents found, the saturated fatty acids varied according to the taxa and the difference between the taxa was statistically significant at the 5% level. When the descriptive statistics of the palmitic acid contents in the seeds of *Rosa* L. taxa were considered, the content of palmitic acid varied between 4.44-7.28% with an average of 5.50%, the stearic acid contents ranged between 1.15-4.80% and averaged at 2.70% (Table 2).

It was determined that *R. pisiformis* has the lowest palmitic acid content; while the *R. montana* subsp. *woronovii* taxa has the highest palmitic acid content. *R. foetida* has the lowest stearic acid content, and hybrid tea rose seeds have the highest stearic acid content.

In some studies on *Rosa* L. taxa, the palmitic acid values for seeds were found by Szentmihalyi *et al.* (2002) to be 7.87%, by Nowak (2005) at 3.05%, Machmudah *et al.* (2007) found 5.01%, and Kazaz *et al.* (2009) at 3.66%. The average palmitic acid values for the *Rosa* L. taxa in this study were found to be 5.50%, which is comparable to the literature findings. Considering the palmitic acid values of the rose taxa used in this research, it was found that they were high for the roses used for landscaping and in *R. foetida* species.

In some studies on *Rosa* L. taxa, the stearic acid values for the seeds were found by Szentmihalyi *et al.* (2002) at 3.18%, by Nowak (2005) at 1.84%, by Machmudah *et al.* (2007) at 2.72%, by Prescha *et al.* (2014) at 1.80%, and Turan *et al.* (2018) at 2.19% stearic acid. The average stearic acid values for the *Rosa* L. taxa examined in this study were found to be 2.70%, which is comparable to the literature.

Table 2. Saturated fatty acid (SFA) contents in seeds of *Rosa* L. taxa (%)

Taxa	C12:0(%)	C14:0(%)	C15:0(%)	C16:0(%)	C17:0(%)	C18:0(%)	C20:0(%)	C22:0(%)
R. canina	0.03±0.01^{de}	0.03±0.01^{e}	0.03±0.01^{c}	4.53±0.89^{e}	0.04±0.01^{e}	1.73±0.18^{e}	0.04±0.02^{bcd}	0.12±0.03^{bc}
R. canina 'Yildiz'	0.05±0.02^{de}	0.03±0.01^{e}	0.04±0.00^{c}	4.45±0.22^{e}	0.09±0.01^{a}	3.92±0.30^{b}	0.06±0.02^{abc}	0.19±0.06^{a}
R. foetida	0.27±0.08^{a}	0.08±0.01^{b}	0.06±0.01^{bc}	6.48±0.39^{bc}	0.08±0.02^{ab}	1.54±0.01^{e}	0.02±0.01^{d}	0.08±0.01^{c}
R. heckeliana subsp. *vanheurckiona*	0.07±0.00^{cd}	0.05±0.01^{cd}	0.06±0.01^{bc}	3.59±0.06^{f}	0.03±0.01^{e}	1.15±0.16^{f}	0.04±0.00^{cd}	0.11±0.01^{c}
R. laxa	0.01±0.00^{e}	0.06±0.01^{c}	0.04±0.01^{c}	5.88±0.16^{cd}	0.07±0.01^{ab}	3.37±0.03^{c}	0.04±0.01^{cd}	0.11±0.01^{c}
R. montana subsp.*woronovii*	0.10±0.01^{bc}	0.12±0.01^{a}	0.08±0.01^{ab}	5.81±0.06^{d}	0.07±0.01^{abc}	2.47±0.06^{d}	0.04±0.01^{cd}	0.09±0.04^{c}
R. pisiformis	0.13±0.01^{b}	0.08±0.01^{b}	0.09±0.03^{a}	4.44±0.36^{e}	0.05±0.01^{cd}	1.19±0.03^{f}	0.08±0.02^{a}	0.18±0.06^{ab}
R. x hybrida	0.05±0.01^{de}	0.06±0.01^{c}	0.08±0.01^{ab}	7.28±0.01^{a}	0.08±0.01^{ab}	4.80±0.04^{a}	0.03±0.01^{d}	0.09±0.01c
LSD (%5)	0.051^{a}	0.015^{a}	0.027^{a}	0.622^{a}	0.023^{a}	0.242^{a}	0.030^{a}	0.058^{a}

[a] Significant at the 5% level. (The data obtained were compared among themselves according to the LSD 5% level) (C12:0: Lauric acid; C14:0: Myristic acid; C15:0: Pentadecanoic acid; C16:0: Palmitic acid; C17:0: Heptadecanoic acid; C18:0: Stearic acid; C22:0: Behenic acid). Each application was analyzed in triplicate.

Table 3. Polyunsaturated fatty acid (PUFA) contents in Rosa L. taxa (%)

Taxa	C18:2n6c (%)	C18:3n3 (%)	C20:5n3 (%)
R. canina	50.11±0.92[a]	19.90±1.12[cd]	0.04±0.02[bcd]
R. canina 'Yildiz'	44.78±0.63[b]	14.00±1.29[g]	0.06±0.02[abc]
R. foetida	43.96±0.49[bc]	16.40±0.90[e]	0.02±0.01[d]
R. heckeliana subsp. *vanheurckiona*	41.64±0.16[c]	28.51±0.36[a]	0.04±0.01[cd]
R. laxa	45.18±0.02[b]	19.03±0.04[d]	0.04±0.01[cd]
R. montana subsp. *woronovii*	41.63±0.17[c]	20.82±0.20[c]	0.04±0.01[cd]
R. pisiformis	43.69±0.14[bc]	23.34±0.18[b]	0.08±0.02[a]
R. x hybrida	49.20±0.34[a]	15.20±0.06[f]	0.03±0.01[d]
LSD (%5)	2.468[a]	1.156[a]	0.030[a]

[a]Significant at the 5% level. (The data obtained were compared among themselves according to the LSD 5% level) (C18:2n6c: Linoleic acid; C18:3n3: alpha-Linolenic acid; C20:5n3: cis-5,8,11,14,17-Eicosapentaenoic acid). Each application was analyzed in triplicate.

Table 4. Monounsaturated fatty acid (MUFA) contents in Rosa L. taxa (%)

Taxa	C16:1(%)	C17:1(%)	C20:1n9(%)	C18:1n9c(%)
R. canina	50.11±0.92[a]	19.90±1.12[cd]	0.37±0.15[b]	22.07±1.34[e]
R. canina 'Yildiz'	44.78±0.63[b]	14.00±1.29[g]	0.35±0.02[b]	30.27±1.41[a]
R. foetida	43.96±0.49[bc]	16.40±0.90[e]	0.63±0.09[a]	29.16±0.62[a]
R. heckeliana subsp. *vanheurckiona*	41.64±0.16[c]	28.51±0.36[a]	0.26±0.23[bc]	23.53±0.04[d]
R. laxa	45.18±0.02[b]	19.03±0.04[d]	0.24±0.02[bc]	24.66±0.16[cd]
R. montana subsp. *woronovii*	41.63±0.17[c]	20.82±0.20[c]	0.29±0.01[bc]	27.00±0.14[b]
R. pisiformis	43.69±0.14[bc]	23.34±0.18[b]	0.65±0.16[a]	25.05±0.27[c]
R. x hybrida	49.20±0.34[a]	15.20±0.06[f]	0.13±0.04[c]	22.04±0.63[e]
LSD (%5)	2.468[a]	1.156[a]	0.194[a]	1.258[a]

[a] Significant at the 5% level. (The data obtained were compared among themselves according to the LSD 5% level). (C16:1: Palmitoleic acid; C17:1: cis-10-Heptadecanoic acid; C20:0: Arachidic acid; C20:1n9: cis-11-Eicosenoic acid; C18:1n9c: Oleic acid). Each application was analyzed in triplicate.

It was determined that there are saturated fatty acids such as lauric acid, mystric acid, pentadecanoic acid, heptadecanoic acid, and behenic acid in the seeds of the taxa in question. A high amount of lauric acid content (0.27%) was found in the *R. foetida* taxa compared to other taxa, and the mystric acid content was found at a higher level (0.12%) in *R.montana* taxa compared to other taxa.

According to the results from the analysis of the unsaturated fatty acid contents in the seeds of the Rosa L. taxa with the data from 2021, oleic, linoleic, linolenic, palmitoleic, heptadecanoic, arachidic, eicosenoic and eicosapentanoic acid contents varied according to the taxa and the difference between the taxa was statistically significant (Table 3).

Linoleic acid (ω6) contents in the investigated rose taxa ranged from 41.63 to 50.11% with an average of 44.88%. Oleic acid (ω9) contents ranged from 20.80 to 30.27% with an average of 24.95%. Linolenic acid (ω3) contents in eicosenoic acid varied between 14.00 and 28.51%, with an average of 19.20%. Arachidic acid contents ranged from 0.75 to 1.63% and the average was 1.97%. Eicosenoic acid contents ranged between 0.13 and 0.65% with an average of 0.33%. Palmitoleic acid contents ranged from 0.08 to 0.60. The content of behenic acid was found to vary between 0.08 and 0.19%, which is 0.11% on average.

According to the data obtained, the lowest oleic acid content was determined in *R.* x *hybrida*, and the highest oleic acid content was found in *R. foetida* and 'Yildiz' seeds from 2021 (Table 4). As a result of the analysis, the lowest linoleic acid content was found in *R. montana* subsp. *woronovii* and *R. heckeliana*, and the highest linoleic acid content was found in *R.*

canina and hybrid rose seeds. It was determined that *R. canina* 'Yildiz' contained the highest alpha-linolenic acid content and *R. heckeliana* species had the highest linolenic acid content.

Szentmihalyi *et al.* (2000), Nowak (2005), Ercisli (2007), Machmudah *et al.* (2007), Kazaz *et al.* (2009), Celik *et al.* (2010), Prescha *et al.* (2014), İlyasoğlu (2014), Turan *et al.* (2018), Kizil *et al.* (2018), Vasic *et al.* (2020) stated that the distribution of fatty acids is more important than the oil content in the seeds, and that rose/rosehip seeds are rich in unsaturated fatty acids and their fatty acid compositions consists of major linoleic, oleic, and alpha-linolenic acids. Considering the fatty acid values for the rose taxa used in the research, it was determined that the data obtained and the literature data were generally comparable.

In Aydın's (2010) study, it was stated that the ideal omega-3/omega-6 ratio should be between 1 and 0.25, and that among these ratios, the anti-inflammatory, analgesic and blood thinning effects of the herbal product would be more effective. The ω-3/ω-6 values for olive oil and grape seed oils were found to be in these ranges. It was determined that *R. canina* 'Yildiz' and *R.* x *hybrid* taxa of *Rosa* L. taxa were close to this oil yield. The hybrid Chinese rose, which is used as a landscape rose and whose fruits were not evaluated, and the *R. canina* 'Yildiz' cultivar, were found to contain high rates of oleic acid, known as omega-9 fatty acid. These are promising results.

3.3. Macro and micro element contents in Rosa seeds

The contents of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) in the macro elements examined in the seed samples differed statistically from one another. Accordingly, the highest nitrogen content was found in the *R. pisiformis s*taxa (Table 5).

It was determined that the iron (Fe), copper (Cu), zinc (Zn), manganese (Mn) and boron (B) contents in the micro elements examined in the seed samples statistically differed from one another by 5%. Accordingly, the highest iron content (73.26 ppm) was found in *R. montana* subsp. *woronovii*; the lowest iron content (30.70 ppm) was detected in the seeds of the *R. canina* 'Yildiz' taxa (Table 6).

Kazaz *et al.* (2009) determined the macro elements in *R. canina* seeds as 0.12% P, 0.32% K, 0.38% Ca, 0.09% Mg. According to the findings obtained in the study, the mean P values of 11 *Rosa* L. taxa were determined as 0.12% P and 0.31% K, and these two elements were found to be similar to the relevant literature. On the other hand, Ca and Mg values were found to be higher in the study. The iron, copper, zinc, manganese and boron contents in the seeds of *R. canina* were averaged and the taxa was also examined. They reached similar findings in the order of the mentioned micro elements and reported that there were higher mineral contents compared to the seeds of *R.* x *damascena*.

Ercisli (2007) and Kazaz *et al.* (2009) also found low Cu contents in the species. It was determined that the 'Yildiz' rosehip cultivar, which was examined within the scope of the research, contained higher levels of copper compared to these studies and other taxa. Szentmihályi *et al.* (2002) determined the average Fe content in the seeds of the

Table 5. Macro element content values in seeds of *Rosa* L. taxa (%)

Taxa	N (%)	P (%)	K (%)	Mg (%)	Ca (%)
R. canina	1.34±0.02[f]	0.06±0.01[ef]	0.23±0.01[cd]	0.13±0.01[g]	0.45±0.04[i]
R. canina 'Yildiz'	1.47±0.01[d]	0.10±0.01[d]	0.25±0.02[cd]	0.16±0.01[e]	0.59±0.03[f]
R. foetida	1.55±0.01[b]	0.07±0.02[ef]	0.34±0.01[a]	0.15±0.01[ef]	0.62±0.04[cd]
R. heckeliana subsp. *vanheurckiona*	1.51±0.02[c]	0.08±0.01[de]	0.33±0.01[ab]	0.19±0.01[b]	0.83±0.02[a]
R. laxa	1.15±0.01[h]	0.08±0.01[de]	0.28±0.00[bc]	0.18±0.00[d]	0.75±0.02[b]
*R. montana*subsp.*woronovii*	1.40±0.01[e]	0.18±0.01[b]	0.24±0.01[cd]	0.13±0.01[g]	0.48±0.02[h]
R. pisiformis	0.98±0.01[i]	0.15±0.00[c]	0.28±0.02[bc]	0.13±0.00[g]	0.60±0.03[ef]
R. x hybrida	1.61±0.01[a]	0.21±0.04[a]	0.34±0.02[a]	0.21±0.00[a]	0.64±0.04[c]
LSD (%5)	0.019[a]	0.023[a]	0.081[a]	0.011[a]	0.064[a]

[a]Significant at the 5% level. (The data obtained were compared among themselves according to the LSD 5% level). Each application was analyzed in triplicate.

Table 6. Micro element content values in seeds of *Rosa* L. taxa (ppm)

Taxa	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)	B (ppm)
R. canina	32.23±0.18[g]	8.28±0.11[f]	20.80±0.11[f]	34.04±0.03[de]	7.39±0.04[f]
R. canina 'Yildiz'	30.70±0.09[h]	18.19±0.30[a]	17.52±0.12[h]	43.06±0.03[b]	7.21±0.03[g]
R. foetida	38.10±0.22[d]	9.87±0.14[c]	22.02±0.11[cd]	18.80±0.02[j]	7.85±0.04[e]
R. heckeliana subsp. *vanheurckiona*	35.36±0.14[e]	9.57±0.18[d]	20.76±0.11[f]	27.73±0.03[f]	10.05±0.02[b]
R. laxa	47.25±0.28[c]	10.93±0.21[b]	26.17±0.10[b]	19.49±0.04[i]	6.83±0.02[h]
R. montana subsp. *woronovii*	34.99±0.11[e]	9.02±0.09[e]	20.75±0.21[f]	50.50±0.04[a]	5.57±0.02[i]
R. pisiformis	73.26±0.12[a]	8.36±0.09[f]	18.15±0.22[g]	41.17±0.03[c]	5.79±0.03[i]
R. x hybrida	52.98±0.24[b]	10.06±0.21[c]	30.92±0.22[a]	21.45±0.04[g]	10.72±0.04[a]
LSD (%5)	0.872[a]	0.199[a]	0.090[a]	0.091[a]	0.062[a]

[a]Significant at the 5% level. (The data obtained were compared among themselves according to the LSD 5% level). Each application was analyzed in triplicate.

R. canina taxa to be 20.15 ppm in their research. Ercişli (2007), Szentmihályi *et al.* (2002) and Kazaz *et al.* (2009) found zinc values between 3.69 and 14 ppm in their studies conducted on different rosehip genotypes. These researchers generally examined the taxa of *R. canina* and *R.* x *damascena*. It was concluded that they may be different species with high element contents apart from the commonly known taxa due to the different reasons for the genotype effect. For example, *R. pisiformis* seeds contain higher amounts of zinc and potassium. As a result of the research, it was found that the taxa examined had higher iron and zinc contents than this value. In light of this information, it can be said that the presence of some mineral substances in the seeds of *Rosa* L. taxa grown under similar greenhouse conditions is directly related to the genotypes, and the seed of the said taxa contains significant amounts of macro and micro nutrients.

The differences between the taxa in terms of the macro and micro element contents in both leaves and seeds show that the element intake of the taxa is under genotype control. As a matter of fact, there are findings in the literature that the plant element contents in the seeds of *Rosa* L. taxa differ from each other (Ercisli, 2007; Szentmihályi *et al.*, 2002; Kazaz *et al.*, 2009). The findings obtained for the seeds of the taxa also bring to mind the effect of antagonism, which is very important in plant nutrition. As a matter of fact, K and Ca and Mg often show antagonism. In this context, it can be said that the elements that are absorbed in high amounts from the soil accumulate in the seeds and that the antagonistic effects can also be seen in the seeds. As a result, it is thought that it is possible to use rose seeds in food and food additive sectors, as well as rosehip fruits, and to use the seeds in different production areas.

4. CONCLUSIONS

Difficulties are often encountered in the identification of *Rosa* L. taxa due to the diversity and variability of morphological features. In addition, these difficulties arise in establishing genetic links between different taxa. Clarity in the diagnostic role of a particular or a group of morphological characters is not only of theoretical but also of practical importance. Nowadays, more attention is paid to vegetable raw materials as a source of biologically active substances. As a result of this widespread scientific interest, *R. canina*, a widely distributed species of the Rosaceae family, is commonly used as a vitamin source and food raw material. Species of the genus *Rosa* have rich vitamin contents and different chemical structures.

The healing and protective health effects of rose/rosehip seeds were known in ancient times and have been supported by current studies. Nowadays, it can be said that the positive effects of extracts obtained from rose seeds such as delaying aging (anti-aging) increase the interest in rose seeds. As a result of this research, it was determined that the taxa examined had higher iron and zinc contents than the values specified in the references. In light of this information, it can be said that the presence of some mineral substances in the seeds of *Rosa* L. taxa grown under similar greenhouse conditions is directly related to the genotypes, and the seeds of the said taxa contain significant amounts of macro and micro elements.

In this study, the seed fatty acid compositions of the *R. montana*, *R. foetida* and *R. laxa* taxa were determined for the first time. The seed oil contents in rosehip seeds were also investigated. The total oil content in the seeds of *R. heckeliana* was above average for the species and subspecies examined, *R. laxa*, *R. canina* cv. Values above average were determined for taxa such as 'Yildiz'. In addition, the different values for *R. canina* and *R. canina* 'Yildiz' seeds obtained under the same ecological conditions and of the same species showed that the fatty acid compositions may vary not only on the basis of species, but also according to variett.

In recent years, alternative oil sources have gained importance in the cosmetic and food industries (Hammond, 2003; Taylor *et al*., 2011). It is thought that it can be considered as a fruit oil sources with 3.71-10.01% oil content in the seeds of different rose taxa examined within the scope of this research. The results obtained from *R. canina* and *R. montana* taxa, which are widely used in food and industry and known as rose hips, and the oil parameters in the seeds of other taxa, show differences.

As a result of the analysis of the fixed fatty acid values in the seeds of the *Rosa* L. taxa, which are the subject of this research, the lowest palmitic acid content was determined in *R. pisiformis*, and the highest content was determined in *R. montana* subsp. *woronovii*taxa, *R. foetida* showed the lowest stearic acid content, and hybrid tea rose seeds had the highest stearic acid content. Higher palmitic and stearic acid contents were determined in hybrid landscape rose compared to other taxa and species examined in the literature. In addition, as a result of this research, it was determined that the related taxa contain low levels of lauric acid, unlike the literature.

The fact that rose seed oil is rich in unsaturated fatty acids is a very important result. Especially its rich contents in linoleic and oleic acids is one of the main reasons for the increasing interest in rose seed oil. Although studies to determine the fatty acid composition of rose seed oil have been carried out by different researchers before, the seed fatty acid compositions of landscape roses and species that have not been studied before, were determined.

It was concluded that the fatty acid contents in the taxa examined within the scope of this research contain higher levels of linolenic acid compared to grape and pomegranate seeds. It has also been determined that rose seeds have a high level of linolenic acid, similar to oils such as canola and soybean oils. It has been stated that rose seed oil contains high linoleic acid and linolenic acid levels, which is an important result, and higher unsaturated fatty acid content compared to other oils consumed today. Based on these findings it can be said that rose seed oil may be beneficial to human health.

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