



Fatty acid composition of rosehip seed oil

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ABSTRACT

Rosehip is a pseudo-fruit of the rose plant, one of the most widespread wild species of the *Rosa* genus in Serbia. Due to its nutritional and sensory properties, rosehip is widely utilized for the production of jams, marmalades, juices, teas, etc. On the other hand, rosehip seeds are waste material from the food industry, which represent a rich source of fatty acids. The aim of this study was to assess the fatty acids profile of rosehip seeds by applying two extraction methods: ultrasound-assisted extraction combined with organic solvent extraction (UAE/OSCE) and organic solvent conventional extraction (OSCE). The identification and quantification of fatty acids (FA), in the form of methyl esters, were performed by gas chromatography with a flame ionization detector (GC/FID). Based on the obtained results, it was observed that the composition of fatty acids and their relative amounts were influenced by the applied method, as well as by the solvent-to-sample ratio. The analysis revealed the presence of unsaturated fatty acids (UFA) as the dominant ones in most studied samples, whereas the most abundant fatty acids were, in descending order, stearic acid (48.11%), linoleic acid (35.38%), palmitoleic acid (33.78%) and eicosadienoic acid (30.57%).

Keywords: rosehip seed oil, waste material, unsaturated fatty acids, ultrasound-assisted extraction, GC-FID.

ИЗВОД

Шипурак је псеудо-плод биљке руже, једне од најраспрострањенијих дивљих врста из рода *Rosa* у Србији. Захваљујући нутритивним и сензорним својствима, шипурак има широку примену у производњи џемова, мармелада, сокова, чајева итд. Семенке шипурка су отпадни материјал у прехранбеној индустрији који представља добар извор масних киселина. Циљ овог рада био је да се процени профил масних киселина у семенкама шипурка применом две методе екстракције: ултразвучне екстракције у комбинацији са екстракцијом органским растварачем (UZE/KEOR) и конвенционалне екстракције органским растварачем (KEOR). Идентификација масних киселина (МК), у форми метил естара, извршена је методом гасне хроматографије са пламено-јонизујућим детектором (GC/FID). На основу добијених резултата, уочено је да су примењене методе екстракције, као и однос растварача и масе узорка, имали утицај на састав масних киселина и њихову релативну обилност. Незасићене масне киселине (NMK) идентификоване су као доминантне у већини испитиваних узорка. Најзаступљеније масне киселине су биле стеаринска (48,11%), линолна (35,38%), палмитолеинска (33,78%) и еикосадиеноинска киселина (30,57%).

Кључне речи: уље семенки шипурка, отпадни материјал, незасићене масне киселине, ултразвучна екстракција, GC-FID.

1. Introduction

Dog rose (*Rosa canina* L.) is widespread in almost all of Europe, western and northern Asia and Africa, showing great adaptability to different types of soils (Mratinić and Kojić, 1998; Nowak, 2005). It grows in forests, forest glades and among shrubs, and in Serbia it can be found on Fruška gora, Kopaonik, Avala, Suva planina, Stara planina, and other mountains (Mratinić and Kojić, 1998). The fruit of dog rose, known as rosehip, has been the subject of numerous scientific studies because it contains bioactive compounds that have a positive effect on human health. Rosehip is a rich source of carotenoids, vitamins C, B₁, B₂, K and E, amino acids, organic acids, minerals and phenolic compounds that exhibit antioxidant, anticancer and antimutagenic properties (Szentmihályi et al., 2002; Ercisli et al., 2007; Kilicgun and Altiner, 2010; Tumbas

et al., 2012). The rosehip fruit is widely used in the food industry. Also, its potential as a component of functional food is notable due to a significant content of numerous bioactive compounds and essential elements in this pseudo fruit (Ercisli et al., 2007; Ilyasoğlu, 2014; Popović-Djordjević et al., 2020). Rosehip fruits contain 30–35 % of seeds, and the content of oil in seeds may vary from 3–7 % depending on applied extraction method (Zlatanov, 1999; Dabrowska et al., 2019). Rosehip seeds are a waste material in the food industry. Extracted seed oil contains mostly polyunsaturated fatty acids and bioactive compounds that promote skin regeneration; therefore, this oil has been used in the pharmaceutical and cosmetic industries (Zlatanov, 1999; Szentmihályi et al., 2002; Ozcan, 2002; Concha et al., 2006).

Using different extraction methods, Zlatanov (1999), Nowak (2005), Kazaz et al. (2009), Ilyasoğlu (2017) and Javanmard et al. (2018) reported that the

predominant fatty acids in rosehip seeds were linoleic acid and oleic acid, while Machmudah et al. (2007) found linoleic acid and stearic acid as the most abundant fatty acids in rosehip seed oil.

The ultrasound-assisted extraction method (UAE) was used as a supplementary technique for extracting oils from various seeds. This method can provide increased efficiency, better quality of the extract and reduction of the extraction time period and temperature (Cravotto et al., 2008). The possibility of lowering the extraction temperature contributes to the preservation of the extracted bioactive compounds (Yuting et al., 2013). The ultrasound-assisted extraction method requires optimization of ultrasonic power, extraction time and temperature, as well as the ratio of solvent volume to seed weight (Yuting et al., 2013). Data on the application of ultrasound-assisted extraction in the analysis of fatty acids from rosehip seed are scarce (Vasić et al., 2020).

In that respect, continuing our research in chemical characterization of rosehip from Serbia, this work aimed to determine fatty acids from rosehip seed

oil, with application of UAE and OSCE methods, and using different solvent-to-sample ratios. In addition, obtained results were discussed in relation to literature data for different extraction methods.

2. Material and methods

Rosehip (*Rosa canina* L.) fruits originating from the vicinity of the town of Čačak (Republic of Serbia) were purchased at the local market (autumn 2018).

Prior to analyzing fatty acid (FA) content, rosehip samples were prepared by the following procedure: the seeds were first separated from the mesocarp of the fruit. Further, seeds were air-dried and then ground using a blender. Two methods for the extraction of fatty acids from rosehip seed oil were used: ultrasound-assisted extraction combined with organic solvent extraction (UAE/OSCE) and organic solvent conventional extraction (OSCE). Experimental conditions are given in Table 1.

Table 1
Experimental conditions

Sample No.	Solvent	Solvent volume (ml)	Time (h)	Solvent to sample ratio*	Extraction method**
S1	n-heptane	2	1.5+68	2:1	UAE/ OSCE
S2		7	1.5+68	3:1	UAE/ OSCE
S3		4	1.5+68	4:1	UAE/ OSCE
S4		5	1.5+68	5:1	UAE/ OSCE
S5		3	70	3:1	OSCE

*- ml/g; ** UAE – ultrasound-assisted extraction, OSCE – organic solvent conventional extraction

Ultrasound was applied to samples S1–S4 for 1.5 hours. Thereafter, samples were subjected to additional extraction (about 68 hours). Organic solvent conventional extraction (OSCE) was applied to sample S5 for 70 hours with occasional shaking. Both types of extractions were performed at room temperature (~23°C).

After solvent evaporation, 1 ml of hexane was added to the lipid fraction for its dissolution and better efficiency of derivatization with 14% boron trifluoride methanol reagent. To complete the derivatization reaction, the mixture was heated at 100°C for one hour. Fatty acid methyl esters (FAMES) were extracted in the hexane phase after the addition of water, and then analyzed by GC-FID (Barać et al., 2018).

Fatty acid content calculated as mg/g of lipid extract and expressed as a relative amount of total fatty acids expressed as percentages (%) was identified by comparing with the retention times of peaks in the

analytical standard mix containing 37 acids (Supelco, Bellefonte, USA).

3. Results and discussion

The results obtained for the fatty acid (FA) composition of the rosehip seed lipid fraction by the application of two methods are presented in Figure 1. In sample S1, no filtrate was obtained after the filtration, indicating that the solvent volume to seed weight ratio (2:1) was not suitable. In other samples, most of FAs were monounsaturated and polyunsaturated fatty acids (MUFA and PUFA, respectively), whereas only four saturated fatty acids (SFA) were identified (stearic, arachidic, heneicosanoic and behenic).

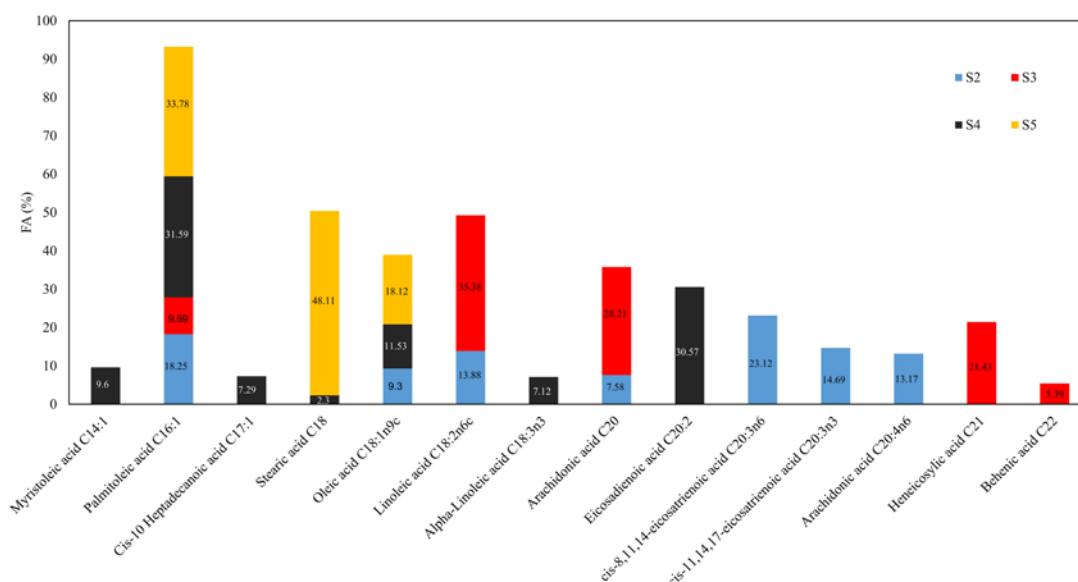


Figure 1. Content of fatty acids in samples S2–S5

In samples S2–S4, the number of identified fatty acids was significantly higher compared with sample S5, which was subjected to conventional extraction with organic solvent. Such results may indicate that the applied ultrasound-assisted extraction combined with the organic solvent extraction method was more effective than organic solvent extraction. The most abundant FA in sample S2 was *cis*-8,11,14-eicosatrienoic acid (23.12%), while in sample S5 stearic acid was the dominant one. Unlike other long-chain saturated fatty acids, stearic acid has no effect on cholesterol lipoprotein concentration (Yu et al., 1995). In this study, palmitoleic acid was detected in all samples (S2–S5) regardless of the applied extraction method. This acid is an omega-7 UFA, and it has been shown to have an antithrombotic effect and can be involved in prevention of stroke (Stedman, 1995; Orsavova et al., 2016). Oleic acid, detected in samples S2, S4 and S5, is an omega-9 fatty acid and it is one of the most widespread fatty acids in nature (Stedman, 1995). In this study, linoleic acid was detected in samples S2 and S3, and in sample S3 this acid was the most abundant (35.38%). The importance of linoleic acid, the one of two essential fatty acids for humans, ch

in metabolism is well documented (MacDonald, 2000). In sample S5, besides stearic acid (as the most abundant), only palmitoleic acid (33.78%) and oleic acid (18.12%), both belonging to unsaturated fatty acids (UFA), were identified, Figure 1.

Although samples S2 and S5 had the same S/S ratio (3:1), they differed in the number of fatty acids as well as in the fatty acids profile, which might be attributed to the extraction method. In addition, it was observed that different numbers of FAs were identified in samples extracted by UAE; seven in S2 and S4, and five in S3. In samples S2 and S4, where S/S ratios were 3:1 and 5:1, respectively, UFAs were the most abundant, unlike sample S3 (S/S-4:1), where SFAs predominated, Figure 2. Moreover, PUFAs were dominant acids in sample S2 (74.17%). The differences observed in the FA profiles of samples may be associated with the S/S ratio, but also with the solvent volume used for the extraction. Namely, the highest volumes of *n*-heptane, 7ml and 5 ml, were used for the extraction of samples S2 and S4, respectively.

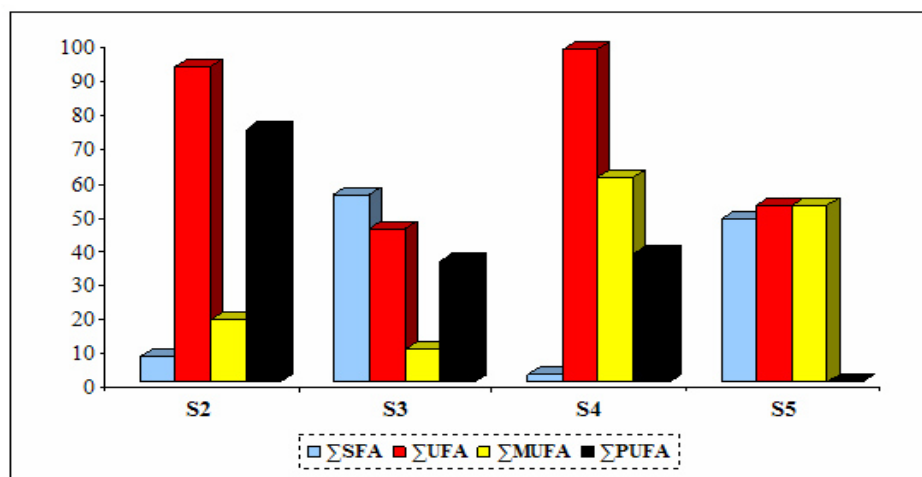


Figure 2. Fatty acids profile of samples S2–S5; saturated fatty acids (SFA), unsaturated fatty acids (UFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA)

Many studies have been conducted on the fatty acid composition of rosehip seeds using different extraction methods, and results were reported in the literature (Zlatanov, 1999; Nowak, 2005; Machmudah et al., 2007; Ercisli et al., 2007; Kazaz et al., 2009; Ilyasoğlu, 2017; Javanmard et al., 2018). Both extraction methods applied in the present research yielded palmitoleic acid, oleic acid and stearic acid. It should be noted that stearic acid was obtained by the

OSCE method in substantially higher amounts compared with the UAE/OSCE method. Linoleic and eicosadienoic acids were obtained by UAE/OSCE and OSCE methods, respectively. Stearic and linoleic acids were also obtained in seed oil using other extraction methods: Soxhlet, supercritical CO₂ and Derynge, Figure 3.

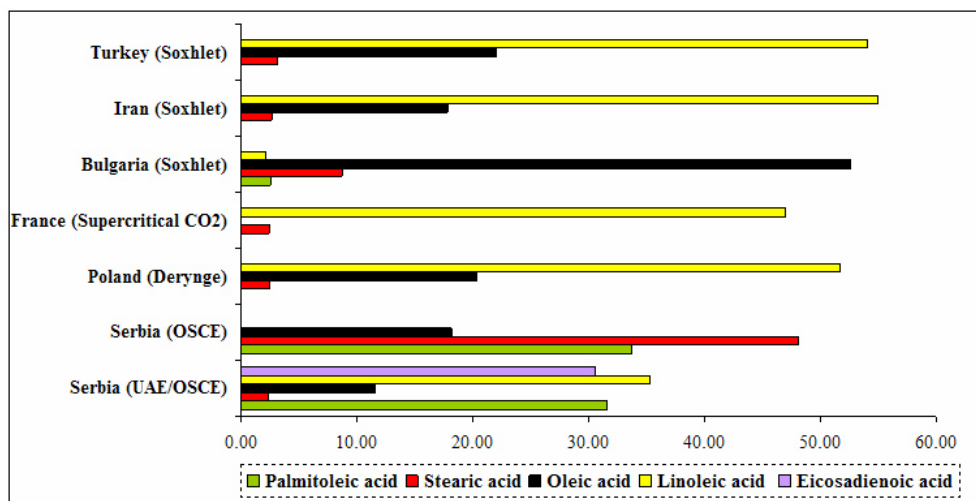


Figure 3. Comparison of data for the most abundant FAs in rosehip seed oil; literature vs. this study (Serbia)

The results of this study were compared with the literature data obtained for fatty acids in rosehip seed samples originating from different countries, Figure 3. In the work of Nowak (2005), extraction was conducted in a Derynge apparatus and it was found that the dominant acids in rosehip seed oil from Poland were linoleic acid and oleic acid, while palmitic, stearic and *cis*-11,14-eicosadienoic acids were present in traces. Machmudah et al. (2007) also extracted linoleic acid and stearic acid in rosehip seed oil from France, using the supercritical CO₂ extraction method. Furthermore, these authors found linolenic acid, which was not identified in rosehip seed oil in this study. Kazaz et al. (2009) analyzed rosehip seed oil from Turkey using the Soxhlet extraction method; they obtained linoleic and oleic acids as the dominant acids, while stearic acid was found in smaller amounts. Zlatanov (1999), Ercisli et al. (2007), Javanmard et al. (2018) and Ilyasoğlu (2017) also used the Soxhlet extraction method. In rosehip seeds from Bulgaria, oleic acid was determined in the highest concentration (Zlatanov, 1999). Javanmard et al. (2018) and Ilyasoğlu (2017) analyzed rosehip seed originating from Iran and Turkey, respectively, and found equal amounts of oleic and linoleic acids, while Ercisli et al. (2007) found linolenic acid as the predominant acid in rosehip seed oil from Turkey. Besides linoleic acid, as a dominant fatty acid, α -linoleic acid was obtained using UAE/OSCE, but in a small amount.

The data discussed here show that differences in the composition and amount of fatty acids in rosehip seed oil may be attributed to climate, the environment and genetics factors, but also of the extraction method applied in the analysis.

4. Conclusion

The obtained results indicated that the extraction method, solvent-to-sample ratio, as well as the solvent volume had an effect on the composition of fatty acids and their relative amounts in rosehip seed oil. Most fatty acids were MUFAs and PUFAs, while the most abundant was stearic acid (SFA), 48.11%. Among UFAs, linoleic acid (35.38%), palmitoleic acid (33.78%) and eicosadienoic acid (30.57%) were the most dominant. The results obtained in this experiment open the possibilities for further studies on this topic.

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