REVIEW

# CHARACTERIZATION OF LIPID SUBSTANCES OF ROSE HIP SEEDS AS A POTENTIAL SOURCE OF FUNCTIONAL COMPONENTS: A REVIEW

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## ABSTRACT

Functional foods receive the greatest attention for nutritional needs of specific consumers. The rose hip fruit, besides carotenoids and polyphenols, are also good sources of lipid substances (fatty acids, sterols and tocopherols), which can be used as functional foods instead of being discarded as waste. The aim of this review is to present an overview of the lipid characterization of rosehip seeds as affected also by the oil extraction procedure.
The rosehip seeds oil is proven to be rich in polyunsaturated fatty acid (PUFA), sterols and tocopherols, which provide specific biological activities (anti-inflammatory, anti-obesity, antioxidant, anti-diabetic activity). In particular, the oil content of rose hip seeds ranges from 5 to 18 % and is composed of unsaturated fatty acids such as linoleic acid (36-55 %) which is the most abundant one, linolenic (17-27 %) and oleic acid (15-22 %) respectively. As for the sterols, its content ranges around 5 g/kg constituting predominantly β-Sitosterol, whereas, the tocopherols amount to around 1 g/kg with γ-tocopherol being the most abundant.

*Keywords*: rosehip oil, oil extraction, fatty acids, unsaponifiable matter components

## 1. INTRODUCTION

Nowadays, the optimization of food production in sustainable way is a requirement with the rise in world population and the reduction of natural resources. As such, the use of abundant natural food sources could be a solution, since food stuffs provide not only nutrition but also exercise a great potential for health benefits (PATEL, 2015). Moreover, the global interest in functional foods increased owing to their promising response to numerous diseases. In accordance, numerous works have reported the potential health properties of plant based products that are rich sources of nutrients and phytochemicals as evidenced through their biological activities (TYLEWICZ *et al*., 2019; NADPAL *et al*., 2016; MOZZON *et al*., 2015; GUIMARÃES *et al*., 2013; DELIORMAN ORHAN *et al*., 2007; REIN *et al*., 2004). In recent times, food wastes are classified as valuable constituents with the emerging technologies ensuring the extraction of target compounds through the food chain (GALANAKIS, 2012).Among fruit and vegetable products, rose hips have gained considerable attention due to their highest content of bioactive compounds (ILYASOĞLUl, 2014).

Rose hips are included in the *Rosaceae* family, with the rose species being large shrubs or small trees that grow in various regions of the world. They are perennial woody plants, with more than 200 species and 18000 cultivars in the world, geographically distributed mainly in Europe, Asia and North America (PATEL, 2017). The rose hips constitute the aggregate fruit of the rose bush plants and are formed of a stretched, pulpy shell called "hypanthium" which encloses the real fruits known as "achenes" (WINTHER *et al*., 2016) (Fig. 1).

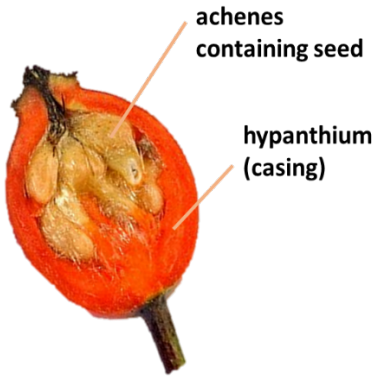


**Figure 1.** Anatomical scheme of rose hip.

The achenes represent the thin membranes close to the seeds of rose hip, which are 30-40 % of the overall weight of fruit. The fleshy part of the rose hips is usually utilized in production of different kind of food products (juice, jam, bakery products, candies etc.), while the seeds are discarded as waste. The nutritional characterization has proven that rose hips are rich in nutrients and are good source for dietary supplements, for direct use as functional food product or as food ingredients and additives such as natural colorants for industrial production process (PATEL, 2017; ROSU *et al*., 2011).

Rose hip seeds furthermore, have been evidenced to exhibit a series of biological activities such as gastrointestinal protection, diabetic (insulin mimicking), anti-aging, enhancing

immunity properties. These can be attributed to their rich chemical composition which include not only phenolic components, mainly flavonoids and proanthocynidins,(FASCELLA *et al*., 2019; KOCZKA *et al*., 2018), but also other nutrients such as fatty acid, terpenes, tocopherol, carotenoids, proteins, sugars and minerals (BHAVE *et al*., 2017; DEMIR *et al*., 2014; NADPAL *et al*., 2016). The expression of the studied biological activities and the functional compounds are strictly related to the harvest period, genotypes and species (BARROS *et al*., 2011; ÇELIK *et al*., 2010; GÜNEŞ *et al*., 2017). In addition, parts of plant such as fruits, seeds, nuts and sprouts could represent a rich sources of oil with valuable components, which usually have discarded as waste (PATEL, 2017).
In particular, the rose hip seeds acquire oil content from 5 to 18 % which includes varying amounts of unsaturated fatty acids such as linoleic acid (36-55 %), followed by linolenic and oleic acid respectively (17-27 % and 15-22 %). Due to their higher favourable polyunsaturated fatty acids and sterols, rose hip seeds oil represents a high value added compound that can be extracted from vegetable wastes and reused in food processing (SALGIN *et al*., 2016). The oil constituents were found to exhibit anti-inflammatory, anti-bacterial, antioxidant activity and potentiality in the cosmetic products production (NADPAL *et al*., 2016; REIN *et al*., 2004).
In consideration, the seed oil extraction methods are extremely important as well as their efficiency in order to preserve the bioactive compounds such as the unsaturated fatty acids, and also to obtain an economical oil yield. Generally, cold pressing is used in the production of seeds oil. However, many other technologies have been investigated such as Soxhlet, organic solvent extraction, ultrasound, microwave and supercritical $CO_2$ extraction with the latter exhibiting a higher solubility of the oils and short extraction times, thus minimizing the degradation of bioactive compounds due to thermal and oxygen exposure (DĄBROWSKA *et al*., 2019a; SALGIN *et al*., 2016).
The objective of this review is to summarize the state of the research, to underline the attention in the lipophilic components extracted from rose hip seeds oil for further use in the food process and pharmaceutical industries in order to enhance the health benefits.

### 1.1. Proximate and energy profile of Rose hip seed oil

The different nutritional profiles and assessed energy values of rose hip seeds are shown in Table 1.
The predominant constituent in the seed was the carbohydrate while the protein represented the lowest content. High carbohydrate content and low protein content avoids protein emulsification, which may limit the oil release.
The difference among the nutritional profiles of rosehip seed is mainly due to the different species and the growing conditions (temperature, rainfall and harvest stage) (İLYASOĞLUl, 2014; DU *et al*., 2017; CONCHA *et al*., 2006; ÖZCAN, 2002).

## 2. OIL EXTRACTION METHODS

Standard procedures for the oil extraction of plant tissues are cold pressing and solvent extraction.
The cold pressing method ensures the production of safe oil since neither heat nor chemical substances are used. On the contrary, this procedure results in low oil yield and hence economically inconvenient in case of rose hip seeds oil (20 % of oil). Whereas,

solvent extraction requires large amounts of solvent, long extraction times and high temperatures, which may provoke the destruction of sensitive bioactive compounds.

**Table 1.** Nutritional composition and energy value of the rosehip seeds.

| **References**<br>**Samples origin** | Ilyasoğlu (2014)<br>Turkey<br>*(Rosa canina)* | Du *et al.* (2017)<br>China<br>*(Rosa acicularis)* | Concha *et al.* (2006)<br>Chile<br>*(Rosa affinis rubiginosa)* | Özcan (2002)<br>Turkey<br>*(Rosa canina)* |
|---|---|---|---|---|
| | | **Parameters** | | |
| **Moisture**<br>g/100g, dry weight | 10.3<br>(g/100 g of fresh weight) | 9.0 | 6.0 | 5.7-6.6 |
| **Carbohydrate**<br>g/100g, fresh weight | 89.1 | 40.4<br>Crude fiber | 56.0<br>Crude fiber | 47.1-65.1<br>Crude fiber |
| **Fat**<br>g/100g, dry weight | 6.3 | 6.7 | 9.0 | 13.4-17.8 |
| **Ash**<br>g/100g, dry weight | 1.6 | 3.9 | 2.0 | 1.2-2.1 |
| **Protein**<br>g/100g, dry weight | 3.0 | 3.8 | 3.0 | 9.6-11.5 |
| **Energy value**<br>kcal/100g, dry weight | 425.0 | - | - | 3797.0-5086.0<br>cal/g |

Studies show that the extraction efficiency of *Rosa affinis rubiginosa* can be increased by enzymatic pre-treatment (up to 30 %) (CONCHA *et al*., 2006). Hydrolytic enzymes are useful tools to selectively depolymerize and break down the cell walls.
Among the innovative technologies ultrasound, microwave, subcritical and supercritical fluid extraction are used for the recovery of rose hip seeds oil fatty acids (JAHONGIR *et al*, 2019; SZENTMIHÁLYI *et al*., 2002). Microwave extraction at 40°C for 30 min, supercritical $CO_2$ extraction (35°C, 250 bar for 80 min.) and subcritical $CO_2$ + $C_3H_8$ (28°C, 100 bar for 35 min.) enhanced the oil extractability compared to Soxhlet and ultrasound methods.
Efficiency of supercritical fluid extraction (SFE) and the bioactive components extractability are ascribed to many factors such as temperature, pressure and flow rate (SALGIN *et al*., 2016; DEL VALLE *et al*., 2004). In contrast to the solvent extraction, SFE works at low temperature and short process times, thus reducing the thermal damages and degradation of oxygen sensitive compounds. Carbon dioxide ($CO_2$) is commonly used as solvent for SFE which is a non-toxic, inert, non-flammable, odourless and cheaper compound. Fatty acids in the oil are soluble in supercritical $CO_2$ at 40°C and up to 280 bar and subsequently increased solubilities can be reached with co-solvent addition (SALGIN *et al*., 2016; SZENTMIHÁLYI *et al*., 2002).

## 3. LIPOPHILIC COMPONENTS OF THE ROSEHIP SEEDS OIL

The oil extracted from rose hip seeds presents high level of bioactive compounds and for this reason it could be used for the enrichment of food products. In particular, the lipophilic part of oil is rich in polyunsaturated fatty acid (PUFA), sterols and tocopherols.

### 3.1. Fatty acid oil composition

The fatty acid composition of the different seed oils extracted from rose hips is affected to the different rose species, environmental factors, agronomic practices, cultivation area and oil extraction methods.

Table 2 provides an overview of the fatty acid composition of rosehip seed oil subjected to different oil extraction methods. The traditional method for oil extraction from plants is a cold pressing procedure (A). This extraction method employs neither the use of chemical solvents nor heat treatment, thus allows the production of natural and safe oils without compromising their quality. However, the cold pressing method produces low oil yield therefore economically inconvenient for raw materials such as rosehip seeds, which contain a low percentage of oil. In fact, CONCHA *et al*. (2006) obtained 30-40 % of oil from *Rosa affinis rubiginosa* by cold pressing procedure, however, the yield was increased to 72 % by the enzymatic pre-treatment (H) which allows the cell wall degradation enhancing the extractability of oil. Nevertheless, several authors reported similar results for what concerns the fatty acid composition of oil by using cold pressing with or without enzymatic pre-treatment. Indeed, the fatty acid composition of oils originating from *R. canina* and *R. rubiginosa* grown in Poland and Chile were characterized by high content of linoleic content (42.20-51.70 %) followed by $\alpha$-linolenic (21.50-34.00 %) and oleic (12.36-18.42 %) rather than palmitic (3.33-4.97 %), stearic (0.11-3.00 %) and arachidonic (0.6-0.7 %) acids (CONCHA *et al*., 2006; DĄBROWSKA *et al*., 2019; GRAJZER *et al*., 2015; PRESCHA *et al*., 2014).

Soxhlet method (B) by using different solvents for extraction such as hexane (ÇELIK *et al*., 2010; DĄBROWSKA *et al*., 2019; FROMM *et al*., 2012; SALGIN *et al*., 2016; SZENTMIHÁLYI *et al*., 2002), petroleum (KAZAZ *et al*, 2009), methanol, chloroform (YILMAZ *et al*., 2011) and diethyl ether (ÖZCAN, 2002) had been widely used for rose seeds. The oil yield ranged from 2.75-12.90 % and varied strongly depending on the solvent type, variety and origin of the raw material. ÇELIK *et al*. (2010) reported seed oil composition of five different rose hip species growing in Turkey (*R. dumalis var. boissieri, R. pulverulenta, R. canina L., R. iberica and R. heckeliana subsp. vanheurckiana*). Among the studied species, soxhlet extraction yield was highest for *R. heckeliana subsp. vanheurckiana* (7.95 %) and the lowest for *R. canina L.* (4.97 %). Although in all reported rose species the main unsatured fatty acids were linoleic, $\alpha$-linolenic and oleic acids, *R. heckeliana subsp. vanheurckiana* contained high quantitie of linoleic acid (51.06 %), while *R. iberica* oil was caractherized by high $\alpha$-linolenic (23.83 %) and oleic acid (23.03 %) contents, respectively. In contrast to these values, other studies reported lower linoleic and $\alpha$-linolenic acids that ranged from 35.94-36.7 and 14.3-21.15 %, respectively (FROMM *et al*., 2012; SZENTMIHÁLYI *et al*., 2002) These discrepancies in studiescan be attributed to the different climatic conditions, geological location and other agronomic factorswhich might have influenced the biosynthesis of fatty acids.

DĄBROWSKA *et al*., (2019) reported fatty acid oil profile, obtained from *Rosa canina* grown in Bulgaria, by Soxhlet with hexane as extraction solvent, and the oil was found to be rich in palmitic (17.80 %) and linoleic (52.60 %) acids and poor in $\alpha$-linolenic (2.10 %) and oleic acids (1.60 %).

When petroleum was used as solvent, theoil content was respectively 7.15 and 2.75 % for *Rosa canina* and *Rosa damascena*. Despite the higher oil yields detected, only 48.84 % linoleic and 22.14 % oleic acids have been found in oil of *Rosa canina*, whereas, 54.18 % linoleic and 23.91 % oleic acids have been found in oil of *Rosa damascena,* respectively (KAZAZ *et al*., 2009). The specific fatty acid profile is also strongly dependent on the species of plant but

even on the growing conditions. In fact, ÖZCAN, 2002 found different percentage of fatty acids for rose seeds coming from different regions of Turkey.
Several studies proposed supercritical fluid extraction (SFE), as a solid-liquid process for extraction of seed oil as an alternative to the traditional methods. Contrary to the traditional solvent extraction, SFE works with low temperature and short process times, thus, allowing for reduced thermal and oxygen degradation of sensitive compounds. Moreover, SFE is widely recognized as a valuable technology due to the extraction efficiency for the use of the fluid (mostly carbon dioxide) which has a high density, a high diffusivity and low viscosity thus leading to rapid solute mass transfer (DASSOFF and LI, 2019).
SALGIN *et al*. (2016) investigated the influence of particle size (125-1000 $\mu$m), pressure (20-40 MPa), volumetric flow rate of fluid solvent (0.75-3.5 mL $min^{-1}$) and temperature (40-60°C) on the extraction yield and oil composition of *Rosa canina* by SFE. The oil yields obtained with seed particles lower than 500 $\mu$m were about 50 % higher compared to the bigger particle sizes (>1000 $\mu$m). This is probably due to the difficulty in extraction of smaller particles (around 30 $\mu$m) closer to the bigger fractions, which may limit the mass transfer inside the pores, causing less enhanced release of oil. Extraction rate of oils increased with decreasing particle sizes (18 % at 250 bar, 50°C and 3 mL $min^{-1}$) (MACHMUDAH *et al*., 2007). Separation process carried out with $CO_2$ (E) provoked the highest extraction yield (16.5 % oil) by the application of 30 MPa, 40°C, 0.75 mL $min^{-1}$ and 355-500 m in extraction time of 150 min. However in the case where 5 % vol. ethanol (G) was used as solvent, the same amount of oil was extracted in about 90 min. Concerning these oils, no significant differences were found in the fatty acid profiles for the different SFE extraction processes, and were composed mainly by linoleic (48.3-49.0 %), $\alpha$-linolenic (19.9-21.2 %) and oleic (19.5-20.7 %) acids (SALGIN *et al*., 2016).
SZENTMIHÁLYI *et al*. (2002) emphasized the oil yield extractability of *Rosa canina* hip seeds by SFE with $CO_2$+$C_3H_8$ (F) (28°C, 100 bar and 35 min.) and SFE with $CO_2$ (E) (35°C, 250 bar and 80 min.), respectively. The yields were determined to be around 6.68 and 5.72 % for (F) and (E) respectively, and were higher compared to that of Soxhlet, microwave and ultrasound water bath extraction (4.85, 5.26 and 3.25 %). Thus, determined an enhanced fatty acids percentage of linoleic acid from 8.18 to 18.81 % rather than oleic and $\alpha$-linolenic acids, which reported similar amount compared to the other extraction method.
The effect of temperature, pressure and $CO_2$ flow rate on fatty acids content of rosehip seeds was investigated (MACHMUDAH *et al*., 2007). The linoleic acid (47.02-49.14 %) and $\alpha$-linolenic (33.02-40.21 %) significantly increased with increasing temperatures (40, 60 and 80°C). Above 300 bar the linoleic acid content tends to be steady; this is probably due to the increased $CO_2$ density at higher pressure causing the enhancement of acid dissolution, while $\alpha$-linolenic acid significantly increased with increasing pressure applied. However, palmitic and stearic acids were not affected by any of the considered parameters for SFE, rather they were not quantified at 150 bar.
*Rosa woodsii* provided a rose seed oil, extracted with Folch method (I), rich in linoleic (37.10 %), $\alpha$-linolenic (30.75 %) and oleic (19.70 %) acids (ANWAR *et al*., 2008).

**Table 2.** Fatty acid composition of rose hip seed oils under different oil extraction methods.

| References | Grajzer *et al.* (2015) | Presha *et al.* (2014) | Szentmihályi *et al.* (2002) | Çelik *et al.* (2010) | Salgin *et al.* (2016) | Du *et al.* (2017) | Yilmaz (2011) | Concha *et al.* (2006) |
|---|---|---|---|---|---|---|---|---|
| **Origin of raw materials** | Poland | Poland | Hungary | Turkey | Turkey | China | Turkey | Chile |
| **Oil extraction system** | A | A | B, C, D, E, F | B | B, E, G | C | B-H | A-H |
| **N. of species** | 2 | 4 | 5 | 5 | 6 | | 4 | 9 |
| **Fatty acid (%)** | | | | | | | | |
| **C16:0** | 4.2-4.8 | 3.8 | 3.60-7.87 | 4.25-5.15 | 2.3-3.8 | 4 | 1.18-3.39 | 3.33-4.97 |
| **C16:1** | - | - | - | 0.22-0.89 | - | - | 0.50-1.88 | - |
| **C18:0** | 2.1-3.0 | 1.8 | 2.45-3.27 | 1.80-2.87 | 1.9-2.5 | 2.9 | 0.84-2.58 | Traces 0.11-1.75 |
| **C18:1** | 14.7-16.3 | 14.6 | l6.25-22.11 | 20.35-23.03 | 19.5-20.5 | 34.2 | 0.48-29.96 | 12.36-14.82 |
| **C18:2** | 44.4-51.7 | 44.1 | 35.94-54.75 | 41.l4-51.06 | 47.0-49.2 | 56.5 | 3.21-36.33 | 42.20-47.87 |
| **C18:3** | 21.5-31.8 | 34.0 | 20.29-26.48 | 19.66-23.83 | 19.9-22 | 1.7 | 0.22-0.31 | 26.41-31.09 |
| **C20:0** | nd 0.7 | 0.6 | - | 0.94-1.29 | 0.8-1 | - | 0.65-0.79 | - |
| **C20:2** | nd 0,4 | | - | - | - | - | - | - |
| **Others** | 1.7-2.4 | 0.4 | - | - | - | - | - | - |
| **Oil content (%)** | - | - | 3.25-6.68 | 4.97-7.95 | 16.5 | - | - | - |
| **Σ SFA** | 7.1-8.0 | 6.5 | - | - | - | - | - | 4.63-5.08 |
| **Σ MUFA** | 15.2-16.4 | 15.2 | - | - | - | - | - | 12.36-14.82 |
| **Σ PUFA** | 73.3-76.3 | 78.4 | - | - | - | - | - | 73.29-76.21 |

A: cold pressing procedure; B: Soxhlet; C: ultrasound; D: microwave; E: SFE with $CO_2$; F: SFE with $CO_2$+$C_3H_8$; G: FSE with 5%vol. ethanol; H: enzymatic pretreatment; I: Folch procedure.

**Table 2.** Continues.

| References | Kazaz *et al.* (2009) | Machmudah *et al.* (2007) | Dabrowska *et al.* (2019) | Özcan (2002) | Fromm *et al.* (2012) | Anwar *et al.* (2008) | Ilyasoğlu (2014) |
|---|---|---|---|---|---|---|---|
| **Origin of raw materials** | Turkey | France | Bulgary Germany Hungary Poland Turkey | Turkey | Germany | Canada | Turkey |
| **Oil extraction system** | B | E | A, B, E | B | B-H | I | E |
| **N. of species** | 2 | 9 | 1 | 1 | 1 | 3 | 1 |
| **Fatty acid (%)** | | | | | | | |
| **C16:0** | 5.26-5.30 | 0-4.68 | 2.72-17.80 | 1.71-3.17 | 3.1 | 3.70 | 3.34 |
| **C16:1** | - | - | 0.04-2.60 | 0.24-1.01 | 0.6 | 0.57 | - |
| **C18:0** | 2.02-3.13 | 0-2.88 | 2.05-8.80 | 1.69-2.47 | 2.2 | 1.59 | 1.69 |
| **C18:1** | 22.14-23.91 | - | 13.17-52.60 | 14.71-18.42 | 18.8 | 19.70 | 19.50 |
| **C18:2** | 48.84-54.18 | 47.02-50.25 | 2.10-55.70 | 48.64-54.41 | 36.7 | 37.10 | 54.05 |
| **C18:3** | 15.09-20.65 | 33.02-40.21 | 1.60-31.80 | 16.42-18.41 | 14.3 | 30.75 | 19.37 |
| **C20:0** | - | - | 0.23-3.50 | 1.87-2.61 | 1.3 | 0.80 | 1.00 |
| **C20:2** | - | - | - | - | - | 0.10 | - |
| **Others** | - | - | - | - | - | - | - |
| **Oil content (%)** | 2.75-7.15 | 18 | 3.1-12.90 | 13.37-17.82 | 10 | - | 6.29 |
| **Σ SFA** | - | - | - | - | 7.1 | 8.20 | - |
| **Σ MUFA** | - | - | - | - | 20.1 | 21.73 | - |
| **Σ PUFA** | - | - | - | - | 51.0 | 68.10 | - |

A: cold pressing procedure; B: Soxhlet; C: ultrasound; D: microwave; E: SFE with $CO_2$ F: SFE with $CO_2$+$C_2H_6$; G: FSE with 5%vol. ethanol; H: enzymatic pretreatment; I: Folch procedure.

### 3.2. Sterols profile

The recent interest for enriched functional foods with plant sterols is due to their demonstrated reducing effects of cholesterol level well as anti-inflammatory and anticarcinogenic properties (ALVAREZ-SALA *et al*., 2018). In particular, among the several plant sterols, approved by European Commission, β-sitosterol, campesterol and stigmasterol are allowed to be used in a higher proportions than the sterol content commonly added as ingredients in functional foods (BARRIUSO *et al*., 2016).
The rosehip seed oil was characterized by higher sterol contents than economically available vegetable oils such as soybean and sunflower (< 5 g/kg) (AMAROWICZ and PEGG, 2019).
Characterization of phytosterols profile of rosehip seed oil is reported in Table 3.
GRAJZER *et al*. (2015) observed that the total content of sterols was high in both rosehip oils (obtained from two different manufacturers), which are respectively 5.891 and 6.485 g/kg compared to camellia (2.312 g/kg) and walnut (1.791 g/kg) oils. No difference in the β-Sitosterol and $\Delta^5$–Avenasterol content of *Rosa canina* oil was found between cold pressing and Folch procedure (GRAJZER *et al*., 2015; ILYASOĞLU, 2014). However, $\Delta^7$-Stigmasterol and clerosterol were quantified by the DGF official method (ILYASOĞLU, 2014)and not confirmed by GC-MS method, whereas up to 0.6 g/kg of cycloartenol was found (GRAJZER *et al*., 2015). Beside that ZLATANOV (1999) in *Rosa canina* oil from Bulgaria β-Sitosterol followed by $\Delta^5$–Avenasterol (81.5 and 4.6 g/kg respectively), which were the main sterols, and were found twenty times more compared to the one obtained by ILYASOĞLU (2014) and GRAJZER *et al*. (2015). While ZLATANOV (1999) reported values of phytosterol, which are not comparable with the other data available from similar studies.

**Table 3.** Phytosterol composition of rose hip seed oils.

| **References** | Zlatanov (1999) | Ilyasoğlu (2014) | Grajzer *et al*. (2015) | Turan *et al*. (2018) |
|---|---|---|---|---|
| | | **Phytosterols (g/kg)** | | |
| Brassicasterol | 5.4 | - | nd | 1 |
| Campesterol | 1.8 | 0.233 | 0.192-0.205 | 43 |
| Cholesterol | 0.5 | - | - | 4 |
| Clerosterol | - | 0.014 | - | - |
| Stigmasterol | 3.5 | 0.189 | 0.077-0.060 | |
| β-Sitosterol | 81.5 | 5.44 | 4.753-5.297 | 780 |
| $\Delta^5$-Avenasterol | 4.6 | 0.316 | 0.242-0.379 | 39 |
| $\Delta^7$-Stigmasterol | nd | 0.414 | nd | 43 |
| $\Delta^{7.25}$-Stigmasterol | 1.8 | - | - | - |
| $\Delta^7$-Avenasterol | 0.9 | 0.019 | 0.037-0.056 | 15 |
| Cycloartenol | - | - | 0.589-0.649 | - |

### 3.3. Tocopherol content

Tocopherols are important compounds of the unsaponifiable fraction, which are present as liposoluble phenols in vegetable oils. Different isomer forms could be found (α, β, γ, and δ) depending on the number and position of methyl groups in the phenolic ring (HERNANDEZ, 2015). They exhibit antioxidant properties and that ensure the oxidative stability of oils.
Table 4 provides a summary of different tocopherols composition of rosehip seed oils.
The cold-pressed oil of rosehip obtained from two different manufacturers were characterized respectively by 1.0 and 1.1 g/kg of total tocopherols content, which were higher compared to camellia and walnut oils (0.7 and 0.4 g/kg) (GRAJZER *et al*., 2015). These results were in agreement with the one obtained by FROMM *et al*. (2012) for *Rosa canina* oil extracted with Soxhlet procedure. However, the tocopherols amount was not comparable with the results obtained by ZLATANOV (1999). Besides, a high level of tocopherols is associated with high oil rich in PUFA
*Rose woodsii* oil obtained with Folch procedure was constituted by a high amount of α-tocopherol (0.4 g/kg) followed by δ-tocopherol and γ-tocopherol (0.09 and 0.002 g/kg) (ANWAR *et al*., 2008). Instead, in experiments with *Rosa canina* oils, the most abundant isomer form was γ-tocopherol ranging from 0.6 to 0.9 g/kg (GRAJZER *et al*., 2015; FROMM *et al*., 2012). In all rosehip oils, β-tocopherol was not detected (ANWAR *et al*., 2008; GRAJZER *et al*., 2015; FROMM *et al*., 2012).

**Table 4.** Total tochopherols of rosehip seed oils.

| **Refereces** | Zlatanov (1999) | Anwar *et al.* (2008) | Grajzer *et al.* (2015) | Fromm *et al.* (2012) |
|---|---|---|---|---|
| | | **Tocopherols (g/kg)** | | |
| α-Tochopherols | 19.0 | 0.4±34.9 | 0.1-0.2 | 0.2±5.1 |
| β-Tochopherols | nd | nd | - | nd |
| ɣ-Tochopherols | 71.0 | 0.002±84.0 | 0.6-0.8 | 0.9±55.6 |
| δ-Tochopherols | 1.8 | 0.09±10.4 | 0.2-0.3 | 0.03±3.7 |
| Total Tochopherols | 91.8 | 0.002±50.2 | 1.0-1.1 | 1.0±55.9 |

## 4. CONCLUSION

The improvement of food products is directed towards ensuring nutritional and functional benefits.
Therefore, an adequate description of lipid food components of rosehip seed oil was provided in order to develop their possible re-use as bioactive component in the functional food production. Considering the possibility of their combination, which may permit an improved solubility, stability or bioactivity than the single one. In particular, the oil content of rose hip seeds ranges from 5 to 18 % and it basically includes different amount of unsaturated fatty acids as linoleic, linolenic and oleic acid. However, for what

concern the sterols content around 5 g/kg with the most abundant β-Sitosterol and tocopherols amount with γ-tocopherol were observed.

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