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Phytochemical Composition and Antioxidant Activity of Rosehips From 11 Rose Samples Collected in Central Italy

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Abstract

The phytochemical composition of rosehip pericarps and seeds has been determined in selected rose plants growing in some Regions of Central Italy (Marche, Lazio, and Emilia Romagna), as possible ingredients in functional food formulations and/or dietary supplements in order to replace synthetic antioxidant with natural alternatives.

This research studies the possibility to use rosehip seed oil as a functional food, due to its particular fatty acid composition and evaluates the effectiveness of polyphenols extracted from rosehip pericarps to protect two sunflower oils (classicand high-oleic) from oxidation.

Results showed a variable total polyphenolic content in pericarps and seeds and a particular composition of fatty acids in the seeds of the rose species, making them a possible functional food.

The DPPH scavenging test to evaluate the antioxidant activity of Total Polyphenolic Content (TPC), measured through the EC50 (Efficient Concentration for DPPH 50% inhibition), was very good for all rose samples and showed a high scavenging power when the TPC was lower, indicating a different composition of phenolic acid and glucosides in different rose samples.

The protection of the two sunflower oils (classic and high-oleic) from lipid peroxidation provided by different rose extracts, evaluated through the % inhibition, was very high for all the rose extracts, except for the three samples with the lowest TPC in classic sunflower oil; however, the TPC composition of these samples indicateda very good antioxidant power suggesting that a correct combination of quantiy and quality is needed when rosehip extracts are used as natural antioxidants.

Keywords: Rosehips; Rosehip Pericarps; Total phenolic content; Fatty acids; Antioxidant activity; Sunflower oil

Introduction

There is increasing interest in the use of functional foods not only as a source of nutrients but also for their promising response to numerous diseases. Among fruit and vegetable products, roses have been the focus of considerable attention due to their high content of bioactive compounds[1-5].

Roses are classified within the *Rosaceae* family, growing in various regions of the world; there are more than 200 species and 18000 cultivars in the world, geographically distributed mainly in Europe, Asia and North America[6]. Rosehips are usually used for the production of different kinds of products (juice, jam, bakery products, candies, etc.); various preparations of rosehips and rosehips and seeds have antioxidative and anti-inflammatory effects[6,7]. During recent years, the possible use of pericarp extracts as natural antioxidants for the protection of some vegetable products has been studied[8,9]. The high content of

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polyphenolic compounds, tocopherols, ascorbic acid and other phytochemicals, makes rosehip pericarps a promising source of substances which protect some vegetableoils from deterioration due to oxidation[8,10]. Rosehip seeds are generally disposed ofas waste after the use of the fleshy part. Due to their rich chemical composition, which includes not only phenolic components[5,11], but also other nutrients such as fatty acids, terpenes, tocopherols, carotenoids, proteins, sugar and minerals[2,12,13], seeds could play an important role as a functional food.In particular, the oil content of rosehip seeds ranges from 5% to 18% and it includes varying amounts of unsaturated fatty acids such as linoleic and oleic acid. Due to their higher content of favorable polyunsaturated fatty acids and sterols, seed oils represent a source of high added value compounds extracted from vegetable wastes which could be reused in food processing[14].

The aim of this study isto determine the phytochemical composition of the rosehip pericarps and seeds of selected rose plants growing in some Regions in Central Italy (Marche, Lazio and Emilia Romagna) as possible ingredients in functional food formulations and/or dietary supplements in order to replace synthetic antioxidants such as BHT (butylated hydroxytoluene) with natural alternatives.

This research studies the possibility to use rosehip seed oil as a functional food, due to its particular fatty acid composition, and evaluates the effectiveness of polyphenols extracted from rosehip pericarps as antioxidants to protect two sunflower oils (classic and high-oleic) from lipidperoxidation; the two oils were chosen for a direct comparison between them, due to their different composition in mono- and polyunsatured fatty acids.

Differences between roses collected from different sites and grown using different management systems will be highlighted and discussed.

Materials and Methods

Rose samples

Rosehips from eleven Rosa species and cultivars were collected from three sites in Central Italy: Località Maciolla (Il Giardino delle rose perdute), Urbino (PU), Marche Region (BS = *Rosa gallica* "La Belle Sultane", BPV = *Rosa gallica* "bella porpora violetta") ; Regional Natural Park of the Monti Simbruini, Camerata Nuova (RM), LazioRegion (CCN = *Rosa canina*) ;Persolino High School Antique Rose Collection, Faenza, (RA), Emilia Romagna Region (CF = *Rosa canina*, RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*). Pericarps and seeds were manually separated, freeze- dried and stored at -20°C until analysis.

Total Phenolic Contentdetermination in pericarps and seeds

The polyphenolic extracts from rosehip pericarps and seeds were prepared following the method described in Yi et al.[8]. Briefly, three 1 g samples of lyophilized rosehip pericarp from the different rose species were each mixed with 40 ml of 80% methanol and the mixture was shaken for 24 h at room temperature. Extracts were filtered through Whatman No. 1 paper (Whatman International Ltd, Maidstone, UK) and methanol and water were removed using a rotary evaporator (Postfach Büchi Rotavapor R110; Laboratoriums-Technik AG, Switzerland) under vacuum at 45°C and reconstituted with 5 ml methanol.

The Total Phenolic Content (TPC) was determined in pericarps and seeds following the Folin-Ciocalteu colorimetric method as described by Singleton and Rossi[15] with some modifications as in Yi et al.[8]. Briefly, the extracted sample (0.1 ml) was placed in a test tube and mixed thoroughly with 1.0 ml of 0.2 N Folin-Ciocalteu reagent. After 5 min, 0.8 ml of 7.5% sodium carbonate solution was added and the reaction mixture was allowed to stand for 30 min before the absorbance at 765 nm was measured. The total concentration of the phenolic compounds was expressed as gallic acid equivalents (GAE) in milligrams/g dry weight.

Fatty acid determination in seeds

Lipid extraction from seeds was carried out using an automated Soxhlet apparatus (Soxterm - Gerhardt, Bonn, Germany). Fatty acid methyl esters (FAME) were obtained by acid-catalyzed transesterification of extracted lipids[16], and analyzed with gas chromatography according to Tavoletti et al.[17]. A Supelco (Bellefonte, PA, USA) standard solution containing a mixture of 37 FAME was used for the identification of peaks. Fatty acid (FA) compositions (wt/wt % of total FAs) were calculated using the peak area normalization method.

DPPH Scavenging Test

The DPPH assay was performed according to a method described by Nenadis and Tsimidou[18] with some modifications[10]. A methanolic DPPH solution (0.1mM; 2960µL) was added to 40 µL of methanolic extracts from each rose sample. The mixture was shaken vigorously and the decrease in absorbance was measured at 515 nm after 30 min of incubation in the dark, using a UV-Visible spectrophotometer Varian Cary 50 Scan.

The blank solution contained the same amount of DPPH reagent and 40µL of methanol and each test was performed in triplicate. The percentage of DPPH inhibition was calculated as follows:

$$\% \text{ inhibition} = [(Ac - As)/ Ac] \times 100$$

where Ac and As are the absorbance of the control and test samples, respectively. Calculated EC50 (Efficient Concentration) represents the concentration of antioxidant required to decrease the amount of DPPH by 50%[10].

Antioxidant activity under storage

The antioxidant activity of the 11 rosehip pericarp extracts was determined for two crude sunflower oils: classic (20.2% monounsaturated and 63.0% polyunsaturated fatty acids) and high-oleic (88.8% monounsaturated and 4.3% polyunsaturated fatty acids). The thiocyanate method[19] was used as follows:20 µL of extracts of each rose sample were added to the vials containing 0.13 mL oil, mixed with 5.0 mL of 0.02 M phosphate buffer pH 7.0 and 5.0 mL of 99.5% ethanol (w/v). The mixture was mixed thoroughly and stored in the dark at 45°C for 7 days. The same mixture, but without the extract, was used as the control. Samples were examined at 24 h intervals by collecting aliquots (0.1 mL) from the incubation mixture, mixed with 3.0 mL of 75% (v/v) ethanol and 0.1 mL of NH4SCN (30% water solution); 3 min after the addition to the reaction mixture of 0.1 mL

of 20 mM $FeCl_2$ in 3.5% (v/v) hydrochloric acid, the absorbance was measured at 500 nm using a UV-Visible spectrophotometer Varian Cary 50 Scan.

A reaction blank containing all the reagents, except the sample, was used to zero the spectrophotometer readings.

All data are the average of triplicate analyses. The inhibition of lipid peroxidation as a percentage was calculated using the equation

% Inhibition = 100 – (A1/A0) x 100

where A_0 is the absorbance of the control reaction and A_1 is the absorbance in the presence of the extract sample[20].

Statistical analysis

Statistical comparisons of the mean values for each experiment were performed with one-way ANOVA, followed by the multiple Duncan test ($P \leq 0.05$ confidence level).

All statistical analyses were performed using JMP.10 (SAS Institute Inc., Cary, NC).

Results and Discussion

Phytochemicals in rosehips

Polyphenolic fraction: The results of total polyphenolic content (TPC) in the pericarps and seeds of the 11 rose samples are reported in Table 1. TPC in lyophilized pericarps ranged widely, from 16.80 ± 0.92 mg GAE g^{-1} in *Rosagallica Versicolor* to 288.19 ± 4.70 mg GAE g^{-1} in *Rosax Damascena*, showing significant differences between the 11 rose samples; RD showed the highest TPC values only comparable to those of GC and BS and significantly higher than the others, while GO, GR and GV showed values significantly lower than the other rose samples. Lower values of TPC were found in the rosehip seeds compared with the pericarps and no strict correlation was found between the two series of data, i.e. the higher TPC in pericarps did not correspond to similar high values in seeds. The TPC in seeds varied from 50.41 mg/g d.w. in RD to 17.50 mg/g d.w. in RG. RD, BPV and CCN showed the highest values which were similar to each other and significantly higher than GO, GC, RG and CF. Comparing the TPC values of this experiment with other studies, it can be stated that the highest TPC values found in the rosehip pericarps used in this research were greater than the data reported by many other authors. However, it is necessary to also bear in mind that many researchers report TPC values found in whole rosehip extracts, using pericarps together with seeds. Olsson et al.[21] reported TPC values for rosehips from 10 different rose samples, varying from 55 mg/g for *R. villosa* to 84 mg/g for *R. dumalis; Demir* et al.[2] found low TPC values in rosehips from 5 rose samples, varying from 31 to 37 mg/g; *Fascella* et al.[5] reported TPC values for rosehips for 4 rose samples, varying from 41 mg/g in R. corymbifera to 68 mg/g in *R. canina*. The low TPC values reported for measurements on whole rosehip extracts suggest the importance of separating pericarps and seeds when rosehips are used as a natural antioxidant.When TPC was determined separately for pericarps and seeds, the values reported by other authors are in agreement with some of those found in the present experiment[1,8,10].

The considerable range in the TPC of different rose species and/or varieties and between the same rose species growing in different parts of the world, together with the differences between TPC in rosehip pericarps and seeds, suggests that only specific experimental tests are able to clarify the real antioxidant power of each rose sample used in the current experiment to protect sunflower oils from oxidative deterioration; this aspect was developed in the present study and is described in the following sections.

Fatty acids

The relative abundance of the main fatty acids found in the seeds of the 11 rose samples is reported in Table 2. The three main unsaturated fatty acids, oleic (C18:1 n-9), linoleic (C18:2 n-6) and α-linolenic (C18:3 n-3), represented about 90% of the total in all the samples. Linoleic acid was predominant, representing around 50% of the total in all the rose samples (in a range from 43.79% to55.91%). Oleic acid ranged between 12.32% in *Rosacanina Camerata* Nuova and 25.83% in *Rosa canina* Faenza, while α-linolenic acid ranged from 13.46% in *Rosa gallicaversicolor* to 23.51% in *Rosacanina Camerata* Nuova. The main saturated fatty acids (C16:0, C18:0, C20:0) represented 7-10% of the total, with some slight differences between rose samples; palmitic acid was the most abundant, varying from 3.76% in CCN to 7.98% in RD. Other fatty acids, i.e. C12:0, C14:0, C15:0, C16:1 n-9, C17:0, C18:1 D11, C20:1 n-11, were present in percentages even lower than 1% and are not reported in Table 2.

Table 1: Total Polyphenolic Content (mg g^{-1}) in the lyophilized rosehips and seeds of the 11 rose samples collected in central Italy (mean of three replicates; standard deviation in parentheses; nd = not detected).

	BS	BPV	CCN	CF	RG	RA	GC	RD	GO	GR	GV
Pericarps	260.41^{ab}	213.19^{cd}	113.19^{f}	190.97^{de}	165.97^{e}	238.19^{bc}	265.97^{ab}	288.19^{a}	41.52^{g}	35.69^{g}	16.80^{g}
	(8.13)	(9.34)	(9.11)	(9.31)	(18.54)	(16.9)	(12.43)	(4.7)	(2.92)	(0.81)	(0.92)
Seeds	30.81^{b}	47.50^{a}	45.08^{a}	21.25^{cd}	17.50^{d}	27.25^{bc}	20.16^{cd}	50.41^{a}	20.35^{cd}	na	na
	(3.14)	(3.65)	(2.12)	(0.65)	(0.05)	(0.11)	(0.12)	(0.11)	(0.07)	--	-

BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor, nd = not analyzed*

Lower case letters represent the Least Significant Differences at $P \leq 0.05$ level, evaluated separately for pericarps and seed

Table 2: Relative abundance (%) of the main fatty acids of rosehip seeds of the 11 rose samples collected in central Italy (mean of three replicates; standard deviation in parentheses)

FA	BS	BPV	CCN	CF	RG	GC	RD	GO	GR	GV
C16:0	4.98^{cde}	4.55^{ef}	3.76^{h}	4.44^{efg}	5.49^{c}	7.06^{b}	7.98^{a}	4.69^{de}	3.93^{gh}	5.13^{cd}
	-0.11	-0.24	-0.13	-0.2	-0.33	-0.07	-0.15	-0.17	-0.12	-0.24
C18:0	1,89^{e}	2.35^{d}	2.67^{bcd}	3.29^{a}	2.51^{cd}	2.61^{bcd}	2.84^{bc}	1.85^{e}	1.61^{e}	1.73^{e}
	-0.06	-0.07	-0.11	-0.16	-0.03	-0.18	-0.23	-0.06	-0.14	-0.08
C18:1 n-9	21.72^{c}	22.96^{bc}	12.32^{e}	25.83^{a}	24.16^{ab}	23.56^{b}	19.18^{d}	24.02^{b}	18.05^{d}	23.98^{b}
	-0.52	-0.16	-0.24	-0.85	-0.57	-0.47	-0.36	-1.03	-0.21	-0.77
C18:2 n-6	47.58^{e}	53.52^{bc}	55.91^{a}	46.89^{e}	44.46^{f}	43.79^{f}	48.40^{e}	50.67^{d}	52.45^{cd}	52.72^{cd}
	-0.47	-0.76	-0.12	-0.42	-0.57	-0.81	-1.21	-0.69	-0.65	-1.2
C20:0	1.02^{cd}	0.76^{e}	0.89^{de}	1.27^{ab}	1.00^{cd}	0.76^{e}	0.79^{de}	1.30a	0.79^{de}	1.13^{abc}
	-0.11	-0.04	-0.04	-0.13	-0.04	-0.05	-0.07	-0.08	-0.05	-0.1
C18:3 n-3	20.99^{bc}	14.57^{fg}	23.51^{a}	17.20^{de}	20.77^{bc}	19.65^{c}	17.96^{d}	15.75^{ef}	21.41^{b}	13.46^{g}
	-0.34	-0.48	-0.44	-0.34	-0.35	-0.48	-0.31	-0.72	-0.83	-0.48

BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor, nd = not analyzed*
Lower case letters represent the Least Significant Differences at $P \leq 0.05$ level, evaluated separately for each fatty acid.

In the different rose samples, the fatty acid content was variable and some significant differences were found, especially for the three main unsaturated fatty acids, i.e. oleic, linoleic and α-linolenic. Oleic acid relative abundance was significantly higher in CF, while CCN showed a value significantly lower than the other rose samples; a value significantly higher for linoleic acid was found in CCN, and significantly lower in RG and GC, while α-linolenic acid showed the highest value in CCN and the lowest in GV

The relative abundance of the main unsaturated fatty acids in the rose samples studied suggests their possible use for many purposes:cosmetic and medicinal[22,23], and/oras natural functional foods thanks to their high unsaturated fatty acid content[24,25].

Antioxidant activity

Radical scavenging activity of phenolic extracts: The relationship between the DPPH radical scavenging activity and the total phenolic content of different rose species is presented in Figure 1. As can be seen, the antioxidant capacity was in agreement with the TPC of different rose samples, with RD being the most effective and GO, GR and GV the least. All fractions exhibited good DPPH radical scavenging properties ; the inhibition of DPPH activity remained almost the same (84.3-93.6%) when the TPC content was in a concentration ranging from 113.2 to 288.2 mg/g in different rose species; this can also be verified by the logarithmic trend in the fitting function with a confidence level of 99% ($R^2 = 0.832$). The EC50 values of the 11 rose species were in linear correlation with the TPC values ($R^2 = 0.995$) (Figure 2) resulting in a direct proportionality, i.e. the lowest EC50 values were found for the rose species with the lowest TPC values, indicating that the quality of TPC composition in these species was better able to preserve food from oxidation than extracts with a high TPC value for which a high polyphenolic content was required in order to have the same antioxidant efficiency. In particular, the lowest EC50 value was 202.3 µg/g for GV which also showed the lowest TPC content and the highest EC50 value was1203.8 µg/g for RD which corresponded to the highest TPC value. In a previous work[10], radical scavenging activity was measured for different fractions of polyphenols extracted from *rosa woodsii* and different values of IC50 (Inhibition Concentration of 50%, comparable with EC50 were found, showing the lowest values for fractions rich in quercetin and/or catechin compared with those rich in gallic acid. The polyphenolic fraction composition of each rose extract proves to be very important in order to obtain an optimal antioxidant activity when the rose extracts are used as a natural antioxidant to be added to vegetableoils so as to prevent lipid peroxidation. On the basis of the results obtained in the present experiment, it could be hypothesized that extracts from the roses with a lower TPC were rich in polyphenolic components which are very active against lipid peroxidation in vegetable oils.

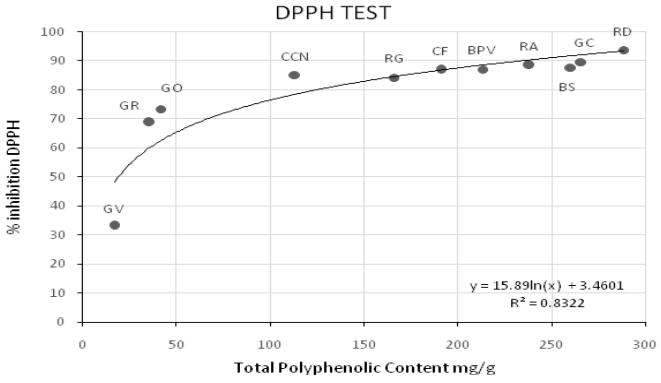

Figure 1: % of DPPH inhibition of polyphenolic extracts from the 11 rose species (mean of three replicates)
BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

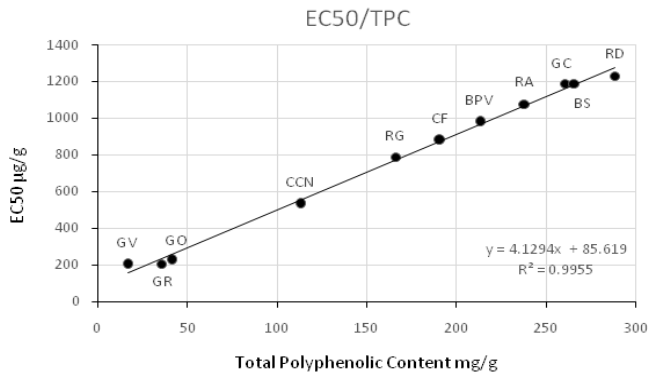

Figure 2: Correlation between Calculated Efficient Concentration (EC50), the amount of antioxidant necessary to decrease the initial DPPH by 50%, and the TPC (Total Phenolic Content) of the 11 rose samples (mean of three replicates)
BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

However, the results of the DPPH assay for potential antioxidative compounds are sometimes poorly correlated with performance in real food, because the nature and polarity of the radicals encountered in the food system are different from those of the DPPH radical. Hence, in the present study, the antioxidant activity of promising phenolic extracts/fractions was further examined in two sunflower oils under storage conditions.

Antioxidant activity under storage: The test was performed for two sunflower oils as described in the M&M section. The two oils, although both derived from sunflowers, had a very different unsaturated fatty acid content, with a monounsaturated fraction of 20.2% in classic sunfloweroil and 88.8% in high-oleic sunflower oil and a polyunsaturated fraction of 63.0% and 4.3% in the two oils, respectively. Results for the antioxidant activity under storage are shownin Figures 3 and 4 and Tables 3 and 4. The formation of lipid hydroperoxides was monitored by absorbance measurements at 500 nm wave length. Figure 3 reports the results of the absorbance recorded for the two sunflower oils without antioxidant addition (CTRL), with the addition of BHT as a reference synthetic antioxidant substance and with the addition of 20 µL of polyphenolic extracts from the 11 rose samples, in a trial performed at 45°C for 7 days. At the end of the 7 day storage period the lower percentage of polyunsaturated fatty acids (4.3%) in the high-oleic sunflower oil compared with the classic sunflower oil (63.0%), showed a greater reduction in peroxidation in the high-oleic control sample with respect to the classic oil, indicating that the high-oleic oil can be stored more safely. The effect of different rose extracts in preventing the lipid peroxidation of the two oils began to be evident four days after the start of the storage period in both oil samples. The protection of the two oils against lipid peroxidation, calculated as percentage inhibition[8] at the end of the 7 day storage period (Table 3), was higher for the roses containing more than 200 mg/g TPC for both oil types, varying from 76.7 to 86.3% for classic sunflower oil and from 79.6 to 85.4% for high-oleic sunflower oil, while the rose samples with a low TPC value (GO, GR and GV) showed a percentage protection which was significantly lower than the other rose samples. These three roses did not appear to be suitable for the purpose; however, considering the antioxidant power reported in Figure 4, i.e. the calculated percentage of protection offered by 1 mg of TPC extract from each rose sample, it can be seen that these three rose extracts showed values which are much higher than the other rose samples. The highest value of 2.46 for GV in high-oleicoil was more than eight-fold higher than the lowest result of 0.29 for RD (Table 4), even if the TPC of the former was fifteen-fold lower than the latter. As also highlighted in the DPPH scavenging test, the best antioxidant power was shown by the polyphenolic extracts with lower TPC content, probably indicating a different composition in phenolic compounds in these extracts with a predominance of quercetin, followed by catechin and some phenolic acids, such as gallic and caffeic. Aladedunye et al.[10] found a positive correlation between antioxidant activity and quercetin and catechin content in different polyphenolic fractions extracted from *rosa woodsii*, thus confirming the above supposition. This may be related to the relatively better lipophilic nature and/or higher radical scavenging activity of quercetin and catechin, compared to gallic acid. Quercetin has been shown to improve the oxidative stability of bulk canola[26] and fish oils[27].

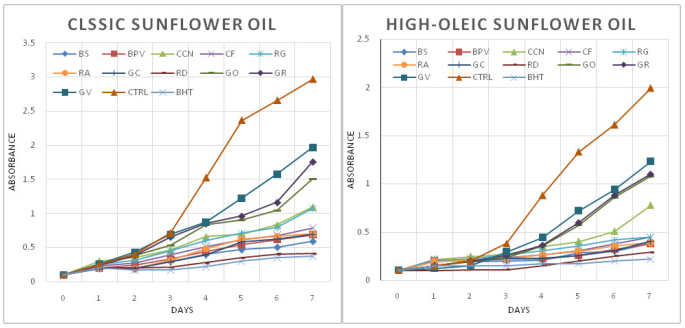

Figure 3: Antioxidant activity of polyphenol extracts from rosehip pericarps of the 11 rose species on lipid peroxidation in the classicsunflower oil and high-oleic oil samples (mean of three replicates)
BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

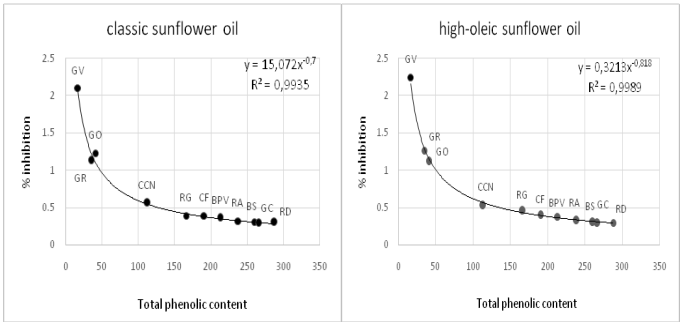

Figure 4: Calculated percentage of inhibition of 1 mg TPC on lipid peroxidation compared with the total TPC content of the respective 11 rose samples, in classicsunflower oil and in high-oleic sunflower oil.
BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

Table 3: Percentage inhibition of lipid peroxidation in the two sunflower oils by polyphenol extracts from rosehip pericarps of the 11 rose samples, after 7 days of storage

	BS	BPV	CCN	CF	RG	RA	GC	RD	GO	GR	GV
Classic sunflower oil	80.7	77.3	64	74	65	77	76.7	86.3	50.7	39.7	35.3
High-oleic sunflower oil	80.6	80.9	61	77.6	77.6	80.4	79.6	85.4	45.7	44.7	38.1

BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

Table 4: Calculated inhibition power (%) of 1 mg of polyhenolic extracts from the 11 rose samples on lipid peroxidation of the two sunflower oils

	BS	BPV	CCN	CF	RG	RA	GC	RD	GO	GR	GV
Classic sunflower oil	0.31	0.36	0.56	0.39	0.39	0.32	0.29	0.30	1.23	1.13	2.10
High-oleic sunflower oil	0.31	0.38	0.53	0.41	0.47	0.34	0.30	0.29	1.13	1.26	2.46

BS = *Rosa gallica* "La belle sultane", BPV = *Rosa gallica* "bella porpora violetta", CCN = *Rosacanina* (Camerata Nuova), CF = *Rosa canina* (Faenza), RG = *Rosa gallica*, RA = *Rosa x alba*, GC = *Rosa gallica complicata*, RD = *Rosa x damascena*, GO = *Rosa gallica officinalis*, GR= *Rosa gallica rugosa*, GV = *Rosa gallica versicolor*.

Conclusions

In conclusion, the nutritional composition and the presence of bioactive compounds make rosehip pericarps and seeds a valuable source of phytonutrients and maybe proposed as natural antioxidants and as ingredients in functional food formulations. The research study performed has highlighted that different rose species and varieties showed very different polyphenolic content, varying up to 17-fold between the highest and the lowest percentages, and a fatty acid composition with few differences between species which isvery interesting for nutritional purposes thanks to the high content of mono- and polyunsaturated fatty acids

All the rose samples showed high antioxidant activity against lipid peroxidation in sunflower oil and high-oleic sunflower oil, except the three species with low polyphenolic content; however, the high quality of the polyphenolic composition in the TPC of these three rose species provides greater antioxidant power than the other rose samples.

A better analysis of the antioxidant power of rose extracts from different species collected from different sites could be useful when choosing the best extracts to protect vegetableoilsfrom lipid peroxidation.

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