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MORPHOLOGICAL AND CHEMICAL CHARACTERISTICS OF FRUITS OF SELECTED *ROSA* SP.

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Abstract. The aim of this study was to evaluate the morphological and chemical parameters, antioxidant activity (DPPH) of five rose species (*Rosa rugosa, R. villosa, R. californica, R. spinosissima,* and *R.* × *damascene*) and grouping them according to the harvest date. On the basis of the study, rose species grown in eastern Poland were grouped according to their harvest time, and three dates of cumulative ripeness of pseudofruits were distinguished. Rosehips of studied species varied referring to their harvest date and morphological properties and were characterized by diverse contents of primary metabolites analyzed. In addition, obtained extracts showed high antioxidant activity, which has a significant impact on their value for processing.

Key words: Rosaceae, *Rosa*, morphology, antioxidant activity, chemical parameters

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Introduction

In recent years, there has been a general increase in the interest in using plants as an alternative source of raw materials for pharmaceutical, food, and cosmetic industries. Numerous studies confirm that many plant components are – in addition to be nutritionally valuable – also important in the prevention from civilization diseases (Youdim *et al.* 2000; Hasik 2001; Daels-Rakotoarison *et al.* 2002; Wolski & Karwat 2004; Bułhak-Jachymczyk *et al.* 2001; Nowak & Gawlik-Dziki 2007; Zafra-Stone *et al.* 2007). Applying analytical and pharmacodynamic methods for the assessment of medicinal substances properties, more and more data on the therapeutic performance and effectiveness of medicinal preparations of natural origin, is achieved (Gardner *et al.* 2000; Bazzano *et al.* 2002; Böhm *et al.* 2003). The increase in consumer's nutritional consciousness, as an alternative treatment, and most of all supporting the pharmacological therapy, stimulates the search for new natural plant compounds having some favorable effects on a human's organism.

The rose pseudofruits, in addition to vitamin C, which are the richest natural source, also contain carotenoids, including lycopene, and pectins. Phenolic compounds are important group of biologically active substances present in rosehips; these include tannins, flavonoids, phenolic acids, and anthocyanins (Razungles *et al.* 1989; Oszmiański & Chomin 1993; Demir & Özcan 2001; Hvattum 2002; Kumarasamy *et al.* 2003; Ercisli 2007; Chrubasik *et al.* 2008). So far, *Rosa rugosa* Thunb. and *R. canina* L. are the most important in the food industry in Europe (Popek 1996; Henker 2000). There are various rose species that differ in their appearance and chemical composition, and they may be a potential raw material for manufacturers interested in new and attractive materials, to convince consumers to their products.

The present study aimed at comparing and evaluating the physicochemical parameters, chemical composition, and antioxidant properties of ripe fruits of selected rose species.

Material and methods

Material for study consisted of pseudofruits of some rose species: *Rosa rugosa, R. villosa* L., *R. californica* Cham. & Schltdl., *R. spinosissima* L. (= *R. pimpinellifolia* L.), and *R.* ×*damascena* Mill.

Table 1. Harvest time, length/width ratio for pseudofruits of selected rose species.

Species	Harvest time period	Fruit length/ width ratio, %
Rosa californica	17.09 – 15.10	1.57 ± 0.31
Rosa villosa	27.08 – 24.09	1.10 ± 0.15
Rosa rugosa	12.09 – 10.10	1.66 ± 0.11
Rosa spinosissima	1.09 – 22.09	1.97 ± 0.23
Rosa × *damascena*	9.09 – 10.10	1.31 ± 0.34

Rosehips were harvested in 2011 from shrubs growing in the collection of the Botanical Garden, University of Maria Curie-Skłodowska in Lublin. Only ripe, healthy and undamaged fruits were subject to determinations; quantities of 0.5 kg were collected, and depending on the species, two or three harvests were performed. Rosehip morphological parameters such as length and width were measured using digital slide caliper. Based on these measurements, the length to width ratio was assessed for rosehips. The weight of a single pseudofruit and nut was determined, and the proportion of nuts in the pseudofruit was calculated, as well.

Following parameters of pseudofruits were determined: acidity in accordance with the Polish Norm (PN-90/A-75101/04), content of extract (PN-90/A-75101/02), total sugars by means of Schorl-Luff method (Charłampowicz 1966), as well as vitamin C applying Roe method modified by Ewelin (Korenman 1973); total polyphenol content was determined applying Folin-Ciocalteu procedure (results expressed in terms of gallic acid GAE) (Singleton & Rossi 1965; Slinkard & Singleton 1977). The ethanol extracts of the fruits were subject to determination of the binding strength of 2,2-diphenyl-1-picrylhydrazyl radicals (DPPH) (Chen & Ho 1997).

Achieved results from laboratory experiments were statistically processed by means of variance analysis method and Tukey's confidence intervals at 5% confidence level.

Results and discussion

Ripening period of rose pseudofruits depends on many factors: species, variety, and weather course (temperature and precipitation) (Buchwald *et al.* 2007). Based on the study, three periods of cumulative rosehips ripeness were distinguished (Tab. 1). Considering studied rose species, the fruits were harvested as early as the third decade of August (*R. villosa*), in September (*R. spinosissima*), and at the end of September and beginning of October (*R.* × *damascena, R. rugosa* and *R. californica*). Most of fruits of tested species was ripened and harvested in late September and beginning of October, therefore, that term may be regarded as typical for species grown under conditions of eastern Poland.

The rosehips may be more or less elongated, as indicated by their length-to-width ratio. The larger the parameter, the fruit is more elongated. The ratio for tested pseudofruits ranged from 1.10 to 1.97%. In available literature, there are no data upon this parameter in relation to the rosehips. According to Pirlak *et al.* (2003) and Demir & Kalioncu (2003), the dogwood fruits are characterized by spherical and elongated-oval shape, the shape factor of which, depending on the variety, ranges from 1.20 to 1.84%.

Physicochemical parameters of selected rose pseudofruits are presented in Tab. 2. *R. californica, R.* × *damascena* and *R. spinosissima* were characterized by the heaviest fruits; their average weight ranged from 2.20 g to 2.08 g and no significant differences were reported between them. The lightest rosehips were produced by *R. villosa* plants and their average weight amounted to 1.03 g. According to various authors (Kazaz *et al.* 2009; Mabellini *et al.* 2011) the weight of a single fruit can vary within quite wide range from 0.95 to 3.27 g and is influenced by many factors such as: species, variety, growing conditions, and location (Popek 1996; Buchwald *et al.* 2007). Species grown in Bulgaria, Romania, Turkey, Portugal, and India form slightly larger fruits (Ercisli & Esitken 2004; Ercisli & Guleryuz 2006; Mabellini *et al.* 2011).

Rosehips, that are potential raw material for the industry, should be characterized by the greatest share of possibly the lowest weight

Table 2. Physical parameters of roses' pseudofruits.

Species	Fruit weight, g	Seeds weight, g	Share of seed in the fruit, %
Rosa californica	2.20 ± 0.14 a	0.27 ± 0.08 a	12.27
Rosa villosa	1.03 ± 0.23 c	0.19 ± 0.04 b	18.44
Rosa rugosa	1.58 ± 0.16 b	0.19 ± 0.01 b	12.03
Rosa spinosissima	2.15 ± 0.17 a	0.26 ± 0.03 a	12.09
Rosa × *damascena*	2.08 ± 0.12 a	0.27 ± 0.02 a	12.98

Explanatory notes: ± – standard deviation; different letters a, b, c… in the same column indicate statistically significant differences ($p < 0.05$).

Table 3. Total acidity, contents of extract and total sugars in pseudofruits of selected rose species.

Species	Total acidity, %	Extract, %	Total sugars, %
Rosa californica	2.07 ± 0.13 a	18.2 ± 0.01 b	20.3 ± 0.06 b
Rosa villosa	0.89 ± 0.02 c	17.0 ± 0.03 b	17.1 ± 0.03 b
Rosa rugosa	1.18 ± 0.07 c	20.1 ± 0.01 a	32.6 ± 0.02 a
Rosa spinosissima.	1.29 ± 0.09 b	19.7 ± 0.04 a	27.5 ± 0.05 a
Rosa × *damascena*	1.21 ± 0.18 b	18.6 ± 0.07 b	21.9 ± 0.01 b

Explanatory notes: see Tab. 2.

of wastes during production. Therefore, the nut proportion in fruit weight is an important parameter of the physical assessment. According to data contained in Tab. 2, the share of nuts in fruits of different rose species was at similar level of about 13%. Among tested species, the *R. villosa* rosehips were less valuable raw material in terms of this parameter. Diverse percentage of nuts in the fruit weight can be a factor determining the purpose of individual rose species. Like other raw materials, nuts (seeds) contain fatty oil rich in essential fatty acids (Ercisli 2007; Yoruk *et al.* 2008; Kazaz *et al.* 2009).

Morphological and genetic diversity of particular rose species suggests that there is similarly great variability of chemical composition of raw material (pseudofruit) within each of them. Therefore, it would be useful to allocate the form with defined chemical composition to a given genotype group. The usefulness of raw materials for processing is determined by fundamental chemical parameters such as contents of extract, total sugars, and total acidity (Tab. 3).

The total acidity of studied raw materials varied in a wide range from 0.89% in *R. villosa* to 2.07% in *R. californica*. Similar results were obtained by Demir & Özcan (2001) and Mabellini *et al.* (2011), while Dogan & Kazankaya (2006) reported slightly lower values. Studied fruits were characterized by a high content of extract, which was directly proportional to the total sugar content, and the results were comparable with those quoted in the literature (Dogan & Kazankaya 2006; Rous *et al.* 2011).

The rosehips contain a lot of different polyphenols and ascorbic acid, which is confirmed by the results from studies conducted around the world (Razugles *et al.* 1989; Hvattum 2002; Gao *et al.* 2005; Saeidi & Beygi 2009; Rous *et al.* 2011).

The content of polyphenols in the studied raw materials was greatly diversed (Tab. 4). The highest polyphenol content characterized rosehips of *R. rugosa* (215.14 mg · 100 g^{-1} FM) and *R. villosa* (192.56 mg · 100 g^{-1} FM), and the lowest – pseudofruits of *R.* × *damascena* (109.67 mg · 100 g^{-1} FM). The rosehips are a rich source of ascorbic acid, the content of which ranges from 200 to 2800 mg · 100 g^{-1} FM (Oszmiański & Chomin 1993; Uggla

Table 4. Contents of total polyphenols, vitamin C, and antioxidant activity in pseudofruits of selected rose species.

Species	Total phenols, mg · 100 g^{-1} FM	Vitamin C, mg · 100 g^{-1} FM	DPPH, μM TE · g^{-1} FM
Rosa californica	161.03 ± 0.14 b	863 ± 0.1 b	59.7 ± 0.01 b
Rosa villosa	192.56 ± 0.25 a	706 ± 0.4 c	51.3 ± 0.07 c
Rosa rugosa	215.14 ± 0.18 a	974 ± 0.1 a	74.5 ± 0.05 a
Rosa spinosissima	121.38 ± 0.05 c	845 ± 0.2 b	61.2 ± 0.08 b
Rosa × *damascena*	109.67 ± 0.15 c	932 ± 0.3 a	70.4 ± 0.11 a

Explanatory notes: see Tab. 2.

et al. 2003). The fresh fruits of studied rose species contained ascorbic acid at the levels from 706 mg · 100 g^{-1} FM to 974 mg 100 g^{-1} FM, which was consistent to literature data (ERCISLI 2007; KAZAZ *et al.* 2009). The maximum capacity of neutralizing free DPPH radicals was shown by extracts obtained from *R. rugosa* and *R.* × *damascena* rosehips, whereas the minimum by *R. villosa* pseudofruits.

Conclusions

1. The rosehips of studied rose species are a valuable raw material characterized by a high extract and large content of total sugars.
2. Diverse contents of secondary metabolites among studied rose species were reported.
3. Antioxidant activity of rosehips of studied species is shaped by the presence of polyphenols and ascorbic acid.
4. Very good physicochemical and antioxidant properties indicate that the rosehips of studied species can be a valuable raw material for the processing industry.

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