

Contents of secondary metabolites at various anatomical parts of three wild strawberry (*Fragaria vesca* L.) cultivars

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Summary

Chemical analyses aimed to evaluate the contents of free phenolic acids, flavonoids and tannins at different anatomical parts of three wild strawberry cultivars: 'Regina', 'Rugia' and 'Baron von Solemacher', originating from agrotechnical experiments, were carried out at Department of Vegetable and Medicinal Plants, University of Life Sciences in Lublin in 2008–2009. The differentiation of determined biologically active substances depending on a leaf part was observed. Mean contents of phenolic acids and flavonoids were the highest at leaf blades of 'Rugia' amounting 1.27% and 2.66%, respectively. No significant differences in tannins contents depending on a cultivar were recorded, although leaf blades accumulated significantly higher quantities of tannins than petioles.

Key words: flavonoids, *Fragaria vesca* L., phenolic acids, tannins, secondary metabolites, wild strawberry

INTRODUCTION

Secondary metabolites present at organs of plants from different systematic groups show multi-directional activity spectrum. Nutritional and health aspects of

fruits and vegetables are widely discussed which is associated among others with polyphenols presence. These compounds, namely phenolic acids, flavonoids and tannins make the antioxidant potential as well as protect against some diseases as cancer or heart disorders [1-6].

Phenolic acids are responsible for sour and bitter taste of some plant-origin foods; they also make them astringent properties. Phenolic acids, namely hydroxybenzoic and hydroxycinnamic ones (the most common at plant tissues) are substances often found in plant-origin food. Phenolic acids can be components of anthocyanins and flavones [7].

Flavonoids are biochemically active constituents of plants. They play as filters protecting them against excessive UV radiation, acting as antioxidants and showing antiviral, antifungal as well as antibacterial features. They are also attractants or deterrents for insects, and control the gene expression and enzymatic activity [8]. As similar as phenolic acids, flavonoids show multi-directional antiviral, anti-inflammatory, antioxidant, anti-allergenic and detoxication activity towards human organisms [9]. Flavonoids are present namely in leaves, flowers, and fruits, while ligneous tissues and seeds contain flavonoids only occasionally [10].

Contents and composition of secondary metabolites are determined both by genetic and ontogenetic factors. Among genetic ones, varietal variability, while development stage and plant part as a herbal material, play important roles [11].

Polyphenols are also the most abundant group of biologically active compounds found at wild strawberry herb [12]. Wild strawberry is a perennial from rose family (*Rosaceae*). The varieties cultivated nowadays are derived from a wild cultivar named common wild strawberry (*Fragaria vesca* L.) [13-16]. Apart from aromatic fruits (*Fragariae fructus*), also leaves (*Fragariae folium*) and roots (*Fragariae radix*) of wild strawberry are herbal materials used in medicine [17].

The present study was aimed to analyze the contents of flavonoids, phenolic acids, and tannins in herbal material composed of leaf blades and petioles of three strawberry cultivars: 'Regina', 'Rugia' and 'Baron von Solemacher'.

MATERIAL AND METHODS

The study material consisted of three wild strawberry cultivars: 'Regina', 'Rugia' and 'Baron von Solemacher' originating from agrotechnical experiments carried out at Department of Vegetable and Medicinal Plants, University of Life Sciences in Lublin in 2008–2009. In both years of study, harvests were made at full flowering stage. Healthy material was cleaned just after the harvest and divided into leaf blades and petioles. Afterwards, the material was dried at 30°C. In air-dried samples (leaf blades and petioles), in the Laboratory for Vegetable and Herbal Material Quality determined the contents of phenolic acids (%) [18], flavonoids (%) [19], as well as tannins [18].

Total flavonoids estimation

Total flavonoids were estimated according to the spectrophotometric method according to Christ and Müller [19], expressed as quercetin equivalent (QE). After 45 min. the absorbance at 425 nm was measured.

Total phenolic acids estimation

Total phenolic acids estimation was carried out according to Arnov method [18]. One milliliter of sample was mixed with 5 ml of distilled water, 1 ml 0.5 M HCl, 1 ml of Arnov reagent and 1 ml 1M NaOH and subsequently completed to 10 ml with distilled water. The absorbance was measured at 490 nm. The total phenolic acid content was expressed as caffeic acid equivalent (CAE).

Tannin estimation

The amount of tannin estimation was determined using procedure described in the pharmacopoeia [18]. The content of tannins was expressed as dry weight percentage.

Statistical analysis

Achieved results from laboratory determinations were statistically processed by means of variance analysis and T-Tukey confidence interval at 5% significance level.

RESULTS AND DISCUSSION

Available literature references provide only with few information on the scientific scope presented in our study. Achieved results revealed that polyphenols (i.e. phenolic acids, flavonoids and tannins) are the most important biologically active compounds responsible for positive features of wild strawberry [12]. The most common are gallic acid, quercetin, and kaempferol. Active substances at *Fragaria vesca* show efficient antioxidant and immuno-stimulating action on a cellular level, intensify an organism's efficiency, as well as protect against toxins [3, 6, 9, 14].

The quantitative contents of particular compound groups present in leaves (leaf blades and petioles) of three wild strawberry varieties are discussed below.

Phenolic acids

Contents of phenolic acids at leaves of three wild strawberry cultivars ranged within 0.11–0.56% (tab. 1), although, regardless of the cultivars, leaf blades produced them 5 times more as compared to the petioles. Considering the influence

of a cultivars it was found that 'Regia` cv. was characterized by the highest concentration of phenolic acids in leaf blades (1.27% on average, tab. 1). Significant differences in phenolic acids contents in leaf blades of analyzed wild strawberry cultivars in particular study years were recorded. That material contained them considerably more in material harvested in 2009. Instead, no significant differences of phenolic acids contents in petioles of all examined cultivars were observed. Najda et al. (2003), when studying various organs of lovage plants, also reported higher phenolic acids concentrations in leaf blades (1.23%) than petioles (0.39).

Table 1.

The content of phenolic compounds in different part of plants in three cultivars of *Fragaria vesca* L.

cultivar	raw material	phenolic acids of dry weight (as caffeic acid, %)			flavonoids of dry weight (as quercetin, %)			tannins of dry weight (%)		
		year								
		2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
'Regina`	leaf blades	0.80	1.56	1.18	1.77	3.45	2.61	2.66	3.65	3.16
	petioles	0.18	0.21	0.20	0.25	0.25	0.25	0.68	0.83	0.76
	mean	0.49	0.89		1.01	1.85		1.67	2.24	
'Regia`	leaf blades	1.14	1.40	1.27	2.08	3.23	2.66	2.69	3.56	3.13
	petioles	0.19	0.19	0.19	0.19	0.24	0.22	0.77	0.98	0.88
	mean	0.67	0.80		1.14	1.74		1.73	2.27	
'Baron von Solemacher`	leaf blades	0.92	1.07	1.00	1.85	2.22	2.04	2.91	3.33	3.12
	petioles	0.11	0.15	0.13	0.15	0.18	0.17	0.65	0.78	0.72
	mean	0.52	0.61		1.00	1.20		1.78	2.06	
Mean	leaf blades	0.95	1.34	1.15	1.90	2.97	2.44	2.75	3.51	3.14
	petioles	0.16	0.18	0.17	0.20	0.22	0.21	0.77	0.86	0.79
	mean	0.56	0.77		1.05	1.60		1.73	2.19	

LSD_{0.05}

cultivar (A)	0.094	0.098	0.019
raw material (B)	0.072	1.678	0.805
year (C)	0.062	0.217	0.378
(AxB)	0.011	0.103	0.021
(AxC)	0.011	0.103	0.021
(BxC)	0.007	0.211	0.042
(AxBxC)	0.008	0.028	0.037

Flavonoids

Level of flavonoids in studied material ranged from 0.15% (petioles at 'Baron von Solemacher` cv.) up to 3.45% (leaf blades at 'Regina` cv.). Significant differences in these compounds contents depending on analyzed plant part were obser-

ved. Regardless of a cultivar, leaf blades contained over 10 times more flavonoids as compared to petioles. No considerable differences in flavonoids concentration in petioles between particular years of study were found. In 2009, plants of all examined varieties produced considerably more flavonoids in leaf blades. Contents found for wild strawberry were many times higher than those reported by Najda et al. (2008) upon flavonoids levels in caraway plants.

Tannins

Significant differences of tannins contents in particular parts of studied wild strawberry cultivars were recorded; however Najda et al. (2003), when examining the tannin contents in lovage leaves, found other dependence. It was confirmed by research carried out by Wolski et al. (2002), who also proved differences in tannins concentrations in celery leaves (petioles and blades) between its varieties. Present study revealed that regardless of a cultivar and analyzed plant part, wild strawberry harvested in 2009 contained slightly more tannins.

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ZAWARTOŚĆ METABOLITÓW WTÓRNYCH W RÓŻNYCH CZĘŚCIACH ANATOMICZNYCH ROŚLIN TRZECH ODMIAN POZIOMKI (*FRAGARIA VESCA* L.)

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Streszczenie

W latach 2008–2009 w Katedrze Warzywnictwa i Roślin Leczniczych Uniwersytetu Przyrodniczego w Lublinie przeprowadzono analizy chemiczne mające na celu określenie zawartości wolnych kwasów fenolowych, flawonoidów i garbników w różnych częściach anatomicznych roślin trzech odmian poziomki. Wykazano zróżnicowanie w zawartości badanych związków biologicznie czynnych w zależności od odmiany oraz części liścia stanowiących źródło analizowanych związków. Średnia zawartość kwasów fenolowych i flawonoidów była największa w blaszkach roślin odmiany 'Rugia' i wynosiła odpowiednio 1,27% i 2,66%. Nie wykazano istotnych różnic w zawartości garbników w zależności od odmiany, jednak istotnie więcej tych związków gromadziły blaszki liściowe w porównaniu do ogonków.

Słowa kluczowe: *Fragaria vesca* L., kwasy fenolowe, garbniki, metabolity wtórne, poziomka dzika