Potentilla erecta (L.) rhizomes as a source of phenolic acids

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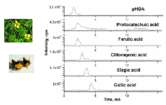
ABSTRACT

The aim of this study was to evaluate the content of major phenolic acids from *Potentilla erecta* rhizomes. Water and ethanol-water mixture was used for extraction of these compounds. The extracts were also evaluated for the quantification of total phenolic content and the antioxidant capacity. The contents of phenolic acids and resulting antioxidant activities are dependent on the nature of extracting solvent due to the presence of different antioxidant compounds. Results showed that *P. erecta* rhizomes contained high amount of gallic and *p*-HBA acids. The contents of chlorogenic and protocatechuic acids in the extracts of *Potentilla* species have not been reported yet. The results suggested that the extracts could be used as the active cosmetics ingredients and nutraceuticals.



KEYWORDS *Potentilla erecta*; phenolic acids; antioxidants

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1. Introduction

Potentilla erecta from the family *Rosaceae* is growing wild in central and northern Europe and in Asia. The extracts from aerial parts and rhizomes have been known for a long time in traditional medicine as a remedy for the treatment of inflammations and gastrointestinal disorders (Tomczyk et al. 2010; Paduch et al. 2015). Positive results of *P. erecta* extract treatment have been observed in individual patients with active ulcerative colitis (Wan et al. 2014).

Phenolic acids and their derivatives are a diverse class of phenolic compounds. Recent interest in these compounds stems from the potential protection they offer against oxidative damage diseases (Saxena et al. 2012). Phenolic acids can act as reducing agents, hydrogen donors, singlet oxygen quenchers as well as a chelators of metal ions, preventing metal catalyzed formation of free radicals (Shahidi and Zhong 2015). However, to the best of our knowledge, the research of the antioxidant properties of the *P. erecta* extracts are poorly investigated.

The aim of this study was to evaluate the effect of water and ethanol-water mixture used for the extraction of major phenolic acids from rhizomes of *P. erecta*. The efficiency of this process was checked out by quantification of these compounds by LC-MS analysis. The extracts were also evaluated for the determination of total phenolics and the antioxidant capacity quantified as scavenging ability on DPPH radicals and reducing capacity using CUPRAC method.

2. Results and discussion

Ethanol–water solution (60:40, v/v) and water alone were used for extraction of phenolic compounds from *P. erecta* rhizomes. Several studies suggested that the content of phenolics decreased with increasing concentration of alcohol above 60% (v/v) (Waszkowiak and Giszczyńska-Świgło 2014; Dróżdż et al. 2017)AQ2.

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As it was expected, extraction of total phenolics with 60% ethanol were higher (111 ± 2.8 mg GA/g) than that obtained by hot water (74.2 ± 1.90 mg GA g^{-1}), probably due to higher solubility of these compounds. Wang et al. (2013) reported the results in Folin-Ciocalteau assay in the range of 93.9–144.5 mg GA g^{-1} for leaves of other *Potentilla* species, such as *P. fruticosa*, *P. glabara* and *P. parvifolia* using acetone for extraction. For water extract from leaves of *P. fructose* 4.01 mmol GA 100 g^{-1} (0.69 mg GA g^{-1}) was obtained (Luo et al. 2016).

The contents of phenolic acids determined in both extracts of *P. erecta* rhizomes are presented in Table 1 and the ESI-MS/MS chromatogram obtained in SRM mode for water-ethanol extract is shown in Figure S1. The extract composition was almost the same in each case, but the phenolic acid yields were different. The analyzed extracts contained the highest amount of gallic and *p*-HBA acids from the group of hydroxybenzoic acids. The literature survey reveals their various biological properties such as antimicrobial, antioxidant, antimutagenic, hypoglycemic, anti-inflammatory, anti-platelet aggregating, etc. (Saxena et al. 2012). The contents of chlorogenic and protocatechuic acids in the extracts of *Potentilla* species have not been reported yet (Wang et al. 2013; Luo et al. 2016; Yu et al. 2016). *p*-Coumaric acid was found in our work only in hydroalcoholic extract as that it is relatively hydrophobic compound and has less solubility in water.

Table 1. Content of phenolic acids and antioxidant capacity of water and EtOH-water extracts of *P. erecta* rhizomes.Table Layout

	Water	EtOH-water
Compound	Content (μg g^{-1})	
p-HBA acid	88.9 ± 3.14[a]	86.6 ± 2.99[a]
Gallic acid	71.7 ± 2.15[a]	59.3 ± 2.21[b]
Protocatechuic acid	12.2 ± 0.49[a]	15.8 ± 0.54[b]
Chlorogenic acid	7.88 ± 0.35[a]	7.09 ± 0.31[b]
Ferullic acid	0.44 ± 0.023[a]	0.83 ± 0.034[b]
Ellagic acid	0.29 ± 0.012[a]	0.49 ± 0.021[b]
p-coumaric acid	nd	0.71 ± 0.028
Assay	Antioxidant capacities (mmol TR g^{-1})	
DPPH	0.79 ± 0.021[a]	0.90 ± 0.082[b]
CUPRAC	15.8 ± 0.15[a]	18.2 ± 0.18[b]
Mean ± standard deviation (n = 3). Values with different letters (a,b) within the same row are significantly different ($p < 0.05$).		

Antioxidant activity of the studied extracts was assessed on the basis of their scavenging effect on the stable DPPH radical, while their reducing capacity was evaluated by CUPRAC method. The obtained results are presented in Table 1. The scavenging ability on DPPH radicals as well as reducing power of *P. erecta* rhizomes extracts were statistically similar ($p < 0.05$) for water and water-ethanol, even though these extracts contain different content of phenolic acids (Table 1). They could differ in the content of other compounds with antioxidant properties such as catechins which are present in many plants. To the best of our knowledge, antioxidant activity or reducing capacity of *P. erecta* rhizomes has not been reported yet. Such studies are presented for other *Potentilla* species (Wang et al. 2013; Luo et al. 2016; Yu et al. 2016). The obtained values are much higher than those reported for different plants used in the manufacture of Van herby cheese as antimicrobial and flavouring aids (Çelik et al. 2008).

The results of this research have provided an insight into the composition of main phenolic acids extracted from the *Potentilla erecta* rhizomes. The prepared extracts have high potential for pharmaceutical and cosmetics applications.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Çelik SE, Özyürek M, Mehmet AM, Bektaşoğlu B, Güçli K, Berker K, Özgökçe F, Apak R. 2008. Antioxidant capacities of herbal plants used in the manufacture of van herby cheese: ‘Otlu Peynir”. *Int J Food Prop*. **11**:747–761.

Dróżdż P, Sentkowska A, Pyrzynska K. 2017. Biophenols and antioxidant activity in wild and cultivated heather. *Nat Prod Res*. **31**:1181–1184.

Luo Z, Wang S, Wang D. 2016. Phenolic profiles and antioxidant capacities of crude extracts and subsequent fractions from *Potentilla fruticosa* L. leaves. *Nat Prod Res*. **30**:1890–1895.

Paduch R, Wiater A, Locatelli M, Pleszczyńska M, Tomczyk M. 2015. Aqueous extracts of selected *Potentilla* species modulate biological activity of human normal colon cells. *Curr Drug Targets*. **16**:1495–1502.

Saxena M, Saxena I, Pradham A. 2012. Flavonoids and phenolic acids as antioxidants in plants and human health. *Int J Pharm Sci Rev Res*. **16**:130–134.

Shahidi F, Zhong Y. 2015. Measurement of antioxidant activity. *J Func Foods*. **18**:757–781.

Tomczyk M, Pleszyńska M, Wiater A. 2010. Variation in total polyphenolics contents of aerial parts of *Potentilla* Species and their anticariogenic activity. *Molecules*. **15**:4639–4651.

Wan P, Chen H, Guo Y, Bai AP. 2014. Advances in treatment of ulcerative colitis with herbs: from bench to bedside. *World J. Gastroenterol*. **20**:14099–14104.

Wang SS, Wang DM, Pu WJ, Li DW. 2013. Phytochemical profiles, antioxidant and antimicrobial activities of three *Potentilla* species. *BMC Med Res Methodol*. **13**:321–332.

Waszkowiak K, Giszczyńska-Świgło A. 2016. Binary ethanol-water solvents affect phenolic profile and antioxidant capacity of flaxseed extracts. *Eur Food Res Technol*. **242**:777–786.AQ3

Yu D, Pu W, Li D, Wang D, Liu Q, Wang Y. 2016. Phenolic compounds and antioxidant activity of different organs of *Potentilla fruticosa* L. from two main production Areas of China. *Chem. Biodivers*. **13**:1140–1148.

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