Journal of Enzyme Inhibition and Medicinal Chemistry, 2010; 25(1): 143–145

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SHORT COMMUNICATION

New antioxidant flavonoid isolated from *Leuzea carthamoides*

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Abstract

A new natural flavonoid patuletin 3′-β-xylofuranoside was isolated from *Leuzea carthamoides* leaves. The antioxidant activity of this compound was evaluated by the DPPH radical assay and ferric reducing antioxidant power (FRAP) assay, and the results were compared with those for trolox and quercetin. DPPH radical scavenging activity of the tested compounds was expressed by the parameter EC_{50}: patuletin 3′-β-xylofuranoside (56.0 μM), trolox (27.8 μM), and quercetin (25.3 μM). The ferric reducing activity of the compounds was demonstrated as FRAP values at 4 and 60 min: patuletin 3′-β-xylofuranoside (28.4 μM, 35.8 μM), trolox (19.3 μM, 20.2 μM), and quercetin (54.3 μM, 79.9 μM). The structure/activity relationship of the flavonoid is also discussed. The results indicate significant antioxidant potency of patuletin 3′-β-xylofuranoside.

Keywords: Leuzea carthamoides*; flavonoid; patuletin; antioxidant; FRAP; DPPH*

Introduction

Plants and their secondary metabolites exhibit a wide range of biological health benefit effects1,2. For this reason, new compounds are being investigated worldwide3–5.

Flavonoids belong to the large group of plant secondary metabolites called polyphenols (8000 compounds)6. Polyphenols have been reported to exhibit a wide range of biological effects, including for example antibacterial, antiviral, anticancer, antiinflammatory, antiallergic, and especially cardiovascular-protective actions2,7. It is presumed that these effects are associated with the antioxidant activity of polyphenols8,9.

According to their structural features, flavonoids are divided into various subclasses such as flavones, flavonols, flavanones, or flavan-3-ols (catechins). All subtypes can also occur as flavonoid glycosides9.

L. carthamoides (*Rhaponticum carthamoides* (Asteraceae)) is a widely used medicinal plant. The principal bioactive constituents are ecdysteroids, flavonoids, and phenolic acids. *L. carthamoides* is traditionally used as a tonic, stimulant, and adaptogen10.

Previous studies have demonstrated that the components and prepared extracts from *L. carthamoides* possess important biological effects such as antioxidant, antiplatelet, or antimicrobial activity10–12. In this study, a new natural compound, patuletin 3′-β-xylofuranoside isolated from *L. carthamoides*, is described. The antioxidant activities of the isolated compound and antioxidant standards (trolox and quercetin) evaluated by 2,2′-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) assays are also discussed.

Materials and methods

Dried powdered leaves of *Leuzea carthamoides* (Willd.) DC (Asteraceae) were obtained from Radka Simakova (medicinal plants cultivation; Ohnisov, Czech Republic). The sample was identified by L. Opletal.

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(Received 10 November 2008; revised 29 April 2009; accepted 01 June 2009)

ISSN 1475-6366 print/ISSN 1475-6374 online © 2010 Informa UK Ltd
DOI: 10.3109/14756360903090970

Patuletin 3′-β-xylofuranoside was obtained from the phenolic fraction of the *L. carthamoides* leaves according to the isolation procedure of Koleckar *et al.*10.

Antioxidant activity was determined using the DPPH radical scavenging assay modified to a sequential injection analysis (SIA) method13,14, and the FRAP assay according to the method of Firuzi *et al.*15.

Results

Structure and characteristics

The structure of the isolated compound is shown in Figure 1.

Patuletin 3′-β-xylofuranoside

Yellow powder; UV max (MeOH): 264; mp 275–278°C; ^{1}H NMR (300 MHz, DMSO) δ 12.50 (1H, bs, OH-5), 10.79 (1H, bs, OH-7), 9.53 (1H, bs, OH-4′), 9.49 (1H, bs, OH-3), 7.91 (1H, d, *J*=2.4 Hz, H-2′), 7.77 (1H, dd, *J*=8.7 Hz, *J*=2.4 Hz, H-6′), 6.97 (1H, d, *J*=8.7 Hz, H-5′), 6.53 (1H, s, H-8), 5.59 (1H, bs, OH), 5.15 (2H, bs, OH), 4.77 (1H, d, *J* =7.5 Hz, CH-1′), 3.86–3.77 (1H, m, CH-5′), 3.74 (3H, s, OCH_3), 3.47–3.18 (4H, m, CH-2′, CH-3′, CH-4′, CH-5′); ^{13}C NMR (75 MHz, DMSO) δ 146.4 (C-2), 135.9 (C-3), 176.4 (C-4), 151.5 (C-5), 131.1 (C-6), 151.9 (C-7), 94.0 (C-8), 157.5 (C-9), 103.6 (C-10), 123.7 (C-1′), 116.4 (C-2′), 145.0 (C-3′), 149.4 (C-4′), 116.9 (C-5′), 122.4 (C-6′), 103.1 (C-1′), 73.3 (C-2′), 76.1 (C-3′), 69.6 (C-4′), 66.0 (C-5′), 60.2 (OCH_3). ESI-MS (positive mode) *m/z* $[M + H]^+$ 465, MS/MS (465) *m/z* $[M + H–C_5O_4H_8]^+$ 333.

The structure of the compound was unequivocally corroborated by 2D nuclear magnetic resonance (NMR). All gHMQC (gradient-selected heteronuclear multiple quantum coherence) correlations are shown in Figure 2. Xylose is bonded via a hydroxy group at position 3′ of the benzene ring; the chemical shift of the carbon atom is 145.0 ppm. A cross-peak to the carbon atom at 145.0 ppm and the hemiacetal hydroxyl of the sugar is displayed. The structure of the glycoside was confirmed by comparison of the spectra of aglycone and xylose obtained upon hydrolysis with those of the authentic samples.

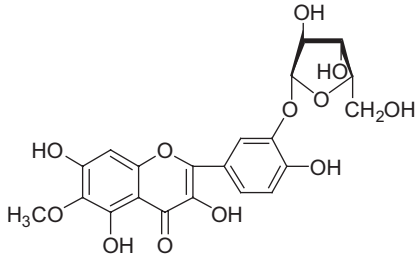

Figure 1. Patuletin 3′-β-xylofuranoside.

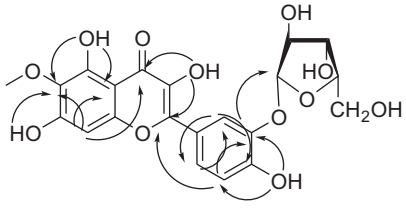

Figure 2. gHMQC correlations.

Antioxidant activity

The results are shown in Table 1.

Discussion

Patuletin 3′-β-xylofuranoside showed significant antioxidant activity in both assays. The DPPH radical scavenging activity of patuletin 3′-β-xylofuranoside was relatively close to those of trolox and quercetin, which were used as antioxidant standards. The ferric reducing activity of the tested compounds followed the order: quercetin > patuletin 3′-β-xylofuranoside > trolox.

The results are in agreement with the generally known structure/antioxidant activity relationship data for flavonoids8,10. Important structural criteria for high DPPH radical scavenging and ferric reducing activity of flavonoids are (1) ortho-dihydroxy groups in the B-ring or in the A-ring, (2) 3-hydroxyl group in the C-ring, and (3) 2,3-double bond in conjugation with 4-oxo function in the C-ring10,14. The structure of the highly antioxidant-active compound quercetin satisfies all mentioned structural requirements, while in the structure of the less active patuletin 3′-β-xylofuranoside the ortho-dihydroxy groups are missing.

The study has presented a new flavonol glycoside, patuletin 3′-β-xylofuranoside. The compound was isolated from *L. carthamoides*, a well known medicinal plant growing in Central and Eastern Europe. The previously performed studies of the authors demonstrated significant antioxidant and antiplatelet action of compounds and extracts of *L. carthamoides*[10,11]. This study isolates a highly antioxidant-active natural compound, patuletin 3′-β-xylofuranoside. In conclusion, these results suggest *L. carthamoides* as a promising cardiovascular-protective plant.

Acknowledgements

This work was supported by a grant from the Charles University (Czech Republic), GAUK 124/2005/B-BIO/FaF, and a research project of the Ministry of Education of the Czech Republic (MSM 0021620822).

***Declaration of interest*:** The authors report no conflicts of interest.

Table 1. DPPH radical scavenging activity (EC_{50}) and FRAP value (at 4 and 60 min) of patuletin 3′-β-xylofuranoside, trolox, and quercetin.

		FRAP value[a] (μM)	
Compound	DPPH test[a] (EC_{50}, μM)	4 min	60 min
Patuletin 3′-β-xylofuranoside	56.0 ± 4.4	28.4 ± 5.4	35.8 ± 7.3
Trolox	27.8 ± 3.2	19.3 ± 2.5	20.2 ± 1.9
Quercetin	25.3 ± 3.7	54.3 ± 8.1	79.9 ± 9.6

[a]All values are mean ± SD.

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