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SHORT COMMUNICATION

A new flavanone glycoside isolated from *Tournefortia sibirica*

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ABSTRACT

A new flavanone glycoside, (2*S*)-dihydrooroxylin A 7-*O*-[β-D-apiosyl(1→2)]-β-D-glucoside (**1**), and four known compounds (**2–5**) were isolated from *Tournefortia sibirica* L. The chemical structures of these compounds were determined by 1 D and 2 D NMR and HR-ESI-MS spectra, and results were compared with data from the literature. These five compounds (**1–5**) were isolated from the family Boraginaceae for the first time. Anti-inflammatory effects of compounds (**1–5**) were evaluated in terms of inhibition of production of NO, TNF-α, and IL-6 in LPS-induced RAW 264.7 cells.

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1. Introduction

Tournefortia sibirica L. (Boraginaceae) is a salt-secreting halophyte that is mainly produced in the Hebei, Shandong, Henan, Gansu provinces in northeastern China, and Mongolia, Korea, and Japan. The whole *T. sibirica* plant has been used in Mongolian traditional folk medicine for the treatment of scrofula, eczema, sores, and ulcers (Zhu 1989). Valuable phytochemical investigations of this plant resulted in the extraction and isolation of essential oils (Morteza-Semnani et al. 2008; Gao et al. 2015), polysaccharides (Zhang et al. 2015), alkaloids (Hikichi et al. 1980), lignans (Song et al. 1992, 1996), flavonoids, steroids, and triterpenoids (Song et al. 1996). The present study describes the isolation, structural elucidation, and anti-inflammatory activities of a new flavanone glycoside (**1**) and four known compounds (**2**–**5**) from the whole plant of *T. sibirica* on the basis of spectroscopic studies, and comparisons with literature data.

2. Results and discussion

Compound **1** was obtained as a yellow amorphous powder, and its molecular formula was determined to be $C_{27}H_{32}O_{14}$ by HR-ESI-MS, which gave a *m/z* 581.1903 for $[M+H]^+$ (calcd. for $C_{27}H_{33}O_{14}$, 581.1870). Acidic hydrolysis of **1** gave D-glucose and D-apiose. The ^{1}H NMR spectrum of **1** showed signals for a mono-substituted benzene ring at δ_H 7.56 (2H, d, $J = 7.2$ Hz, H-2′, 6′), δ 7.42 (2H, t, $J = 7.2$ Hz, H-3′, 5′), 7.37 (1H, t, $J = 7.2$ Hz, H-4′) attributed to benzene ring B, one singlet aromatic proton at δ_H 6.76 (1H, s, H-8), and two anomeric proton signals at δ_H 6.59 (1 H, d, $J = 1.5$ Hz, H-1‴), δ_H 5.77 (1H, d, $J = 7.8$ Hz, H-1″), which indicated a β-configuration of the glucosyl moiety. The apiose unit was also determined to have a β-configuration at C-1‴ by comparison of the ^{13}C NMR data of the apiose of **1** with those of methyl α-D- and β-D-apiofuranosides (Ishii and Yanagisawa 1998; Lei et al. 2008). Extra sugar signals at δ_H 4.06–5.39, an oxygenated methine proton at δ_H 5.39 (1H, dd, $J = 13.2$, 3.1 Hz, H-2), and a methoxyl proton at δ_H 4.10 (3H, s, 6-OCH_3) were also observed. The ^{13}C-NMR and DEPT spectra exhibited a total of 27 carbon signals, including a carbonyl carbon at δ_C 197.6 (C-4), two benzene rings (12 carbons) at δ_C 159.7 (C-7), 158.9 (C-9), 156.3 (C-5), 139.7 (C-1′), 132.0 (C-6), 129.4 (3′, 5′), 129.3 (C-4′), 127.1 (C-2′, 6′), 104.6 (C-10) and 95.5 (C-8), two sugar moieties at δ_C 111.0 (C-1‴), 100.0 (C-1″), 81.1 (C-3‴), 79.2 (C-5″), 79.0 (C-3″), 78.3 (C-2‴), 77.9 (C-2″), 75.9 (C-4‴), 71.3 (C-4″), 66.2 (C-5‴) and 62.3 (C-6″), an oxygenated carbon signal at δ_C 79.9 (C-2), and a methoxyl group at δ_C 61.3 (6-OCH_3). All the above information suggested that compound **1** was similar to (2*S*)-dihydrooroxylin A- 7-*O*-[β-D-apiosyl(1→6)]-β-D-glucoside (Yang et al. 2014), except for the position of the apiose unit which was linked to the C-2″ of the D-glucoside in **1**. This conclusion was further supported by an HMBC correlation between H-1‴ (δ_H 6.59) of apiose and C-2″ (δ_C 77.9) of D-glucoside, which suggested the apiose unit was located at C-2″ (Figure S1). The absolute configuration of C-2 was determined to be the *S*-configuration by comparison of the optical rotation value with (2*S*)-dihydrooroxylin A-7-*O*-[β-D-apiosyl(1→6)]-β-D-glucoside (Yang et al. 2014). Thus, the structure of compound **1** was elucidated as (2*S*)-dihydrooroxylin A 7-*O*-[β-D-apiosyl(1→2)]-β-D-glucoside.

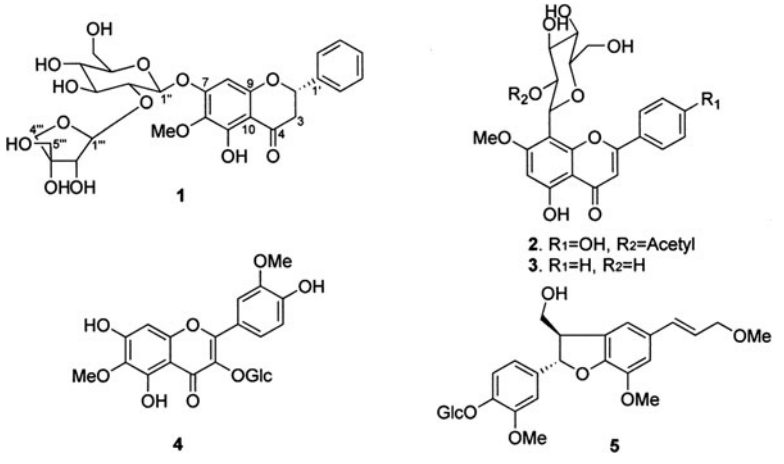

Figure 1. The structures of compounds **1**–**5**.

The four known compounds (**2**–**5**) were identified as 2″-*O*-acetyl-7-*O*-methylvitexin (**2**) (Mbing et al. 2014), 5-hydroxy-7-methoxy-8-C-β-glucosylflavone (**3**) (Moreira et al. 2000), spinacetin 3-*O*-β-glucopyranoside (**4**) (Ito et al. 2000) and 9′-methoxydehydrodiconiferyl alcohol 4-*O*-β-D-glucopyranoside (**5**) (Iizuka et al. 2001) (Figure 1).

Compounds **1**–**5** were assayed for their inhibitory effects on the production of NO, TNF-α and IL-6 in LPS-induced RAW264.7 cells. Compounds **1**–**5** did not affect cell viability at 100 μM (Figure S9). We found that LPS-induced production of NO, TNF-α and IL-6 was substantially suppressed by compounds **1**–**5** in a dose-dependent manner, all of which showed strong anti-inflammatory activities at 30 and 100 μM. In particular, compounds **1** and **3**–**5** exhibited inhibitory activity against NO and IL-6 production even at 10 μM (Figures S10, S12). Compounds **2**–**5** displayed significant inhibitory effects on LPS-induced production of TNF-α at 10 μM (Figure S11).

3. Conclusion

In this study, a new flavanone glycoside (**1**) and four known compounds (**2**–**5**) were isolated from *T. sibirica*, supporting the need for further research to reveal new chemical constituents that remain undiscovered in this species. The bioactivity data showed that some compounds from *T. sibirica* could inhibit the production of the pro-inflammatory cytokines NO, TNF-α and IL-6 in LPS-stimulated RAW 264.7 cells. These compounds represent potential drug candidates for the treatment of inflammatory diseases.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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