TERPENOID COUMARINS FROM *Ferula feruloides*

K. A. Eshbakova,* A. I. Saidkhodzhaev, A. D. Vdovin, and N. D. Abdullaev

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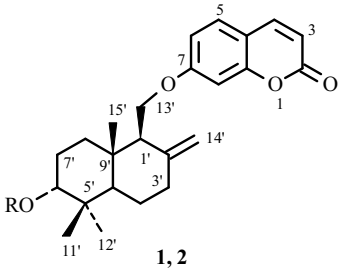
Ferula feruloides Korov. (Apiaceae) is widely distributed in western Siberia and Central Asia [1]. It is used in folk medicine as an antihelmintic [2] and lactogenic agent [3]; in veterinary medicine, to treat abscesses [4]. Phenylcarboxylic acids, steroids [5], and terpenoids [6] were isolated from roots of *F. feruloides*. Essential oils were observed [7]. Fruits yielded coumarins [8].

In continuation of systematic studies of plants from the genus *Ferula* L., we studied components of *F. feruloides* roots collected in Dzhungar Alatau region (Republic of Kazakhstan).

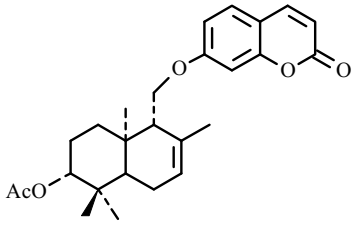
Air-dried roots (1000 g) were extracted exhaustively with EtOH at room temperature. The extract was evaporated in vacuo. The resulting total (41 g) extracted substances were separated by column chromatography over silica gel (KSK, 1:20 ratio) with elution by benzine and then benzine:EtOAc with gradually increasing EtOAc concentration. Three compounds of coumarin nature were isolated by elution with benzine:EtOAc systems in the ratios 7:1, 5:1, and 3:1.

Compound **1**, $C_{24}H_{30}O_4$, mp 199–200°C. The IR spectrum had absorption bands at 3200–3500 cm^{-1}; 1720, 1680, and 1620; characteristic of umbelliferone derivatives. Its PMR spectrum (100 MHz, C_5D_5N) exhibited proton resonances at 0.76, 0.77, 1.03 ppm (3H each, s, H-11′,12′,15′), 3.49 (1H, br.s, $W_{1/2}$ = 6 Hz, H-6′), 4.19 (2H, d, J = 6.5 Hz, H-13′α,13′β), 4.59 and 4.77 (1H each, br.s, $W_{1/2}$ = 5 Hz, H-14′α,14′β), 5.52 (1H, d, J = 7, C6′-OH); 7-*O*-coumarin proton resonances: 6.20 (1H, d, J = 8, H-3), 6.82 (1H, br.d, J = 9, H-6), 6.90 (1H, br.s, H-8), 7.30 (1H, d, J = 9, H-5), 7.55 (1H, d, J = 8, H-4).



1, 2

1: R = H; **2:** R = Ac



3

Compound **2**, $C_{26}H_{32}O_5$, mp 173–174°C. The IR spectrum also had absorption bands typical of umbelliferone derivatives. A comparison of the PMR spectra of **1** and **2** showed that **2** was a natural acetate of **1**. The PMR spectrum of **2** compared with that of **1** showed additional proton resonances for the acetyl methyl (2.00 ppm, 3H, s), a weak-field shift of the C-6′ resonance (4.71, 1H, br.s), and disappearance of the hydroxyl resonance.

Comparison of the results with the literature revealed that **1** was badrakemin [9]; **2**, the natural acetate of badrakemin [10].

Compound **3**, $C_{26}H_{32}O_5$, mp 158–160°C. The IR spectrum also exhibited characteristic absorption bands for 7-hydroxycoumarin. Its PMR spectrum (100 MHz, C_5D_5N) exhibited proton resonances at 0.70, 0.75, 0.80 (3H each, H-11′,12′,15′), 1.70 (3H, s, H-14′), 2.00 (3H, s, OAc), 3.95 (1H, dd, J = 5, 10 Hz, H-13′), 4.17 (1H, dd, J = 5, 10, H-13′), 4.72 (1H, br.s, H-6′), 5.43 (1H, br.s, $W_{1/2}$ = 8 Hz, H-3′); coumarin proton resonances: 6.25 (1H, d, J = 9, H-3), 6.82 (1H, d, J = 2, H-8), 6.72 (1H, dd, J = 9, 2, H-6), 7.36 (1H, d, J = 9, H-5), 7.63 (1H, d, J = 9, H-4). Compound **3** was conferol acetate [11].

Badrakemin and badrakemin and conferol acetates were isolated for the first time from *F. feruloides*.

S. Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, Tashkent, fax: 99871 120 64 75, e-mail: e_komila@yahoo.com. Translated from Khimiya Prirodnykh Soedinenii, No. 5, p. 594, September–October, 2009. Original article submitted November 24, 2008.

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