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A NEW *seco*-IRIDOID GLYCOSIDE FROM THE AERIAL PART OF *Fraxinus raibocarpa*

Kh. Sh. Kamoldinov, K. A. Eshbakova,* Kh. M. Bobakulov, and N. D. Abdullaev

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The new seco-*iridoid glycoside raibocarpaoside was isolated from the aerial part of* Fraxinus raibocarpa *Rgl. (Oleaceae). The structure 1*-O-β-*D-glucopyranosyl-4,6-dicarboxymethyl-8-methyl-7,8*-seco-*cyclopent-8-en[c]-1,9-dihydropyran was established based on spectral characteristics and chemical transformations.*

Keywords: *Fraxinus raibocarpa*, *seco*-iridoid, dicarboxymethyl, dihydropyran, raibocarpaoside, PMR and ^{13}C NMR spectra, DEPT, HETCOR.

We isolated previously from the aerial part of the plant *Fraxinus raibocarpa* Rgl. (Oleaceae) tyrosol, 7-ketologanin, salidroside, mannite, and rutin [1].

In continuation of phytochemical studies of the aerial part of the plant, column chromatography over KSK silica gel with elution by $CHCl_3$:MeOH (9:1–4:1) isolated from the BuOH fraction of the alcohol extract from *F. raibocarpa* collected during mass flowering in Tashkent Oblast, Republic of Uzbekistan, fractions containing 7-ketologanin and another terpenoid compound. Rechromatography of these fractions over silica gel with elution by hydrocarbons:EtOAc (2:1) isolated a new *seco*-iridoid glycoside of formula $C_{18}H_{26}O_{11}$ that we called raibocarpaoside (**1**).

The IR spectrum of **1** had characteristic absorption bands for hydroxyls at 3422 cm^{-1} (OH), ester carbonyls at 1734 and 1709 (C=O), and double bonds at 1633 and 1245–1250 (C=C). The UV spectrum showed an absorption maximum at 237.95 nm that was characteristic of an enol—ester system conjugated to a carbonyl on C-4 [2–4]. This was confirmed by PMR and ^{13}C NMR spectra (Table 1), where resonances for carbonyl C at 168.55 ppm, C-4 at 109.28, and a methoxyl C at 52.10, to which a 3H singlet at 3.65 ppm corresponded, were observed.

A detailed comparison of the PMR and ^{13}C NMR spectral data (Table 1) of the isolated compound **1** with those of 7-ketologanin (**2**) showed that **1** was also a glycosylated iridoid.

Acid hydrolysis of **1** produced D-glucose and a mixture of genin products.

The anomeric proton of D-glucose in the PMR spectrum of **1** resonated at 4.77 ppm as a doublet with SSCC J = 7.6 Hz. This indicated that the carbohydrate had a β-glycoside bond.

PMR, ^{13}C NMR, and DEPT spectra of **1** (Table 1), which contained another 3H singlet at 3.58 ppm and a resonance for the corresponding C atom at 52.35 ppm, indicated that **1** was a dimethyl ester.

The chemical shifts of C-7, 8, and 9 in the ^{13}C NMR spectrum (Table 1) differed from those of the same C atoms in 7-ketologanin and were observed at δ 173.52 (217.78), 124.91 (42.74), and 130.38 (44.25). Furthermore, the PMR spectrum exhibited a significant change of chemical shift and multiplicity for the H-8 resonance (from 1.89 ppm to 6.04), disappearance of the H-9 resonance, and a shift to weak field for the CH_3-10 resonance. These data indicated that a double bond had formed between C-8 and C-9.

The site of attachment of the second methoxyl and the double bond between C-8 and C-9 were confirmed using a through-space heterocorrelation experiment. Cross-peaks of C-7 and the methoxyl resonance at 3.58 ppm and resonances for the C-6 protons were observed in the through-space heterocorrelation spectrum. This indicated that the second methyl ester was located in the C-7 position. The resonance at 124.91 ppm (C-8) gave in the same spectrum cross-peaks with resonances of the CH_3-10 methyl and H-1 (Fig. 1). Figure 1 shows schematically the through-space heterocorrelations that confirmed the lack of a bond between C-7 and C-8.

S. Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences, Republic of Uzbekistan, Tashkent, fax (99871) 120 64 75, e-mail: e_komila@yahoo.com. Translated from *Khimiya Prirodnykh Soedinenii*, No. 1, January–February, 2012, pp. 49–51. Original article submitted June 7, 2011.

TABLE 1. PMR and ^{13}C NMR Chemical Shifts of Raibocarpaoside (**1**) and 7-Ketologanin (**2**) (δ, ppm) and DEPT Experiment Data for **1**

C atom	**1** (CD_3OD)			**2** (DMSO-d_6)	
	DEPT	δ_C	δ_H, J/Hz	δ_C	δ_H, J/Hz
1	CH	95.20	5.85 br.s	93.24	5.51 (s, J = 2.9)
2	–	–	–	–	–
3	CH	155.17	7.47 s	151.66	7.39 (s, J = 1.4)
4	C	109.28		109.13	
5	CH	31.81	3.92 (dd, J = 9.5, 4.4)	26.47	3.06 m
6	CH_2	41.04	2.38 (dd, J = 14.2, 9.5)	42.04	2.36 (br.d, J = 18.9)
			2.69 (dd, J = 14.2, 4.4)		2.56 (dd, J = 18.9, 8.4)
7	C	173.52		217.78	
8	CH	124.91	6.04 (q, J = 7.1)	42.74	1.89 m
9	C	130.38		44.25	2.26 (ddd, J = 10.5, 7.0, 2.9)
10	CH_3	13.69	1.67 (dd, J = 7.1, 1.5)	13.14	1.01 (d, J = 7.0)
11	C	168.55		166.58	
11-OCH_3	CH_3	52.10	3.65 s	51.07	3.58 s
7-OCH_3	CH_3	52.35	3.58 s		
			β-D-Glc*p* unit		
1′	CH	100.89	4.77 (d, J = 7.6)	98.65	4.44 (d, J = 7.8)
2′	CH	74.66	3.27* m	73.07	2.92 (t, J = 8.0)
3′	CH	77.76	3.40* m	76.63	3.08 m
4′	CH	71.34	3.28* m	70.04	2.98 (t, J = 8.9)
5′	CH	78.21	3.30* m	77.35	3.08 m
6′	CH_2	62.68	3.62 (dd, J = 12.0, 5.0)	61.13	3.39 (dd, J = 11.9, 6.2)
			3.83 (br.d, J = 12.0)		3.62 (dd, J = 11.9, 1.6)

*Chemical shifts were established using a HETCOR experiment.

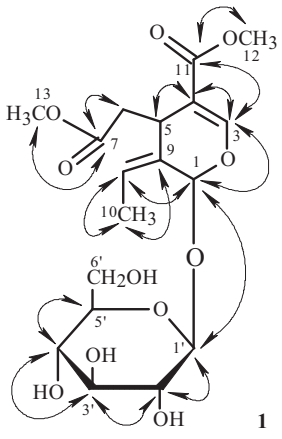

Fig. 1. Through-space heterocorrelations in **1**.

Thus, **1** was a new *seco*-iridoid glycoside and had the structure 1-*O*-*β*-D-glucopyranosyl-4,6-dicarboxymethyl-8-methyl-7,8-*seco*-cyclopent-8-en[*c*]-1,9-dihydropyran.

EXPERIMENTAL

General Comments. UV spectra were measured on a Lambda-16 spectrophotometer (Perkin–Elmer). Melting points were determined on a Boetius heating stage. IR spectrum was recorded in KBr on a Model 2000 Fourier-spectrometer

(Perkin–Elmer). PMR and ^{13}C NMR spectra were recorded in CD_3OD on a Unity 400plus spectrometer (Varian) at operating frequency 400 MHz. The internal standard for PMR spectra was HMDS; for ^{13}C NMR spectra, the CD_3OD resonance (49.15 ppm vs. TMS). DEPT and HETCOR experiments were performed using the standard spectrometer methods. TLC used Silufol UV-254 chromatographic plates and detection by I_2 vapor, NH_3 vapor, UV light at 254 and 365 nm, and vanillin solution (1%) in conc. H_2SO_4. Paper chromatography (PC) was carried out on Filtrak No. 11 paper using *n*-BuOH:HOAc:H_2O (4:1:5) (1) and *n*-BuOH:Py:H_2O (6:4:3) (2). Free monosaccharides were detected in PC by spraying with anilinium phthalate.

Extraction and Isolation of 1 from the Aerial Part of *Fraxinus raibocarpa*. Air-dried ground plant raw material (740 g) was extracted at room temperature with EtOH (70%, 6 × 4 L). The combined extract was evaporated in vacuo. The condensed residual (80 g) was diluted with H_2O (1:1) and worked up sequentially with extraction by benzine (6 × 0.5 L), $CHCl_3$ (6 × 0.5 L), EtOAc (10 × 0.5 L), and *n*-BuOH (10 × 0.5 L). Solvents were evaporated to afford $CHCl_3$ (8 g), EtOAc (15 g), and BuOH (30 g) fractions.

The total BuOH fraction (30 g) was chromatographed over a column (3.0 × 150 cm) of KSK silica gel (600 g) using a $CHCl_3$:MeOH gradient (25:1–9:1). Fractions (7 g) eluted by 9:1 $CHCl_3$:MeOH were rechromatographed over a column (1 × 100 cm) of KSK silica gel (125 g) using a benzine:EtOAc gradient (9:1–1:1).

Raibocarpaoside (1) was isolated as an oil upon elution of the column by 15:1 $CHCl_3$:MeOH, $C_{18}H_{26}O_{11}$. UV spectrum (MeOH, λ_{max}, nm): 237.95. IR spectrum (ν, cm^{-1}): 3422.99 (OH), 2952.75 (CH), 2918.76 (CH), 1737.06 (C=O), 1709.11 (C=O), 1633.34 (C=C), 1439.34, 1376.10 (CH), 1304.81, 1292.65, 1202.98, 1161.31, 1077.13 (C–O), 922.62, 851.40, 817.37, 757.00, 696.18 (CH), 666.87, 635.34, 570.89.

Table 1 presents the PMR and ^{13}C NMR spectra.

Acid Hydrolysis. A solution of **1** (20 mg) in H_2SO_4 solution (5 mL, 5%) was heated on a water bath for 2 h. The resulting precipitate was filtered off. The precipitate contained a mixture of genin products. The filtrate was neutralized with $BaCO_3$, filtered again, condensed in vacuo to 0.5 mL, and chromatographed on paper with glucose standard. Glucose was detected in the hydrolysate.

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