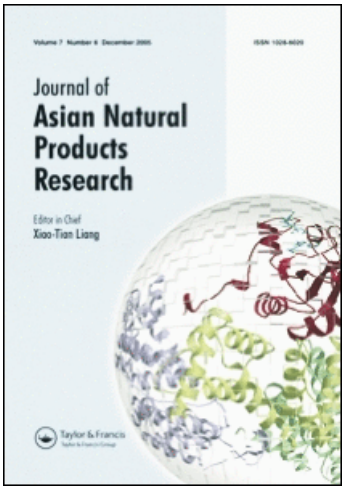

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Two new arylbenzofurans from the roots of *Hedysarum multijugum*

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Two new arylbenzofurans, hedysarimbenzofuran A (**1**) and hedysarimbenzofuran B (**2**), were isolated from the roots of *Hedysarum multijugum.* The structures were determined by spectroscopic methods.

Keywords: *Hedysarum multijugum*; Arylbenzofuran; Hedysarimbenzofuran A; Hedysarimbenzofuran B

1. Introduction

Hedysarum multijugum is a plant in *Hedysarum* Linn. of the family *Leguminosae*, which has been used widely for grazing, and sometimes used as sand-fixation in Xinjiang, Qinghai, Gansu and Neimenggu provinces of China. *H. multijugum* has also been used in folk herbal drugs in China and is recorded in many Chinese herbal books as to be used for the treatment of palpitation and chronic nephritis. There are few reports on its chemical and biological research. Our previous phytochemical studies on the root of *H. multijugum* resulted in the isolation of some isoflavones and pterocarpenes [1–3]; further studies on the plant led to the isolation of two new arylbenzofurans, hedysarimbenzofuran A (**1**) and hedysarimbenzofuran B (**2**) by repeated chromatography, and the structures were identified on the basis of spectroscopic analyses.

2. Results and discussion

Compound **1** was obtained as a yellow amorphous powder; its molecular formula was determined as $C_{21}H_{20}O_7$ from the negative HRESI-MS (*m/z* 383.1129 $[M - H]^-$). The UV

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spectrum of **1** showed absorption maxima at 255 and 337 nm, closely resembling that of 2-aryl-3-carbaldehydebenzofuran [4]. The ^{1}H NMR spectrum displayed signals of four hydroxyl groups at δ 10.14 (1H, s), 9.12 (1H, s) and 9.26 (2H, s), one methoxyl group at 3.85 (3H,s), one formyl group at 9.69 (1H, s), three aromatic protons at δ 6.13 (2H, s), 6.70 (1H, s), and a 3-methyl-2-butenyl (prenyl) group at δ 5.22 (1H, t, $J = 7.0$ Hz), 3.37 (2H, d, $J = 7.0$ Hz), 1.76 (3H, s) and 1.61 (3H, s). The ^{13}C NMR signals (table 1) also proved the presence of the formyl, prenyl, methoxyl groups and aromatic rings. They were similar to the published data of 2-arylbenzofuran-3-carbaldehydes (andinermal A, **3**) [5]. The HMBC spectrum of **1** showed cross-peaks between the chelated hydroxyl proton (δ 10.14) and C-3a (δ 107.0); the carbaldehyde proton (δ 9.69) and C-3 (δ 120.4); the aromatic proton singlet (δ 6.70) and C-3a (δ 107.0), C-7a (δ 155.3), respectively, which determined the linkage of the hydroxyl group to C-4, the aromatic proton to C-7, and the formyl group to C-3 (figure 1). The positions of the methoxyl and prenyl groups were established by the following HMBC correlations: the methoxyl singlet at δ 3.85 with the carbon signal at δ 158.9; the aromatic proton signal H-7 at δ 6.70 with carbon signal at δ 158.9; H-1$''$ of prenyl group at δ 3.37 with C-4 at δ 149.0, 158.9 and 112.0, indicating that the methoxyl group should be linked to C-6 (δ 158.9), and the prenyl group linked to C-5 (δ 112.1). The positions of the other three hydroxyl groups were deduced by the ^{1}H NMR and HMBC spectra. In the ^{1}H NMR spectrum, the other two aromatic protons at δ 6.13 (2H, s) in the B-ring revealed a 1,2,4,6-substitution pattern, which indicated the three hydroxyl groups at C-2$'$, C-4$'$ and C-6$'$, respectively. The HMBC experiment (figure 1 and table 1) supported the locations of the hydroxyl groups.

Table 1. NMR spectral data of **1**, **2** and **3** (acetone-d_6, δ ppm).

	1		***2***		***3***	
Position	^1H	^{13}C	^1H	^{13}C	^1H	^{13}C
2		163.2		162.8		164
3		120.4		121.0		119
3a		107.0		108.0		108
4		149.0		152.4		153
5		112.1	6.29 (1H, d, 2.1)	98.6	6.36 (1H, d, 1.9)	98
6		158.9		161.9		162
7	6.70 (1H, s)	86.7	6.62 (1H, d, 2.1)	88.6	6.72 (1H, d, 1.9)	88
7a		155.3		157.9		157
1$'$		95.5		97.5		115
2$'$		159.2		159.2		146
3$'$	6.13 (1H, s)	95.4	6.17 (1H, s)	94.5		141
4$'$		162.3		164.6		152
5$'$	6.13 (1H, s)	95.4	6.17 (1H, s)	94.5	6.99 (1H, d, 8.6)	108
6$'$		159.2		159.2	7.22 (1H, d, 8.6)	122
1$''$	3.37 (2H, d, 7.0)	22.5				
2$''$	5.22 (1H, t, 7.0)	123.9				
3$''$		130.5				
4$''$	1.76 (3H, s)	17.5				
5$''$	1.61 (3H, s)	25.5				
CHO	9.69 (1H, s)	190.9	9.69 (1H, s)	191.0	9.81 (1H, s)	192
OCH_3-6	3.85 (3H, s)	56.1	3.79 (3H, s)	56.1	3.85 (3H, s)	56
OCH_3-4$'$			3.75 (3H, s)	55.6	3.97 (3H, s)	56
OCH_3-2$'$					3.82 (3H, s)	61
OH-4	10.14 (1H, s)		9.94 (1H, s)		10.15 (1H, s)	
OH-2$'$,6$'$	9.26 (2H, s)		9.03 (2H, s)			
OH-4$'$	9.12 (1H, s)					

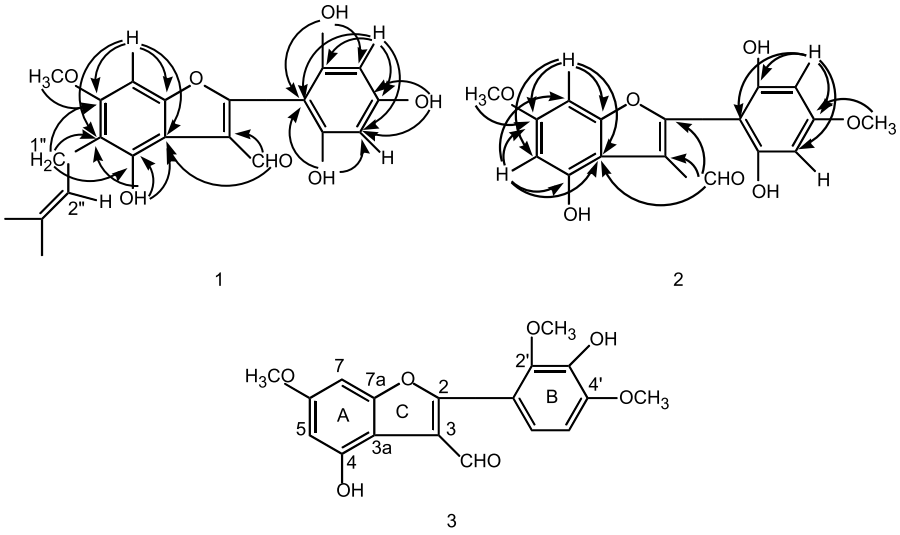

Figure 1. The structures and HMBC correlations of **1**, **2** and **3**.

Thus, the structure of **1** was identified as 2-(2′,4′,6′-trihydroxyphenyl)-4-hydroxy-6-methoxy-5-prenylbenzofuran-3-carbaldehyde, named hedysarimbenzofuran B.

Compound **2** was obtained as a yellow amorphous powder; its molecular formula was determined as $C_{17}H_{14}O_7$ from the negative HRESI-MS (*m/z* 329.0666 $[M - H]^-$). The UV spectrum of **2** showed absorption maxima at 250 and 339 nm, similar to that of **1**. The ^{1}H NMR spectrum displayed three hydroxyl groups at δ 9.94 (1H, s) and 9.03 (2H, s), two methoxyl groups at δ 3.75 (3H, s) and 3.79 (3H, s), one formyl group at δ 9.69 (1H, s) and four aromatic protons at δ 6.29 (1H, d, $J = 2.1$ Hz), 6.62 (1H, d, $J = 2.1$ Hz), and 6.17 (2H, s). In the ^{1}H NMR and ^{13}C NMR spectra of **2** (table 1), the signals for A and C rings and formyl group were in good agreement with those of **3**. In the ^{1}H NMR spectrum, two of the four aromatic protons at δ 6.17 (2H, s) were assigned to the B ring, and revealed a 1,2,4,6-substituented pattern. The HMBC spectrum of **2** showed the following correlations: the carbaldehyde proton at δ 9.69 with carbon signals at δ 162.8 (C-2) and 108.0 (C-3a), the meta-coupled aromatic protons at δ 6.29 and 6.62 with carbon signals at δ 152.4 (C-4) and 157.9 (C-7a), the two methoxyl groups at δ 3.75 and 3.79 with carbon signals at δ 164.6 (C-4′) and 161.9 (C-6), and the two aromatic protons at δ 6.17 (2H, s) with the carbon signal at δ 164.6 (C-4′) and 97.5 (C-1′), which supported above deduction and indicated that the methoxyl group (δ 3.79) should be linked to C-6; the other methoxyl group could be deduced to C-4′ (figure 1). Thus, the structure of **2** was determined as 2-(2′,6′-dihydroxy-4′-methoxyphenyl)-4-hydroxy-6-methoxy-benzofuran-3-carbaldehyde, named hedysarimbenzofuran B.

3. Experimental

3.1 General experimental procedures

Melting points were determined on an X_4-A micro-melting point apparatus and were uncorrected. UV spectra were recorded on a Shimadzu UV-260 spectrometer. NMR spectra were recorded on a Bruker DRX-500 NMR spectrometer with acetone-d_6 as solvent and TMS as internal standard. HRESI-MS was carried out on an APEX II mass spectrometer.

TLC was performed on silica gel GF_{254} (10–40 μ, Qingdao). Separation and purification were performed by column chromatography on macroporous resin D101 (Nankai), silica gel (200–300 mesh, Qingdao), and Sephadex LH-20 (Pharmacia).

3.2 Plant material

The roots of *Hedysarum multijugum* Maxim. were collected in July 1999, from Yongdeng, Gansu province of China. Voucher specimens were identified by Professor Hu-Biao Chen and deposited in the Herbarium of the Department of Natural Medicines, School of Pharmaceutical Sciences, Peking University.

3.3 Extraction and isolation

The powdered roots of *H. multijugum* Maxim. (8 kg) were percolated with 95% EtOH. After evaporation of the solvent under reduced pressure, the residue was suspended in water and extracted with petroleum ether, EtOAc and *n*-BuOH, respectively. The EtOAc extract (300 g) was subjected to silica gel column chromatography with petroleum ether/acetone (100:0 → 0:100) as gradient eluent to give ten fractions. Fraction 9 was chromatographed on repeated silica gel column eluting with petroleum ether/acetone and Sephadex LH-20 column eluting with 90% methanol to yield **1** (11 mg). The *n*-BuOH extract (165 g) was subjected to D101 resin, eluted with water, 50% EtOH, 70% EtOH and EtOH. The 50% EtOH soluble parts (27.8 g) were subjected to silica gel column chromatography with $CHCl_3$/MeOH (100:0 → 0:100) as gradient eluent to give eight fractions. Fraction 2 was chromatographed on a Sephadex LH-20 column eluting with 90% MeOH to yield **2** (8 mg).

3.3.1 Hedysarimbenzofuran A (1). Yellow amorphous powder, mp 169–170°C, UV λ_{max} (nm) MeOH: 255, 337. HRESI-MS (negative) *m/z*: 383.1129 $[M - H]^-$ (calcd for $C_{21}H_{19}O_7$, 383.1123). ^{1}H NMR data (500 Hz, acetone-d_6) and ^{13}C NMR data (125 Hz, acetone-d_6): see table 1.

3.3.2 Hedysarimbenzofuran B (2). Yellow amorphous powder, mp 170–180°C, UV λ_{max} (nm) MeOH: 250, 339. HRESI-MS (negative) *m/z*: 329.0666 $[M - H]^-$ (calcd for $C_{17}H_{13}O_7$, 329.0667). ^{1}H NMR data (500 Hz, acetone-d_6) and ^{13}C NMR data (125 Hz, acetone-d_6): see table 1.

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References

[1] W. Wang, W. Chen, H.B. Chen, J.Q. Liu, Y.Y. Zhao. *J. Peking Univ. (Health Sci.)*, **33**, 205 (2000).
[2] W. Wang, H.B. Chen, W.M. Wang, Y.Y. Zhao. *Acta Pharm Sin.*, **37**, 196 (2002).
[3] W. Wang, D.G. An, H.B. Chen, G.Z. Tu, Y.Y. Zhao. *J. Asian Nat. Prod. Res.*, **5**, 31 (2003).
[4] F.A. Macías, A.M. Simonet, J.C.G. Galindo, D. Castellano. *Phytochemistry*, **50**, 35 (1999).
[5] C. Kraft, K. Jenett-Siems, K. Siems, P.N. Solis, M.P. Gupta, U. Bienzle, E. Eich. *Phytochemistry*, **58**, 769 (2001).