LIGNANS FROM *Daphne giraldii*

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The stem barks of *Daphne giraldii* Nitsche (Thymelaeaceae) (Chinese name 'Zu Shima') have been used in Chinese folk medicine to treat aches and rheumatism, especially for toothache, waist ache, rheumatoid arthritis, and quadriplegia [1]. Earlier chemical work on this plant is confined to diterpenes [2, 3], coumarins [4, 5], and biflavonoids [6]. In the present paper, we report the isolation and characterization of nine lignans from the alcoholic extract of this plant.

The stem barks of *Daphne giraldii* (11kg) were collected in May 2005, in Shaanxi province, P. R. China, and extracted three times with 95% EtOH at room temperature. After removal of EtOH, the water suspension was partitioned with petroleum ether, $CHCl_3$, EtOAc, and *n*-BuOH. The $CHCl_3$ extract (50 g) and the EtOAc extract (200 g) were repeatedly subjected to silica gel column chromatography, eluting with the gradient $CHCl_3/CH_3OH$, and the fractions obtained were purified through reverse phase ODS column chromatography to afford **1** (300 mg), **2** (60 mg), **3** (115 mg), **4** (44 mg), **5** (26 mg), **6** (100mg), **7** (10 mg), **8** (35mg), and **9** (65 mg).

Nine compounds were determined as (–)-lariciresinol (**1**) [7], (–)-lariciresinol-4-*O*-*β*-D-glucopyranoside (**2**) [8], (–)-pinoresinol (**3**) [7], (–)-pinoresinol-4-O-*β*-D-glucopyranoside (**4**) [9], (–)-pinoresinol-di-*O*-*β*-D-glucopyranoside (**5**) [10], (±)-syringaresinol (**6**) [11], (±)-syringaresinol-4,4′-bis-*O*-*β*-D-glucoside (**7**) [12], 5′-demethoxydaphneticin (**8**) [13], and daphneticin (**9**) [14] on the basis of ^{1}H NMR (500 MHz), ^{13}C NMR (125 MHz), HSQC, HMBC, and MS spectral analysis. All spectral data of **1, 3, 6** were in good agreement with the literature data. Except for compound **9**, compounds **1**–**8** were obtained from *Daphne giraldii* for the first time.

(–)-Lariciresinol (1). $C_{20}H_{24}O_6$, white powder. ESI-MS: *m/z* 383 $[M+Na]^+$, 359$[M-H]^-$.

(–)-Lariciresinol-4-*O*-*β*-D-glucopyranoside (2). $C_{26}H_{34}O_{11}$, white powder. ESI-MS: *m/z* 523 $[M+H]^+$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.88 (1H, brs, H-2), 8.74 (4-OH), 6.64 (1H, d, J = 8.0, H-5), 6.75 (1H, s, H-6), 2.40, 2.80 (each 1H, m, H_2-7), 2.56 (1H, m, H-8), 3.44 (2H, m, H-9), 6.56 (1H, d, J = 2.0, H-2′), 7.00 (1H, d, J = 9.0, H-5′), 6.76 (1H, d, J = 7.0, H-6′), 4.72 (1H, d, J = 6.0, H-7′), 2.20 (1H, m, H-8′), 3.88 (1H, dd, J = 6.0, 6.0, H-9′), 3.72 (6H, 2 × OCH_3), 4.84 (1H, d, J = 7.0, Glc-1), 3.56 (1H, m, Glc-3), 3.24 (3H, m, Glc-2, 4, 6), 3.16 (1H, m, Glc-5), 3.64 (1H, m, Glc-6).

^{13}C NMR (DMSO-d_6, 125 MHz, δ, ppm): 131.6 (C-1), 112.6 (C-2), 147.4 (C-3), 144.5 (C-4), 115.3 (C-5), 120.5 (C-6), 32.0 (C-7), 41.9 (C-8), 71.8 (C-9), 137.0 (C-1′), 112.6 (C-2′), 148.7 (C-3′), 145.5 (C-4′), 115.3 (C-5′), 117.7 (C-6′), 81.5 (C-7′), 52.4 (C-8′), 58.5 (C-9′), 55.5, 56.0 (2 × OCH_3), 100.1 (Glc-1), 71.8 (Glc-2), 76.8 (Glc-3), 69.6 (Glc-4), 76.9 (Glc-5), 60.6 (Glc-6).

(–)-Pinoresinol (3). $C_{22}H_{22}O_6$, white powder. ESI-MS: *m/z* 357 $[M-H]^-$.

(–)-Pinoresinol-4-*O*-*β*-D-glucopyranoside (4). $C_{26}H_{32}O_{11}$, white powder. ESI-MS: *m/z* 519 $[M-H]^-$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.92 (1H, d, J = 1.0, H-2), 7.04 (1H, d, J = 9.0, H-5), 6.84 (1H, dd, J = 1.0, 9.0, H-6), 4.68 (1H, d, J = 4.0, H-7), 3.04 (1H, m, H-8), 4.12 (2H, m, H_2-9), 6.76 (1H, d, J = 1.0, H-2′), 6.88 (1H, d, J = 4.0, H-5′), 6.72 (1H, dd, J = 1.0, 4.0, H-6′), 4.60 (1H, d, J = 4.0, H-7′), 3.04 (1H, m, H-8′), 4.12 (2H, m, H_2-9′), 3.76 (6H, s, 2 × OCH_3), 4.88 (1H, d, J = 7.0, Glc-1), 3.40 (1H, m, Glc-3), 3.24 (3H, m, Glc-2, 3, 4), 3.12 (1H, m, Glc-5), 3.64 (1H, m, Glc-6).

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^{13}C NMR (DMSO-d_6, 125 MHz, δ, ppm): 135.2 (C-1), 110.6 (C-2), 145.9 (C-3), 147.5 (C-4), 115.3 (C-5), 118.6 (C-6), 85.1 (C-7), 53.6 (C-8), 70.9 (C-9), 132.2 (C-1′), 110.4 (C-2′), 145.8 (C-3′), 149.0 (C-4′), 115.1 (C-5′), 118.1 (C-6′), 84.8 (C-7′), 53.5 (C-8′), 70.8 (C-9′), 55.7, 55.6 (2 × OCH_3), 100.2 (Glc-1), 73.2 (Glc-2), 77.0 (Glc-3), 69.7 (Glc-4), 76.8 (Glc-5), 60.6 (Glc-6).

(–)-Pinoresinol-di-*O*-β-D-glucopyranoside (5). $C_{32}H_{42}O_{16}$, white powder. ESI-MS: *m/z* 705 $[M+Na]^+$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.95 (1H, d, J = 1.0, H-2), 7.04 (1H, d, J = 8.0, H-6), 6.85 (1H, dd, J = 1.0, 8.0, H-6), 4.68 (1H, d, J = 4.0, H-7), 3.05 (1H, m, H-8), 6.95 (1H, d, J = 1.0, H-2′), 7.04 (1H, d, J = 8.0, H-5′), 6.85 (1H, dd, J = 1.0, 8.0, H-6′), 4.68 (1H, d, J = 4.0, H-7′), 3.05 (1H, m, H-8′), 4.15, 3.78 (each 2H, m, H_2-9, H_2-9′), 3.78 (6H, 2 × OCH_3), 4.87 (1H, d, J = 7.0, Glc-1), 3.46 (1H, m, Glc-3), 3.26 (3H, m, Glc-2, 4, 6), 3.17 (1H, m, Glc-5), 3.67 (1H, m, Glc-6).

^{13}C NMR (DMSO-d_6, 125 MHz, δ, ppm): 135.2 (C-1), 110.6 (C-2), 145.9 (C-3), 115.3 (C-5), 118.2 (C-6), 84.8 (C-7), 53.6 (C-8), 71.0 (C-9), 135.2 (C-1′), 110.6 (C-2′), 145.9 (C-3′), 149.0 (C-4′), 115.3 (C-5′), 118.2 (C-6′), 84.8 (C-7′), 53.6 (C-8′), 71.0 (C-9′), 55.8 (OCH_3), 100.2 (Glc-1), 73.2 (Glc-2), 77.0 (Glc-3), 69.7 (Glc-4), 76.8 (Glc-5), 60.7 (Glc-6).

(±)-Syringaresinol (6). $C_{22}H_{26}O_8$, white powder. ESI-MS: *m/z* 441 $[M+Na]^+$.

(±)-Syringaresinol-4′,4′-bis-*O*-β-D-glucoside (7). $C_{34}H_{46}O_{18}$, white powder, ESI-MS: *m/z* 765 $[M+Na]^+$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.68 (1H, s, H-2), 6.68 (1H, s, H-6), 4.64 (1H, d, J = 4.0, H-7), 3.12 (1H, m, H-8), 3.80, 4.16 (each 1H, m, H_2-9), 6.68 (1H, s, H-2′), 6.68 (1H, s, H-6′), 4.64 (1H, d, J = 4.0′, H-7′), 3.12 (1H, m, H-8′), 3.80, 4.16 (each 1H, m, H_2-9′), 3.72 (12H, 4 × OCH_3), 4.84 (1H, d, J = 5.0, Glc-1), 3.20 (1H, m, Glc-2), 3.08 (1H, m, Glc-3), 3.16 (1H, m, Glc-4), 3.04 (1H, m, Glc-5), 3.36, 3.56 (each 1H, m, Glc-6).

^{13}C NMR (DMSO-d_6, 125 MHz, δ, ppm): 134.0 (C-1), 104.2 (C-2), 152.6 (C-3), 137.1 (C-4), 152.6 (C-5), 104.2 (C-6), 85.0 (C-7), 53.6 (C-8), 71.3 (C-9), 134.0 (C-1′), 104.2 (C-2′), 152.6 (C-3′), 137.1 (C-4′), 152.6 (C-5′), 104.2 (C-6′), 85.0 (C-7′), 53.6 (C-8′), 71.3 (C-9′), 56.4 (OCH_3), 102.7 (Glc-1), 74.1 (Glc-2), 77.2 (Glc-3), 69.9 (Glc-4), 76.5 (Glc-5), 60.9 (Glc-6).

5′-Demethoxydaphneticin (8). $C_{19}H_{16}O_7$, pale yellow powder. ESI-MS: *m/z* 379 $[M+Na]^+$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.33 (1H, d, J = 10.0, H-3), 8.00 (1H, d, J = 10.0, H-4), 7.20 (1H, d, J = 7.0, H-5), 6.95 (1H, d, J = 7.0, H-6), 7.00 (1H, s, H-2′), 9.14 (4′-OH), 6.86 (1H, d, J = 9.0, H-5′), 6.91 (1H, d, J = 9.0, H-6′), 4.20 (1H, brs, H-8′), 3.43, 3.67 (each 1H, m, H-9′), 5.10 (1H, d, J = 7.0, 9′-OH), 3.81 (3H, s, OCH_3).

^{13}C NMR (DMSO-d_6, 125 MHz, δ): 159.8 (C-2), 112.6 (C-3), 144.7 (C-4), 119.7 (C-5), 113.2 (C-6), 146.7 (C-7), 131.0 (C-8), 143.0 (C-9), 126.7 (C-1′), 111.9 (C-2′), 147.2 (C-3′), 147.6 (C-4′), 115.4 (C-5′),120.6 (C-6′), 76.3 (C-7′), 78.0 (C-8′), 59.8 (C-9′), 55.7 (-OCH_3).

Daphneticin (9). $C_{20}H_{18}O_8$, pale yellow powder. ESI-MS: *m/z* 387 $[M+H]^+$.

^{1}H NMR (DMSO-d_6, 500 MHz, δ, ppm, J/Hz): 6.31 (1H, d, J = 10.0, H-3), 7.98 (1H, d, J = 9.0, H-4), 7.20 (1H, d, J = 8.0, H-5), 6.94 (1H, d, J = 8.0, H-6), 6.78 (2H, s, H-2′, 6′), 8.39 (4′-OH), 3.75 (3H, s, 3′,5′-OCH_3), 5.04 (1H, m, H-7′), 4.31 (1H, brs, H-8′), 3.40 (1H, brs, H-8′), 3.67 (1H, m, H-9′).

^{13}C NMR (DMSO-d_6, 125 MHz, δ): 159.5 (C-2), 113.3 (C-3), 144.7 (C-4), 119.7 (C-5), 112.6 (C-6), 146.7 (C-7), 136.2 (C-8), 143.0 (C-9), 113.0 (C-10), 125.8 (C-1′), 105.5 (C-2′,6′), 147.9 (C-3′, 5′), 131.0 (C-4′), 76.6 (C-7′), 78.0 (C-8′), 59.8 (C-9′), 56.1 (3′,5′-OCH_3).

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