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CHEMICAL CONSTITUENTS FROM THE ROOTS OF *Cinnamomum reticulatum*

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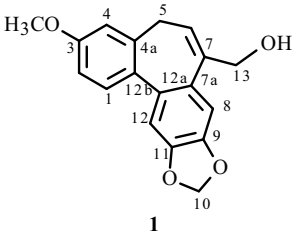
Cinnamoum reticulatum Hayata (Lauraceae) is an evergreen tree, a tree indigenous to Taiwan [1]. The chemical constituents and biological activity of the roots of this plant have not yet been reported [1, 2]. There are only two papers describing the constituents of leaves of *Cinnamomum reticulatum* Hayata [1, 2]. In the course of screening for biologically and chemically novel agents from Formosan Lauraceous plants [2–21], the roots of *C. reticulatum* were chosen for further phytochemical investigation. The H_2O extract of its roots was subjected to solvent partitioning and chromatographic separation to afford seven pure substances. The chemical constituents in the roots of *C. reticulatum* were separated by column chromatography.

Investigation on the MeOH extract of the roots has led to the isolation of nine compounds, one homosesquiterpenoid: (3-methoxy-5*H*-9,11-dioxabenzo[3,4]cyclohepta[1,2-*f*])inden-7-yl)methanol (**1**); six benzenoids: *p*-hydroxybenzoic acid [22], *p*-hydroxybenzaldehyde [18], protocatechuic acid [23], ferulic acid [22], *trans*-methyl *p*-coumarate [22], and *p*-dihydrocoumaric acid [22]; and two amides: *N-trans*-feruloyltyramine [24] and *N-cis*-feruloyltyramine [24]. These compounds were obtained and characterized by comparison of their physical and spectral data (UV, IR, NMR, and MS) with values in the literature [22–24]. In addition to *p*-hydroxybenzoic acid and protocatechuic acid, all of these compounds were found for the first time from this plant. In this paper, we report the isolation and structural elucidation of this homosesquiterpenoid compound.

Compound **1** was isolated as a white, amorphous powder with a molecular formula of $C_{18}H_{16}O_4$, as determined by HR-ESI-MS (obsd. $[M + Na]^+$ at *m/z* 319.0947; calcd $[M + Na]^+$ 319.0946). This formula agrees with deductions from the ^1H and ^{13}C NMR data and corresponds to 11 degrees of unsaturation. The UV spectrum contained absorption bands typical of 5*H*-dibenzo[*a,c*]cycloheptene derivatives [6]. IR absorption peaks at 920, 1070, and 3400 cm^{-1} indicated the presence of methylenedioxy and hydroxy functionalities, respectively. The ^1H NMR resonances of **1** were well dispersed in $CDCl_3$ and displayed an ABX pattern (H-4 at δ 6.70, H-2 at 6.75, and H-1 at 7.31), singlets at δ 7.06, 7.12 for H-12 and H-8, respectively, in addition to the methylenedioxy protons at δ 6.01, accounting for seven protons. A three proton-singlet at δ 3.89 indicated the presence of the methoxy group. The C-6 olefinic proton (δ 6.13, t, J = 7.5 Hz) is coupled with the C-5 and C-13 methylene protons, the latter four hydrogens resonating at δ 2.75 (dd, J = 13.0, 6.5 Hz, H-5a), 3.03 (dd, J = 13.0, 8.5 Hz, H-5b), 4.32 (d, J = 13.0 Hz, H-13a), and 4.50 (d, J = 13.0 Hz, H-13b), respectively. The ^{13}C NMR and DEPT spectra of **1** showed 18 resonances comprising one methyl, three methylene, six methine, and eight quaternary carbons. Structure **1** was also confirmed by 2D NMR experiments. A COSY correlation was observed between H-1 and H-2, and between H-5 and H-6. A triplet of quartets at δ 6.13 was assigned to H-6 and showed coupling to the nearby C-5 and C-13 methylene protons, which appeared at δ 2.75 and 3.03, and at δ 4.50, respectively. Thus, the structure of **1** was elucidated as (3-methoxy-5*H*-9,11-dioxabenzo[3,4]-cyclohepta[1,2-*f*])inden-7-yl)-methanol.



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The roots of *C. reticulatum* were collected from Pingtung County, Taiwan in March 2006. Plant material was identified by Professor Fu-Yuan Lu (Department of Forestry and Natural Resources, College of Agriculture, National Chiayi University). A voucher specimen (*Cinnamo*. 6) was deposited in the School of Medical and Health Sciences, Fooyin University, Kaohsiung County, Taiwan. The air-dried roots of *C. reticulatum* (1.3 kg) were extracted with *n*-hexane (10 L × 3), $CHCl_3$ (10 L × 3), and H_2O (10 L × 3) at room temperature, and an *n*-hexane extract (21.5 g), $CHCl_3$ extract (61.2 g) and H_2O extract (23.7 g) were obtained upon concentration under reduced pressure. The H_2O extract was chromatographed over silica gel (2500 g, 70–230 mesh) using $CHCl_3$–MeOH as eluent to produce six fractions. Fraction 1 (2.88 g) was subjected to Si gel chromatography by eluting with *n*-hexane–EtOAc (20:1) to obtain (3-methoxy-5*H*-9,11-dioxabenzo[3,4]cyclohepta[1,2-*f*])inden-7-yl)-methanol (**1**) (2 mg). Part of fraction 2 (3.46 g) was subjected to Si gel chromatography by eluting with *n*-hexane–EtOAc (10:1), then enriched with EtOAc to furnish five fractions (2-1–2-5). Fraction 2-1 (0.88 g) was re-subjected to Si gel chromatography, eluting with *n*-hexane–acetone (50:1), and enriched gradually with acetone to obtain *N-trans*-feruloyltyramine (6 mg) and *N-cis*-feruloyltyramine (7 mg). Fraction 2-2 (0.51 g) was re-subjected to Si gel chromatography, eluting with *n*-hexane–acetone (50:1), and enriched gradually with acetone to obtain ferulic acid (4 mg), *trans*-methyl-*p*-coumarate (2 mg) and *p*-dihydrocoumaric acid (6 mg). Fraction 2-3 (0.56 g) was re-subjected to Si gel chromatography, eluting with *n*-hexane–acetone (50:1), and enriched gradually with acetone to obtain *p*-hydroxybenzoic acid (6 mg), *p*-hydroxybezaldehyde (3 mg), and protocatechuic acid (2 mg).

(3-Methoxy-5*H*-9,11-dioxabenzo[3,4]cyclohepta[1,2-*f*])inden-7-yl)-methanol (1): white amorphous powder; UV (MeCN, λ_{max}, nm, log ε): 235 (3.23), 255 (2.65), 290 (2.11). IR (ν_{max}, neat, cm^{-1}): 3400 (br, OH), 3000, 1700, 1250, 1070, 920 (methylenedioxy). ^1H NMR (400 MHz, $CDCl_3$, δ, ppm, J/Hz): 2.75 (1H, dd, J = 13.0, 6.5, H-5a), 3.03 (1H, dd, J = 13.0, 8.5, H-5b), 3.89 (3H, s, OMe-3), 4.32 (1H, d, J = 13.0, H-13a), 4.50 (1H, d, J = 13.0, H-13b), 6.01 (2H, d, J = 1.0, H-10), 6.13 (1H, t, J = 7.5, H-6), 6.70 (1H, d, J = 2.5, H-4), 6.75 (1H, dd, J = 8.5, 2.5, H-2), 7.06 (1H, s, H-12), 7.13 (1H, s, H-8), 7.31 (1H, d, J = 8.5, H-1). ^{13}C NMR (100 MHz, $CDCl_3$, δ): 33.2 (t, C-5), 55.1 (q, OMe-3), 66.3 (t, C-13), 101.1 (t, C-10), 106.1 (d, C-8), 109.5 (d, C-12), 111.6 (d, C-4), 111.8 (d, C-2), 127.8 (d, C-6), 129.8 (s, C-7a), 130.4 (d, C-1), 131.1 (s, C-12b), 134.7 (s, C-12a), 137.5 (s, C-7), 143.5 (s, C-4a), 146.2 (s, C-9), 146.3 (s, C-11), 159.1 (s, C-3). ESI-MS *m/z:* 319 $[M + Na]^+$; HR-ESI-MS *m/z:* 319.0950 $[M]^+$ (calcd for $C_{18}H_{16}O_4Na$, 319.0946).

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