SHORT REPORT

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Pandanusphenol A and B: Two New Phenolic Compounds from the Fruits of *Pandanus tectorius* Soland

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Abstract: Two new phenolic compounds, Pandanusphenol A (**1**) and B (**2**), were obtained from the fruits of *Pandanus tectorius*. Their structures including absolute configurations were determined by extensive spectroscopic analysis including 2D NMR experiments (^{1}H-^{1}H COSY, HMBC, and NOESY) and HRESIMS results as well as CD data. The substituted pattern of two methoxy groups on the phenyl ring of Pandanusphenol A (**1**) is rarely seen in natural furofuran lignans.

Keywords: *Pandanus tectorius*; Pandanusphenol A; Pandanusphenol B.

1. Plant Source

In the course of phytochemical studies of medicinal plants from genus *Pandanus* distributed in China, we investigate the chemical constituents of the fruits of *Pandanus tectorius* Soland (Pandanaceae). Herein, we report on the structure elucidation of the two new phenolic compounds of Pandanusphenol A (**1**) and Pandanusphenol B (**2**) (Figure 1).

The fruits of *P. tectorius* were collected from Hainan Province, P.R. China, in July 2011 and identified by Prof. Weiyong Lai at the School of Pharmaceutical Science, Hainan Medical University. A voucher specimen has been deposited there (Voucher specimen NO. PT20110714).

2. Previous Studies

Phenolic compounds and flavonoids such as ethyl caffeate, dihydroconiferyl alcohol and tangeretin have been isolated from the fruits of *P. tectorius* previously [1].

3. Present Study

The fruits of *P. tectorius* were dried followed by cutting into pieces and macerated in ethanol (95%) at room temperature for 48 h and then filtered. The filtrate was concentrated under vacuum to give 120 g of crude residue. The crude fraction (85 g) was then subjected to column chromatography (silica gel, *n*-hexane, *n*-hexane-EtOAc and EtOAc, in order of increasing polarity) yielding 5 fractions.

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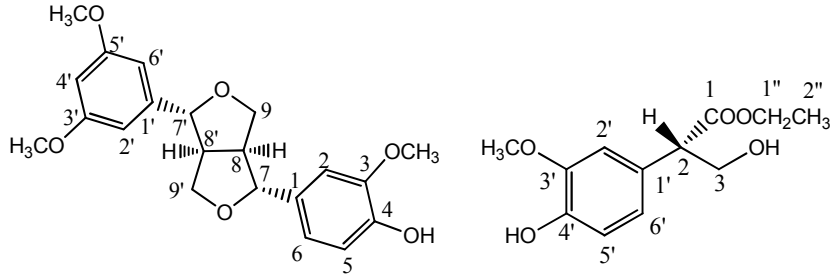
Fraction F_2 was eluted with a mixture of hexane-Acetone (3:1) yielding 3 subfractions. Fraction $subF_2$ was further purified by preparative HPLC eluting with MeOH-H_2O (65:35) to afford Pandanusphenol A (**1**) (5.2 mg). Fraction F_4 was chromatographied over a coloum of Sephadex LH-20 eluting with MeOH-$CHCl_3$ (50:50) to give 2 subfractions ($subF_a$ and $subF_b$). Fraction $subF_b$ was further purified by preparative HPLC eluting with MeOH-H_2O (60:40) to yield Pandanusphenol B (**2**) (5.2 mg).

*Pandanusphenol A **(1)***: White amorphous solid, $[\alpha]_D^{25}$ = +12.5 (*c* = 0.1, MeOH); UV ($CHCl_3$): λ_{max} (log ε): 282 (1.52), 242 (1.96); IR ν_{max} ($CHCl_3$): = 3410, 1608, 1520, 1022 cm^{-1}; ^1H NMR (600 MHz, CD_3OD) δ (ppm)= 6.95 (1H, d, *J* = 1.8 Hz, H-2), 6.77 (1H, d, *J* = 7.8 Hz, H-5), 6.80 (1H, dd, *J* = 7.8, 1.8 Hz, H-6), 4.72 (1H, d, *J* = 4.8 Hz, H-7), 3.15 (1H, m, H-8), 4.24 (1H, dd, *J* = 9.0, 7.0 Hz, H-9a), 3.85 (1H, m, H-9b), 6.92 (1H, brs, H-2'), 6.98 (1H, brs, H-4'), 6.92 (1H, brs, H-6'), 4.75 (1H, d, *J* = 4.2 Hz, H-7'), 3.15 (1H, m, H-8'), 4.25 (1H, *J* = 9.0,7.2 Hz, H-9a'), 3.85 (1H, m, H-9b'), 3.86 (3H, s, 3-OMe), 3.82 (3H, s, 3'-OMe), 3.84 (3H, s, 5'-OMe); ^{13} C NMR (150 MHz, CD_3OD): δ (ppm) = 56.6 (CH_3, 3', 5'-OMe), 56.8 (CH_3, 3-OMe), 134.0 (C, C-1), 111.2 (CH, C-2), 149.0 (C, C-3), 147.3 (C, C-4), 116.3 (CH, C-5), 120.3 (CH, C-6), 87.7 (CH, C-7), 56.7 (CH, C-8), 72.8 (CH_2, C-9), 135.5 (C, C-1'), 120.0 (CH, C-2'), 150.4 (C, C-3'), 111.4 (CH, C-4'), 150.7 (C, C-5'), 113.1 (CH, C-6'), 87.5 (CH, C-7'), 56.6 (CH, C-8'), 72.9 (CH_2, C-9'). HRESIMS: *m/z* 395.1469 ($[M+Na]^+$, calcd. $C_{21}H_{24}O_6Na^+$ for 395.1471).

*Pandanusphenol B **(2)***: Colorless oil, $[\alpha]_D^{25}$-14.0 (*c* = 0.2, $CHCl_3$); UV (MeOH): λmax (log ε) 280 (3.45), 230 (3.80); IR ν_{max} ($CHCl_3$): = 3421, 1730, 1602, 1520, 1380, 1020 cm^{-1}; ^1H NMR (600 MHz, CD_3OD): δ (ppm)= 3.69 (1H, dd, *J* = 12.0, 4.5 Hz, H-2), 3.67 (1H, dd, *J* = 12.0, 4.5 Hz, H-3a), 4.05 (1H, t, *J* = 12.0 Hz, H-3b), 6.74 (1H, *J* = 1.8 Hz, H-2'), 6.87 (1H, *J* = 7.8 Hz, H-5'), 6.73 (1H, *J* = 7.8, 1.8 Hz, H-6'), 4.16 (2H, m, H-1''), 1.23 (t, *J* = 7.2 Hz, H-2''), 3.84 (3H, s, -OMe); ^{13} C NMR (150 MHz, CD_3OD): δ (ppm)= 55.7 (CH_3, OMe), 174.9 (C, C-1), 56.6 (CH, C-2), 65.5 (CH_2, C-3), 128.9 (C, C-1'), 122.0 (CH, C-2'), 147.4 (C, C-3'), 149.2 (CH, C-4'), 116.5 (C, C-5'), 112.9 (CH, C-6'). HRESIMS: *m/z* 263.0884 ($[M+Na]^+$, calcd. $C_{12}H_{16}O_5Na^+$ for 263.0895).

The dried and powdered fruits of *P. tectorius* were extracted with ethanol (95%). The crude extract obtained after evaporation of the solvent was subjected to conventional purification procedures and resulting in the isolation of two new pheonlic compounds of Pandanusphenol A (**1**) and Pandanusphenol B (**2**) as shown in Figure 1.



1 **2**

Figure 1. Structure of Pandanusphenol A (**1**) and Pandanusphenol B (**2**) isolated from *P. tectorius*.

Compound **1,** Pandanusphenol A, was isolated as white amorphous solid, for which the UV spectrum showed λ_{max} at 282 and 242 nm. Its molecular formula was determined as $C_{22}H_{24}O_6$ by HRESIMS analysis. The IR spectrum of **1** showed absorption bands for hydroxyl groups (3410 cm^{-1}) and an aromatic moiety (1608, 1520 cm^{-1}). The ^1H NMR spectra of **1** showed six aromatic protons [δ = 6.98 (1H, brs, H-4'), 6.92 (2H, brs, H-2', 6'), 6.95 (1H, d, *J* = 1.8 Hz, H-2), 6.80 (1H, dd, *J* = 7.8 Hz, 1.8 Hz, H-6), 6.77 (1H, d, *J* = 7.8 Hz, H-5)]**.** Further analysis of the resonanted signals suggested the two phenyl rings accepted an ABX type coupling pattern and a 1, 3, 5-trisubstituted pattern, respectively. Combination with the analysis of the ^{13} C NMR and HSQC, COSY spectra, there are two oxymethylene carbons [δ = 72.8 (CH_2) and 72.9 (CH_2)], four methine carbons [δ = 87.7 (CH), 87.5 (CH), 56.7 (CH) and 56.5 (CH)], which were the typical signals of the furofuran moiety [2, 3]. These data summarized above, in combination with biogenetic considerations, suggest that **1** is a furofuan

type lignan [4]. The NMR spectra also exihibited the presence of three methoxy groups presenting at δ = 3.82, 3.84, and 3.86 and δ_C (55.6, 56.6 and 56.8). HMBC correlations between H-2', 6' and C-3', C-5', C-7'and correlations between -OCH_3 (δ = 3.82, 3.84) and C-3', C-5' established the connectivities of the 1, 3, 5-trisubstituted phenyl ring. These were further confirmed by the NOE correlations between H-2', 6', H-4' and the two methoxy groups. The other methoxy group was located at C-3 by an observed NOE correlation between -OCH_3 (δ = 3.86) and H-2. The relaive sterochemistry of **1** was determined by comparing the chemical shifts of H-7 (7'), H-8 (8'), and H-9 (9') with pinoresinol and eudesmin A [3, 4]. The relative stereochemistry of the two phenyl groups at C-8 and C-8' were also assigned in the same way. The absolute configuration of **1** was established by applying CD method. The observed positive cotton effects at 204 nm (Δε +1.23), 232.0 nm (Δε +0.45), 280.0 nm (Δε +0.18) were almost identical to that of (+)-sesamin [5], which suggested the 7R, 8S, 7'R, 8'S absloute configuration for **1**. Therefore, compound **1** was determined as shown in Figure 1, and the trivial name, Pandanusphenol A, was given to this compound. (Spectroscopic data provided in Supporting Information).

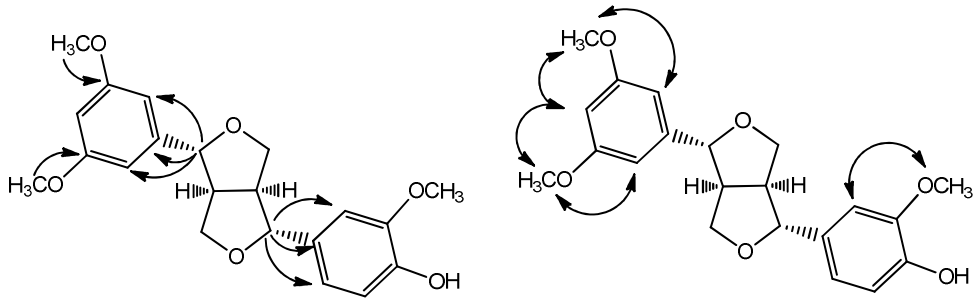


Figure 2. Key HMBC (⌒) and NOSEY (⌒) correlations of Pandanusphenol A (**1**)

Compound **2** was obtained as colorless oil with a molecular formula $C_{12}H_{16}O_5$ as established by HRESIMS analysis. Its IR spectrum displayed the presence of hydroxyl (3421 cm^{-1}), carbonyl ($\nu_{C=O}$ 1730 cm^{-1}) and phenyl (1602, 1520 cm^{-1}) groups. Analysis of its ^{13}C NMR spectrum along with APT and HSQC spectra of **2** revealed 12 carbons, which were ascribed to two methyl groups, one phenyl group, two methylenes, one methine, and one carbonyl group. Furthermore, the presence of a methoxy group [δ = 3.84 (3H, s)] and an ethyl goup [δ = 4.16 (2H, m, H-1˝) and 1.23 (3H, t, J = 7.2 Hz, H-2˝)] were supported by the ^{1}H NMR spectrum. The existence of an ABX type phenyl group [δ = 6.73 (1H, brd, J = 7.8 Hz, H-6'), 6.74 (1H, brs, H-2') and 6.87 (1H, d, J = 7.8 Hz, H-5')] were also undoubtedly assigned by analyzing their chemical shifts and coupling constant. In addition, resonances exhibited at δ = 3.67 (1H, dd, J = 12.0 Hz, 4.5 Hz, H-3a), 4.05 (1H, t, J = 12.0 Hz, H-3b) and 3.69 (1H, dd, J = 12.0 Hz, 4.5 Hz, H-2), suggesting the presence of an aliphatic ABX system which was further confirmed by the ^{1}H-^{1}H COSY correlations. These data suggest that **2** is extremly similiar to those of ficusol [6]. HMBC correlations from H-2 to C-1', C-2', C-6', C-3, C-1 established the connectivities of C-2 with C-1', C-3, and C-1˝. Further analysis of HMBC correlation between H-1˝, H-2˝ and C-1 allowed the assignment of the connection of the ester ethyl group. NOE correlation between –OCH_3 (δ = 3.84) and H-2' determined the position of this methoxyl group. Furthermore, the configuration of C-2 was determined to be S by comparing its optical rotation with ficusol [6]. Therefore, compoud **2** was assigned as ethyl (S)-2-(4-hydroxy-3-methoxyphenyl)-3-hydroxypropanoate with a trial name of Pandanusphenol B. (Spectroscopic data provided in Supporting Information).

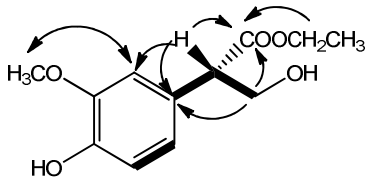


Figure 3. Important ^{1}H-^{1}H-COSY (▬) and HMBC (↷) correlations for Pandanusphenol B (**2**).

Acknowledgements

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