Phenolic compounds and flavonoids from the fruits of *Pandanus tectorius* Soland

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Fifteen (1-15) compounds including ten phenolic compounds and five flavonoids were isolated from the fruits of *Pandanus tectorius*. All of the compounds were isolated and purified by various column chromatographies especially by semi-preparative high performance liquid chromatography (HPLC). Their structures were determined under the aid of spectral methods. All compounds were isolated from this medicinal plant for the first time. The biological activities of some compounds were discussed according to the results of related literature.

Key words: *Pandanus tectorius* Soland, Pandanaceae, phenolic compounds, flavonoids, biological activities.

INTRODUCTION

The genus *Pandanus* of Pandanaceae family comprises of about 700 species distributed worldwide in the subtropical and tropical regions (Tan et al., 2008). Various *Pandanus* species are important commercial crops and also used as folk medicine as a treatment for leprosy, bronchitis, measles, dermatitis and urinary tract ailments (Vahirua-Lechat et al., 1996). In China, five species and one varied species belonging to the genus are spread in the subtropical and tropical regions including Hainan Province, Guangdong Province, Taiwan Province, etc. The extract of roots and stem of *Pandanus tectorius* possessing many medicinal effects in treating influenza, hepatitis, urinary tract infection, and nephritis have been recorded in standardized and benchmarked Chinese Materia Medica of Guangdong Province (Peng et al., 2010). Its fruits with the biological activity of anti-inflammatory attracted our interest. However, little information is available on the chemical constituents of the fruits of the medicinal plants. Based on these, we carried out the studies on chemical principles of the fruits. During this course, ten phenolic compounds and five flavonoids were obtained, and the reported biological activities of some isolated compounds were summarized in this paper.

EXPERIMENTAL

General experimental procedures

The NMR data were recorded on Bruker AV 600 (600 MHz for $^1$H and 150 MHz for $^{13}$C) in MeOD or CDCl$_3$ with TMS as internal standard. Chromatography was performed on silica gel column (200-300 mesh, Qingdao Haiyang) and Sephadex LH-20 column (GE Healthcare, Sweden). HPLC isolation was conducted on a lumtech K1001 analytic LC equipped with two pumps of K-501, a UV detector of K-2600, and a column of YMC-Pack ODS-A (250×10 mm, 5 µm).

Collection and preparation of plant material

The medicinal material was collected at Hainan Province 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).
Extraction and isolation

The fruits (20 kg) of *P. tectorius* were dried in shade and exhaustively extracted with 95% ethanol. The extract was filtered and concentrated on reduced pressure until only H2O remained. The remaining solution was sequentially partitioned with petroleum ether (34 g), CHCl3 (42 g), EIOAc (53 g) and n-BuOH (100 g). The CHCl3 extract (42 g) was subjected to a column chromatography on silica gel using petroleum ether-EtOAc as the mobile phase and six fractions (Fr. 1-6) were obtained. Five fractions (Fr. 2-6) were purified by a column chromatography of Sephadex LH-20 eluting with CHCl3 at 4°C. The obtained residues were further purified by semi-preparative HPLC using MeOH-H2O as the eluent to yield compounds 1-15 (Figure 1).

RESULTS AND DISCUSSION

**Compound 1, NMR data:** 1HNMR (600 MHz, MeOD) δ: 9.83 (1H, s, -CHO), 7.43 (1H, dd, J = 8.4, 1.8 Hz, H-5), 7.42 (1H, d, J = 1.8 Hz, H-2), 7.04 (1H, d, J = 8.4 Hz, H-5), 3.97 (-OMe). These spectral data showed basically agreement with the reported literature of coniferyl alcohol (Kim et al., 2011).

**Compound 2, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.57 (1H, d, J = 15.6 Hz, H-7), 7.09 (1H, d, J = 1.8 Hz, H-2), 7.00 (1H, dd, J = 7.8, 1.8 Hz, H-5), 6.87 (1H, d, J = 7.8 Hz, H-6), 6.24 (1H, d, J = 15.6 Hz, H-5), 4.25 (2H, q, J = 6.6 Hz, -CH2), 1.34 (3H, t, J = 6.6 Hz, -CH3). These spectral data showed basically agreement with the compound of vanillin (Xiang et al., 2011).

**Compound 3, NMR data:** δ: 7.32 (1H, d, J = 1.8 Hz, H-2), 7.02 (1H, dd, J = 8.4, 1.8 Hz, H-6), 6.77 (1H, d, J = 12.6 Hz, H-7), 6.72 (1H, d, J = 8.4 Hz, H-5), 5.73 (1H, d, J = 12.6 Hz, H-8), 4.16 (2H, q, J = 6.6 Hz, -CH2), 1.26 (3H, t, J = 6.6 Hz, -CH3). These spectral data showed basically agreement with the reported literature of cis-ethyl caffeate (Xiang et al., 2009).

**Compound 4, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.60 (1H, d, J = 16.2 Hz, H-7), 7.45 (2H, d, J = 8.4 Hz, H-2, 6), 6.80 (2H, d, J = 8.4 Hz, H-3, 5), 6.31 (1H, d, J = 16.2 Hz, H-8), 4.21 (2H, q, J = 6.6 Hz, -CH2), 1.31 (3H, t, J = 6.6 Hz, -CH3). These spectral data showed basically agreement with the reported literature of ethyl coumarate (Kaewamatawong et al., 2007).

**Compound 5, NMR data:** 1HNMR (600 MHz, MeOD) δ: 9.58 (1H, d, J = 7.8 Hz, -CHO), 7.58 (1H, d, J = 15.0 Hz, H-7), 7.00 (2H, s, H-2, 6), 6.87 (1H, dd, J = 15.0, 7.8 Hz, H-8), 3.89 (6H, s, 2x-OCH3). These spectral data showed basically agreement with the reported literature of sinapaldehyde (Wen et al., 1996).

**Compound 6, NMR data:** 1HNMR (600 MHz, MeOD) δ: 9.59 (1H, d, J = 7.8 Hz, -CHO), 7.11 (1H, dd, J = 8.4, 1.8 Hz, H-6), 7.06 (1H, d, J = 1.8Hz, H-6), 6.95 (1H, d, J = 8.4 Hz, H-6), 6.59 (1H, dd, J = 15.0, 7.8 Hz, H-8). These spectral data showed basically agreement with the reported literature of trans-3, 4-dihydroxycinnamaldehyde (Demin et al., 2004).

**Compound 7, NMR data:** 1HNMR (600 MHz, MeOD) δ: 6.77 (1H, d, J = 1.8 Hz, H-2), 6.69 (1H, d, J = 8.4 Hz, H-5), 6.61 (1H, dd, J = 8.4, 1.8 Hz, H-6), 3.86 (3H, -OMe), 3.55 (2H, t, J = 6.6 Hz, H-9), 2.59 (2H, t, J = 6.7 Hz, H-7), 1.80 (2H, m, H-8). These spectral data showed basically agreement with the reported literature of dihydroconiferyl alcohol (Saracoğlu et al., 2002).

**Compound 8, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.00 (1H, d, J = 2.4Hz, H-2), 6.85 (1H, dd, J = 8.4, 1.8 Hz, H-6), 6.72 (1H, d, J = 8.4 Hz, H-5), 6.50 (1H, d, J = 15.6 Hz, H-7), 6.19 (1H, dt, J = 15.6, 6.0 Hz, H-8), 4.19 (2H, d, J = 6.0 Hz, H-9), 3.86 (3H, -OMe). These spectral data showed basically agreement with the reported literature of coniferyl alcohol (Kim et al., 2011).

**Compound 9, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.58 (1H, dd, J = 8.4, 2.4 Hz, H-6), 7.54 (1H, d, J = 2.4 Hz, H-2), 6.86 (1H, d, J = 8.6 Hz, H-5), 3.94 (2H, t, J = 6.0 Hz, H-9), 3.16 (2H, t, J = 6.0 Hz, H-8). These spectral data showed basically agreement with the reported literature of 3-hydroxy-(4-hydroxy-3-methoxyphenyl) propan-1-one (Li et al., 2011).

**Compound 10, NMR data:** 1HNMR (600 MHz, MeOD) δ: 9.89 (1H, s, -CHO), 8.15 (1H, d, J = 8.4 Hz, H-6), 8.10 (1H, s, -OH), 7.48 (1H, d, J = 8.4Hz, H-2), 7.28 (1H, t, J = 8.4 Hz, H-3), 7.28 (1H, t, J = 8.4 Hz, H-4). These spectral data showed basically agreement with the reported literature of salicylaldehyde (Janes et al., 2008).

**Compound 11, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.98 (2H, d, J = 8.4 Hz, H-2, 6'), 7.12 (2H, d, J = 8.4Hz, H-3'), 6.68 (1H, s, H-3), 4.11 (s,-OMe), 4.03 (s,-OMe), 3.93 (s,-OMe), 3.90 (s,-OMe), 3.89 (s,-OMe). These spectral data showed basically agreement with the reported literature of tangeretin (Hamdan et al., 2007).

**Compound 12, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.58 (2H, d, J = 8.4Hz, H-2, 6'), 6.82 (2H, d, J = 8.4 Hz, H-3', 5'), 6.05 (1H, d, J = 2.4 Hz, H-8), 6.04 (1H, d, J = 2.4 Hz, H-6), 5.38 (1H, dd, J = 13.2, 3.0 Hz, H-2), 3.94 (3H, s, -OMe), 3.15 (1H, dd, J = 16.8, 13.2 Hz, H-3a), 2.73 (1H, dd, J = 16.8, 3.0 Hz, H-3b). These spectral data showed basically agreement with the reported literature of sakuranetin (Freitas et al., 2008).

**Compound 13, NMR data:** 1HNMR (600 MHz, MeOD) δ: 8.00 (2H, d, J = 8.4 Hz, H-2', 6'), 7.58 (3H, m, H-3', 4', 5'), 6.50 1H, d, J = 1.8 Hz, H-8), 6.24 (1H, d, J = 1.8 Hz, H-6). These spectral data showed basically agreement with the reported literature of chrysin (Subramanian et al., 1972).

**Compound 14, NMR data:** 1HNMR (600 MHz, MeOD) δ: 7.30 (2H, d, J = 8.4 Hz, H-2, 6'), 6.82 (2H, d, J = 8.4Hz,
Figure 1. Structures of compounds 1–15.

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Compounds 15, NMR data: $^1$HNMR (600 MHz, CDCl$_3$) δ: 12.52 (1H, brs, 5-OH), 7.91 (2H, d, $J = 7.8$ Hz, H-2', 6'), 7.55 (3H, m, H-3', 4', 5'), 6.69 (1H, s, H-6), 6.45 (1H, s, H-3). These spectral data showed basically agreement with the reported literature of 5, 8-dihydroxy-7-methoxy-flavone (Prabir et al., 1992).

H-3', 5'), 5.84 (1H, d, $J = 2.4$ Hz, H-8), 5.83 (1H, d, $J = 2.4$ Hz, H-6), 5.32 (1H, dd, $J = 13.2, 3.6$ Hz, H-2), 3.15 (1H, dd, $J = 17.4, 13.2$ Hz, H-3a), 2.73 (1H, dd, $J = 17.4, 3.6$ Hz, H-3b). These spectral data showed basically agreement with the reported literature of naringenin (Wilcox et al., 1999).
Natural compounds obtained from the genus of *Pandanus* were mainly alkaloids, terpenoids, organic acids, and lignans according to the literature. Meanwhile, most studies have focused on the chemical constituents from the leaves and roots and few researches concerning the compositions of the fruits of genus *Pandanus* have been investigated. The 15 compounds were isolated from *P. tectorius* for the first time and have not been obtained from any other fruits belonging to genus *Pandanus*. Among these compounds, the content of trans-ethyl caffeate was the highest one in the fruits with approximately 0.1% of the dry material.

Most of these compounds possessed anti-oxidative activities and some anti-inflammatory activities corresponding to the activity of the fruits of *P. tectorius*. Chiang et al. (2005) studied the anti-inflammatory functions and mechanisms of ethyl caffeate, and they found that ethyl caffeate markedly suppressed the LPS-induced nitric oxide production and exerted an inhibitory effect on COX-2 transcriptional activity. Chrysin has been shown to induce an anti-inflammatory effect, most likely by inhibition of COX-2 expression and via IL-6 signaling (Woo et al., 2005). The biological activities of some isolated compounds were listed in Table 1.

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**REFERENCES**


REFERENCES

Table 1. Reported biological activities of some isolated compounds.

<table>
<thead>
<tr>
<th>Name of compounds</th>
<th>Activities (Reported)</th>
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<tbody>
<tr>
<td>Vanillin</td>
<td>Inhibition of tryrosinase (Gong et al., 2006); Anti-oxidant (Burri et al., 1989)</td>
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<tr>
<td>trans-ethyl caffeate</td>
<td>Anti-inflammatory (Chiang et al., 2005)</td>
</tr>
<tr>
<td>Tangeretin</td>
<td>Cholesterol-lowering activity (Kurowska et al., 2004); Anti-tumor (Chamontet et al., 1997)</td>
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<tr>
<td>Chrysin</td>
<td>Aromatase inhibitor (Van Meeuwen et al., 2007); Apoptotic effects (Khoo et al., 2010)</td>
</tr>
<tr>
<td>Naringenin</td>
<td>Antiviral (Nahmias et al., 2008); Cholesterol-lowering activity (Lee et al., 1999)</td>
</tr>
</tbody>
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