PRENYLATED ISOFLAVONES FROM DERRIS SCANDENS

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Abstract- 3′-Formylalpinumisoflavone (1), and 2-(1-hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone (2) were isolated from the stem of Derris scandens along with five known isoflavones. The two new compounds were characterised by extensive use of high resolution NMR spectroscopy. Senegalensin (3) was reported here for the first time in D. scandens

D. scandens (Leguminosae) stem has been widely used as Thai traditional medicine for relieving muscular pain and diuretic.1 Hypotensive,2 immunostimulating activities1 and smooth muscle stimulant3 were also evaluated. Investigations of the plant from various sources obtained numerous isoflavones.4-8 However, rotenoids were isolated from our earlier investigation of the chemical constituents of the Derris species.9

We recently examined D. scandens stem collected from Chantaburi Province, Thailand during 1997 and reported here two new prenylated isoflavone, 3′-formylalpinumisoflavone (1), 2-(1-hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone (2) along with revised chemical shifts senegalensin (3). Structures of the known compounds were principally deduced from NMR spectroscopic data and by comparison with those found in Lupinus albus roots11 and previous reports.7,8,10 They were identified as lupalbigenin,8 lupinisoflavone G,8 lupinisol A8 and 5,7,4′-trihydroxy-6,8-diprenylisoflavone.8
Formylalpinumisoflavone (1) was a colorless solid (mp 205-208°C) with molecular formula C_{21}H_{16}O_{6} determined by HREIMS (m/z = 364.0945). The $^1$H NMR spectrum revealed a characteristic singlet signal ($\delta$ 7.84, H-2) of isoflavone, 2,2-dimethylpyrano ring ($\delta$ 1.48, s, 6H, 2xMe; two olefinic protons at $\delta$ 5.64 d, $J = 10$ Hz and 6.73 d, $J = 10$ Hz) associated with a singlet H-8 at $\delta$ 6.36. Chemical shifts of H-2′ ($\delta$ 7.82, d, $J = 1.2$ Hz), H-6′($\delta$ 7.66, dd, $J = 8.8$, 1.2 Hz) and H-5′ ($\delta$ 7.08, d, $J = 8.8$ Hz) were deduced as three aromatic protons having m-, o/m- and o-coupling of B-ring. Moreover, the location of two hydroxy protons at C-5 and C-4′ which nearby carbonyl groups suggested magnetically anisotropic down field shifted signals at $\delta$ 12.97 and $\delta$ 11.10 respectively, indicating intramolecular hydrogen bondings in both cases. The IR spectrum displayed strong absorption at 1650 cm$^{-1}$ which indicated the presence of $\alpha,\beta$-unsaturated carbonyl group along with downward shifted absorption at 3200 cm$^{-1}$ due to the chelated hydroxy group. An intense MS ion at m/z 349 belongs to ion [M-15]$^+$ which was typically found in pyranoisoflavone due to loss of methyl group. The $^{13}$C NMR spectrum indicated the presence of 15 distinct carbon resonances of the isoflavone moiety ($\delta$ 95.0-161.6) including a carbonyl carbon (C-4) at $\delta$ 180.4. Carbon resonances of 2,2-dimethylpyrano ring were also apparent from olefinic $^{13}$C NMR signals ($\delta$ 115.3, C-1″ and $\delta$ 128.4, C-2″) associated with a quaternary carbon ($\delta$ 78.2, C-3″) and two methyl carbons ($\delta$ 28.3, C-4″, 5″). The location of the ring was assigned at C-6 and C-7 by HMBC experiment which revealed correlations of olefinic H-1″ ($\delta$ 6.73) with C-5 ($\delta$ 156.8), C-6 ($\delta$ 105.8) and C-7 ($\delta$ 159.8) (Figure 1). Olefinic and aromatic carbons of the isoflavone moiety contained a total of 14 resonances according to the HMQC and DEPT spectra. These were 5 tertiary carbons ($\delta$ 95.0, C-8; $\delta$ 118.1, C-5′, $\delta$ 137.2, C-6′; $\delta$ 134.2, C-2′ $\delta$ 152.6, C-2 and 9 quaternary carbons ($\delta$ 122.2, C-1′; $\delta$ 107.5, C-4a; $\delta$ 156.8, C-5; $\delta$ 105.8, C-6; $\delta$ 159.8, C-7; 157.2, C-8a; 122.6, C-3; $\delta$ 120.5, C-3′; $\delta$ 161.6, C-4′). The placement of the formyl group at C-3′ was confirmed by the HMBC spectrum, in which the formyl proton H-1″($\delta$ 9.96) showed long range correlation with C-2′ ($\delta$ 134.2) and C-4′ ($\delta$ 161.6) in agreement with correlation
of H-2’ (δ 7.82) with intense signal of the formyl carbonyl C-1”’ (δ 196.5) (Figure 1). Therefore, the structure of 1 was deduced as 3′-formylalpinumisoflavone.

\[ \text{(1)} \]

\[ \text{(2)} \]

\[ \text{(3)} \]

2-(1-Hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone (2) was found as colorless gum and showed the location of 2,2-dimethylpyranoisoflavone moiety in \(^1\)H NMR, \(^{13}\)C NMR, DEPT and HMQC spectra like those of compound (1) thus, only B-ring substitution remain to be established. Three aromatic protons of the B-ring assembled the same pattern \( m-, o/m \) and \( o \)-coupling as compound (1) with coupling constants 8.3 (\( \text{ortho} \)) and 1.9 (\( \text{meta} \)) Hz in \(^1\)H NMR spectrum. Chemical shifts of H-1”’ (δ 5.42, br d, \( J = 4.6 \) Hz), H-2”’ (δ 4.34, d, \( J = 4.8 \) Hz), HO-1”’ (δ 2.50, br s) and H-4”’ ,5”’ (δ 1.31, 1.37, s, 6H) were deduced as dihydrofuran ring with 2-(1-hydroxy-1-methylethyl) and 3-hydroxy substituted groups. The position of H-1”’ and H-2”’ signals were confirmed from the COSY spectrum in which they demonstrated vicinal couplings of the H-1”’ to both H-2”’ and HO-1”’ protons along with 3-bonds correlation of H-1”’ with C-3”’ carbon in HMBC spectrum. As evidenced from the 3-bond correlation between aromatic H-2’ (δ 7.54) proton of the B-ring and the C-1”’ (δ 73.4) of dihydrofuran ring indicated the location of the dihydrofuran ring at 3’ and 4’ positions of the B-ring (Figure 1).

\[ \text{Senegalensin (3)} \]

showed most of the \(^1\)H and \(^{13}\)C signals very similar to previous report. \(^{13}\) Careful examination of the COSY, HMQC and HMBC spectra led to some revision of the assignments as showed in the EXPERIMENTAL.
EXPERIMENTAL

**General**: Mps were uncorrected. Analytical thin-layer separation was carried out on Merck pre-coated silica gel plates (F-254; layer thickness 0.25 mm). Silica gel 60, particle size (0.063-0.260 mm) and less than 0.063 mm were used in column chromatography. UV spectra were taken on a JASCO Uvidex-650 spectrophotometer. IR spectra were recorded on a JASCO FT-IR 700 spectrophotometer. $^1$H and $^{13}$C NMR spectra were recorded on a Bruker Avance 400 spectrometer at 400 or 100 MHz. EIMS, HREIMS and HRFABMS spectra were determined on a Finnigan MAT 8200 mass spectrometer.

**Plant material**: The white stems of *D. scandens* were collected from Chantaburi Province, Thailand during summer of 1997, the plant was identified by comparison with the herbarium specimen kept at the Forest Herbarium, Royal Forest Department, Bangkok, Thailand. A voucher specimen (MCDS/1997) is kept at the Department of Chemistry, Faculty of Science, Ramkhamhaeng University.

**Extraction and Isolation**: Dried and pulverized white stems (1.6 kg) were extracted successively with n-hexane, CHCl$_3$ and MeOH at refluxing temperature in a Soxhlet extractor (5 days each). After evaporation of the solvents under reduced pressure, the n-hexane (42 g), CHCl$_3$ (35 g) and MeOH (40 g) extracts were obtained. The extracts were each chromatographed on silica gel column eluting with a gradient of n-hexane, CHCl$_3$ and finally MeOH giving combined 3′-formylalpinumisoflavone (1) (120 mg), 2-(1-hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone (2) (32 mg) and senegalensin (3) (56 mg).

**3′-Formylalpinumisoflavone (1)**: pale yellow solid, mp 205-208°C; IR (CHCl$_3$ solution) $\nu_{max}$: 3200 (chelated OH), 1654 (conjugated C=O), 1589, 1488, 1463, 1266 cm$^{-1}$; UV $\lambda_{max}$ (MeOH) [log $\varepsilon$]: 289 (2.2) nm; $^1$H NMR (CDCl$_3$, 400 MHz) $\delta$: 1.48 (6H, s, H-4″, 5″), 5.64 (1H, d, $J$=10 Hz, H-2″), 6.36 (1H, s, H-8), 6.73 (1H, d, $J$=10 Hz, H-1″), 7.08 (1H, d, $J$=8.8 Hz, H-5′), 7.66 (1H, dd, $J$=8.8, 1.2 Hz, H-6′), 7.82 (1H, d, $J$=1.2 Hz, H-2′), 7.84 (1H, s, H-2), 9.96 (1H, s, formyl H-1″′), 11.10 (1H, s, HO-4′) and 12.97 (1H, s, HO-5); $^{13}$C NMR (CDCl$_3$, 100 MHz): $\delta$: 28.3, 28.3 (C-4″, 5″), 78.2 (C-3″), 95.0 (C-8), 105.8 (C-6), 107.5 (C-4a), 115.3 (C-1″), 118.1 (C-5′), 122.2* (C-1′), 122.6* (C-3), 120.5 (C-3′), 128.4 (C-2″), 134.2 (C-2′), 137.2 (C-6′), 152.6 (C-2), 156.8 (C-5), 157.2 (C-8a), 159.8 (C-7), 161.6 (C-4′), 180.4 (C-4), 196.5 (C-1″′) *interchangable assignments; EIMS m/z (rel.int.) 364 [M]$^+$ (17), 349 [M-15]$^+$ (100), 350 (20), 321 (2), 203 (3), 174 (3), 61 (2.4); HREIMS m/z 364.0945 [M]$^+$ (calcd for C$_{21}$H$_{16}$O$_6$, 364.0947).

**2-(1-Hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone (2)** colorless gum; IR (CHCl$_3$ solution) $\nu_{max}$: 3574 (free OH), 2968, 2909, 1653 (conjugated C=O), 1616, 1583, 1494, 1456, 1249 cm$^{-1}$; UV $\lambda_{max}$ (CHCl$_3$) [log $\varepsilon$]: 285 (6.6) nm; $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$: 1.31, 1.37 (6H, s, H-4″, 5″), 1.47 (6H, s, H-4″, 5″), 2.50 (1H, br s, HO-1″′), 5.42 (1H, br d, $J$=4.6 Hz, H-1″′), 4.34 (1H, d,
\( J = 4.8 \text{ Hz}, \ H-2'' \), 5.63 (1H, d, \( J = 10 \text{ Hz}, \ H-2'' \)), 6.34 (1H, s, H-8), 6.72 (1H, d, \( J = 10 \text{ Hz}, \ H-1'' \)), 6.93 (1H, d, \( J = 8.3 \text{ Hz}, \ H-5' \)), 7.37 (1H, dd, \( J = 8.3, 1.9 \text{ Hz}, \ H-6' \)), 7.54 (1H, d, \( J = 1.9 \text{ Hz}, \ H-2' \)), 7.83 (1H, s, H-2), 13.08 (1H, s, HO-5); \( ^{13} \text{C NMR (CDCl}_3, 100 \text{ MHz}) \): \( \delta 24.5, 25.7 (\text{C-4}''', \text{5}''' \), 28.3, 28.3 (C-4''', 5'''), 71.3 (C-3'''), 73.4 (C-1'''), 94.9 (C-8), 97.3 (C-2'''), 105.5 (C-6), 105.6 (C-4a), 110.3 (C-5'), 115.4 (C-1''), 123.5* (C-3), 123.6* (C-1'), 126.1 (C-2'), 128.2 (C-2''), 129.1 (C-3'), 131.3 (C-6'), 152.6 (C-2), 156.0 (C-5), 156.8 (C-8a), 159.6 (C-7), 160 (C-4'), 180.8 (C-4) * * interchange assignments; EIMS \( m/z \) (rel.int.): 400 (8), 385 (27), 360 (17), 346 (21), 345 (100), 203 (25); HRFABMS \( m/z \): 437.1604 [M+H]+ (calcd for C\text{25}H\text{24}O\text{7}, 437.1600).

**Senegalesin (3):** yellow amorphous solid, IR (KBr) \( \nu \text{max} \): 3357 (free OH), 1651 (conjugated C=O), 1576, 1515, 1215 cm\(^{-1}\); UV \( \lambda \text{max} \) (MeOH) [log \( \varepsilon \)]: 273 (3.9 nm); \( ^{1} \text{H-NMR (CDCl}_3, 400 \text{ MHz}) \): \( \delta \) 1.21, 1.31 (6H, s, H-4''', 5'''), \( \delta \) 1.67, 1.77 (6H, s, H-4'''', 5''''), \( \delta \) 3.11, 3.25 (2H, dd, \( J_{\text{gem}} = 15.7, J_{\text{vic}} = 9.4, 7.8 \text{ Hz}, \ H-1'' \)), \( \delta \) 3.37 (2H, d, \( J = 6.9 \text{ Hz}, \ H-1''' \)), \( \delta \) 4.77 (1H, dd, \( J = 9.4, 7.8 \text{ Hz}, \ H-2'' \)), \( \delta \) 5.20 (1H, t-like, \( J = 6.9, \ H-2''' \)), \( \delta \) 6.83 (2H, d, \( J = 8.5 \text{ Hz}, \ H-3', 5' \)), \( \delta \) 7.38 (2H, d, \( J = 8.5 \text{ Hz}, \ H-2', 6' \)), \( \delta \) 7.84 (1H, s, H-2), \( \delta \) 12.95 (1H, s, HO-5); \( ^{13} \text{C NMR (CDCl}_3+\text{CD}_3\text{OD, 100 MHz}) \): \( \delta \) 17.7, 25.6 (C-4'''', 5''''), 21.9 (C-1'''), 24.2, 25.0 (C-4'', 5''), 27.0 (C-1''), 71.7 (C-3'''), 91.2 (C-2''), 102.5 (C-8), 106.7 (C-4a), 108.5 (C-6), 110.6 (C-3', 5'), 121.6 (C-2'''), 122.2 (C-1'), 123.8 (C-3), 130.5 (C-2', 6'), 132.3 (C-3''''), 152.5 (C-2), 153.4 (C-5), 154.0 (C-8a), 157.0 (C-4'), 164.2 (C-7), 181.1 (C-4); EIMS \( m/z \) (rel.int.): 422 [M]+ (100), 420 (35), 407 [M-Me]+ (21), 405 [M-OH]++ (24), 389 [M-H2O-Me]++ (34), 363 [M-59]++ (19), 349 (71), 335 (35); HRFABMS \( m/z \): 423.1808 [M+H]++ (calcd for C\text{25}H\text{27}O\text{6}, 423.1808).

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**REFERENCES**


