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# PRENYLATED ISOFLAVONES FROM *DERRIS SCANDENS*

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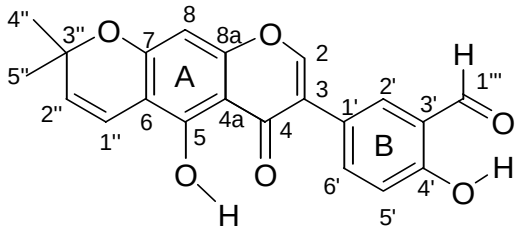
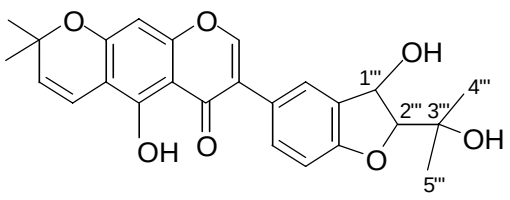
**Abstract**- 3′-Formylalpinumisoflavone **(1),** and 2-(1-hydroxy-1-methylethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone **(2)** were isolated from the stem of *Derris scandens* along with five known isoflavones. The two new compounds were characterised by extensive use of high resolution NMR spectroscopy. 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 activities[1] and smooth muscle stimulant[3] 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]

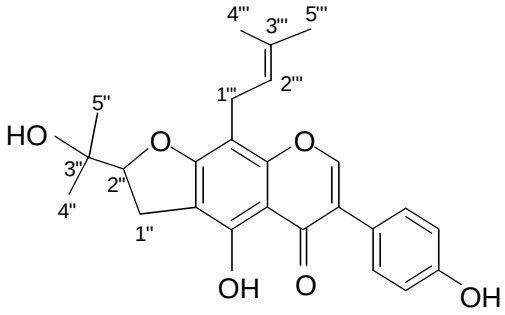
We recently examined *D. scandens* stem collected from Chantaburi Province, Thailand during 1997 and reported here two new prenylated isoflavone, 3′-formylalpinumisoflavone **(1)**, 2-(1-hydroxy-1-methyl-ethyl)-3-hydroxy-2,3-dihydrofuranoalpinumisoflavone **(2)** along with revised chemical shifts senegalensin **(3)**. Structures of the known compounds were principally deduced from NMR spectroscopic data and by comparison with those found in *Lupinus albus* roots[11] and previous reports.[7,8,10] They were identified as lupalbigenin,[8] lupinisoflavone G,[8] lupinisol A[8] and 5,7,4′-trihydroxy-6,8-diprenyliso-flavone.[8]




**(1)**




**(2)**




**(3)**

**3′-Formylalpinumisoflavone (1)** was a colorless solid (mp 205-208°C) with molecular formular $C_{21}H_{16}O_6$ determined by HREIMS (*m/z* = 364.0945). The $^1$H NMR spectrum revealed a characteristic singlet signal (δ 7.84, H-2) of isoflavone,[12] 2,2-dimethylpyrano ring (δ 1.48, s, 6H, 2xMe; two olefinic protons at δ 5.64 d, *J* = 10 Hz and 6.73 d, *J* = 10 Hz) associated with a singlet H-8 at δ 6.36. Chemical shifts of H-2′ (δ 7.82, d, *J* = 1.2 Hz), H-6′(δ 7.66, dd, *J* = 8.8, 1.2 Hz) and H-5′ (δ 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 δ 12.97 and δ 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 α,β-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.[10] The $^{13}$C NMR spectrum indicated the presence of 15 distinct carbon resonances of the isoflavone moiety (δ 95.0-161.6) including a carbonyl carbon (C-4) at δ 180.4. Carbon resonances of 2,2-dimethylpyrano ring were also apparent from olefinic $^{13}$C NMR signals (δ 115.3, C-1″ and δ 128.4, C-2″) associated with a quaternary carbon (δ 78.2, C-3″) and two methyl carbons (δ 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″ (δ 6.73) with C-5 (δ 156.8), C-6 (δ 105.8) and C-7 (δ 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 (δ 95.0, C-8; δ 118.1, C-5′, δ 137.2, C-6′; δ 134.2, C-2′ δ 152.6, C-2 and 9 quaternary carbons (δ 122.2, C-1′; δ 107.5, C-4a; δ 156.8, C-5; δ 105.8, C-6; δ 159.8, C-7; 157.2, C-8a; 122.6, C-3; δ 120.5, C-3′; δ 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‴(δ 9.96) showed long range correlation with C-2′ (δ 134.2) and C-4′ (δ 161.6) in agreement with correlation

of H-2′ (δ7.82) with intense signal of the formyl carbonyl C-1‴( δ 196.5) (Figure 1) . Therefore, the structure of **1** was deduced as 3′-formylalpinumisoflavone.

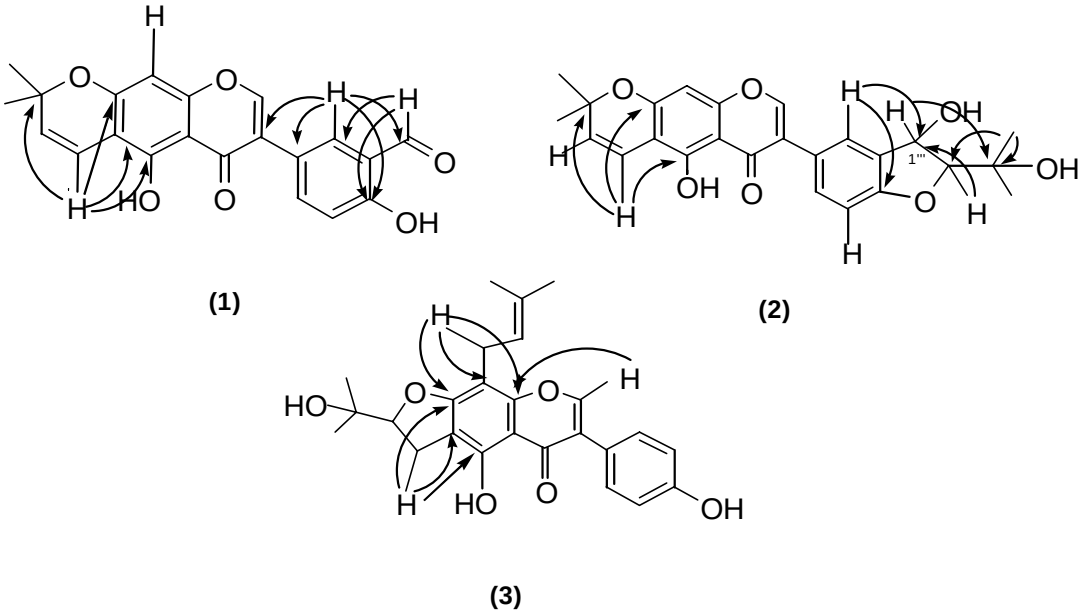



*Figure 1. Important H-C correlations observed in HMBC spectra of **(1)**, **(2)** and **(3)***

**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 (*ortho*) and 1.9 (*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).

**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$^{o}$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 ε] : 289 (2.2) nm; $^{1}H$ NMR ($CDCl_3$, 400 MHz) δ 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): δ 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 ε]: 285 (6.6) nm; $^{1}H$ NMR ($CDCl_3$, 400 MHz): δ 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 Hz, H-2‴), 5.63 (1H, d, *J*=10 Hz, H-2″), 6.34 (1H, s, H-8), 6.72 (1H, d, *J*=10 Hz, H-1″), 6.93 (1H, d, *J*=8.3 Hz, H-5′), 7.37 (1H, dd, *J*=8.3, 1.9 Hz, H-6′), 7.54 (1H, d, *J*=1.9 Hz, H-2′), 7.83 (1H, s, H-2), 13.08 (1H, s, HO-5); $^{13}$C NMR($CDCl_3$, 100 MHz): δ 24.5, 25.7 (C-4‴, 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) •, * interchangable 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 $C_{25}H_{24}O_7$, 437.1600).

**Senegalensin (3):** yellow amorphous solid, IR (KBr) $\nu_{max}$ : 3357 (free OH), 1651 (conjugated C=O), 1576, 1515, 1215 $cm^{-1}$; UV$\lambda_{max}$ (MeOH) [log ε]: 273 (3.9) nm; $^1$H-NMR ($CDCl_3$, 400 MHz): δ 1.21, 1.31 (6H, s, H-4″, 5″), δ 1.67, 1.77 (6H, s, H-4‴, 5‴), δ 3.11, 3.25 (2H, dd, $J_{gem}$=15.7, $J_{vic}$=9.4, 7.8 Hz, H-1″), δ 3.37 (2H, d, *J*=6.9 Hz, H-1‴), δ 4.77 (1H, dd, *J*=9.4, 7.8 Hz, H-2″), δ 5.20 (1H, t-like, *J*=6.9, H-2‴), δ 6.83 (2H, d, *J*=8.5 Hz, H-3′, 5′), δ 7.38 (2H, d, *J*=8.5 Hz, H-2′, 6′), δ 7.84 (1H, s, H-2), δ 12.95 (1H, s, HO-5); $^{13}$C NMR ($CDCl_3$+$CD_3OD$, 100 MHz): δ 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 $[M-H_2O-Me]^+$ (34), 363 $[M-59]^+$ (19), 349 (71), 335 (35); HRFABMS *m/z*: 423.1808 $[M+H]^+$ (calcd for $C_{25}H_{27}O_6$, 423.1808).

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