



Gossypidien, a lignan from stems of *Jatropha gossypifolia*¹

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Abstract

A new lignan, gossypidien, has been isolated from the stems of *Jatropha gossypifolia*. The structure of the compound was deduced from its spectral data, as well as from its synthesis. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: *Jatropha gossypifolia*; Euphorbiaceae; Stems; Lignan; Gossypidien

1. Introduction

Jatropha gossypifolia, a small shrub, grows wild in different parts of India (Sastri, 1959). This plant exhibits various important medicinal (Sastri, 1959; Das & Das, 1994) and pesticidal properties (Sastri, 1959; Chatterjee, Das, Adityachaudhury, & Debkirtaniya, 1980). Previous workers reported several diterpenoids (jatraphone (Kupchan et al., 1970; Kupchan, Sigel, Matz, Gilmore, & Bryan, 1976) and its analogues (Taylor et al., 1983), jatropholones A and B (Purushothaman et al., 1979) and jatrophatrione (Rahman, Ismail, & Yin, 1990)) and lignans (jatrophane (Chatterjee, Das, Pascard, & Prange, 1981), gadain (Banerji, Das, Chatterjee, & Schoolery, 1984) and their analogues (Chatterjee et al., 1988)) as its major constituents. We have recently isolated a new lignan, gossypidien (**1**) from the stems of this species. The structural elucidation and synthesis of the compound are reported here.

2. Results and discussion

Gossypidien was isolated as pale yellow crystals. Its mass spectrum showed the $[M]^+$ at m/z 410 in accordance with the molecular formula $C_{22}H_{18}O_8$. The molecule possesses no optical activity. The IR spectrum ($\nu_{\max}^{KBr}$, cm^{-1} : 1702, 1600 and 1489) indicated it to be an aromatic compound containing an α,β -unsaturated ester moiety. The 1H NMR spectrum showed the presence of two olefinic

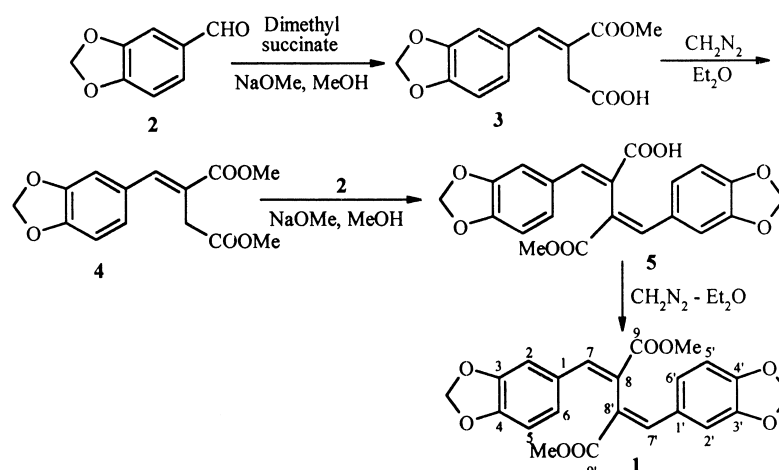
(δ 7.82, s, H-7 and H-7') and six aromatic protons (δ 7.07–6.99, m, H-2, H-5, H-6, H-2', H-5' and H-6'), along with two methylenedioxy (δ 5.98, 4H, s). The deshielded olefinic protons (H-7 and H-7') indicated (Chatterjee et al., 1981; Banerji et al., 1984) the *trans* (*E*) configuration for two double bonds at C-7, C-8 and C-7', C-8'. The ^{13}C NMR spectrum showed the signals for only 11 carbons present in the half portion of the molecule. These signals revealed the presence of six aromatic carbons, one tri-substituted double bond, one methylenedioxy and one carbomethoxyl group (vide Section 3). Structure **1** incorporates all the spectral features of the new lignan, gossypidien.

The structure of gossypidien (**1**) was settled unambiguously by synthesis starting from piperonal (**2**) (Scheme). Stobbe condensation of **2** with dimethylsuccinate in the presence of sodium methoxide in methanol, afforded compound **3**. Its 1H NMR spectrum showed the presence of a deshielded vinylic proton at δ 7.72 indicating (Chatterjee et al., 1981; Banerji et al., 1984) the *trans* (*E*) configuration of the olefinic double bond. Compound **3** was methylated with diazomethane to form the diester **4**. A second Stobbe condensation of **4** with piperonal produced compound **5**. The *trans* (*E*) configuration of both the olefinic double bonds present in **5** was evident (Chatterjee et al., 1981; Banerji et al., 1984) from the appearance of two deshielded vinylic protons at δ 7.81 and 7.79 in its 1H NMR spectrum. Compound **5** was finally methylated to form a diester, which was found to be identical to the naturally occurring gossypidien (**1**) in all its physical and spectral (IR, 1H NMR and mass spectrum) properties.

Gossypidien (**1**) is the second compound representing an intermediate in the biosynthetic scheme for the formation of lignans of Blears & Haworth (1985). The first

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Scheme 1. Synthesis of gossypidien (1).

compound, jatrodien (Das, Rao, Srinivas, & Das, 1996), was also reported from the same species, *J. gossypifolia*. These two compounds possibly act as intermediates for the biosynthetic formation of the lignan constituents of the plant.

3. Experimental

3.1. General

Mps uncorr. CC: silica gel (BDH, 100–200 mesh). TLC: silica gel G. TLC spots visualized by exposure of plates to I_2 vapor.

3.2. Plant material

Stems of *J. gossypifolia* L. were collected from West Bengal, India, in August, 1997, and identified botanically. A voucher specimen (No. JG-St) is preserved in our laboratory. Another voucher specimen (JG-St) is preserved in IICT herbarium.

3.3. Extraction and isolation

Air-dried stems (1 kg) were powdered and extracted with hexane in a Soxhlet apparatus for 120 h. The extract was filtered and concd by rotary evapn. The thick brown residue obtained was chromatographed over silica gel and the column eluted with solvents of increasing polarity using hexane and EtOAc. The frs eluted with hexane–EtOAc (2:3) were mixed, concd and rechromatographed. Early frs from hexane–EtOAc (2:3) afforded a solid which was recrystallized from EtOH to produce gossypidien (1), as pale yellow crystals, 31 mg, mp 180–181°. $[\alpha]_D^{25} \pm 0^\circ$ (MeOH, c 0.7816). ^{13}C NMR (50 MHz, $CDCl_3$): δ 167.5 (C-9 and C-9'), 142.4 (C-7 and C-7'), 149.0 (C-4 and C-4'), 147.9 (C-3 and C-3'), 128.8 (C-1 and C-1'), 125.7 (C-6 and C-6'), 124.9 (C-8 and C-8'), 108.7 (C-5 and C-5'),

108.4 (C-2 and C-2'), 102.0 ($2 \times -OCH_2O-$), 53.0 ($2 \times -COOMe$). MS m/z (rel. int.): 410 $[M]^+$ (42), 350 (14), 319 (33), 292 (15), 257 (40), 149 (98), 135 (100).

3.4. Synthesis of gossypidien (1)

3.4.1. Stobbe condensation of piperonal with dimethylsuccinate

Piperonal (1 g) and dimethylsuccinate (10 ml, d:1.4 g ml^{-1}) were added to a soln of NaOMe (0.5 g) in MeOH (50 ml). The reaction mixt. was refluxed for 2 h, cooled and acidified with HCl (1 N). The mixt. was extracted with Et_2O (3×50 ml). The Et_2O fr. was reextracted with aq. $NaHCO_3$ soln (3×50 ml). Acidification of the aq. $NaHCO_3$ extract with conc. HCl (12 N) produced an oily layer which was again extracted with CH_2Cl_2 (3×50 ml). The extract was washed with H_2O (3×50 ml), dried and concd to produce a yellow solid, which was recrystallized from EtOH to produce the compound 3, 655 mg. Mp 142–143°, IR $\nu_{max}^{KBr} cm^{-1}$: 3400, 1705, 1619, 1502. 1H NMR (200 MHz, $CDCl_3$): δ 7.72 (1H, s, vinylic-H), 6.97–6.75 (3H, m, Ar-H), 6.04 (2H, s, $-OCH_2O-$), 3.86 (3H, s, $-COOMe$), 3.59 (2H, s, $-CH_2-COOH$). MS m/z (rel. int.): 264 (45), 220 (48), 189 (8), 165 (9), 160 (100).

3.4.2. Methylation of 3 with diazomethane

A soln 3 (500 mg) in MeOH (10 ml) was added to an ice-cold soln of CH_2N_2 – Et_2O . The mixt. was kept for 12 h, filtered and then concd. The residue was recrystallized from EtOH to yield the diester 4, 450 mg. Mp 84–85°. IR $\nu_{max}^{KBr} cm^{-1}$: 1702X, 1654, 1508. 1H NMR (200 MHz, $CDCl_3$): δ 7.75 (1H, s, vinylic-H), 7.90–6.66 (3H, m, Ar-H), 5.96 (2H, s, $-OCH_2O-$), 3.76 and 3.70 (3H each, s, $2 \times -COOMe$), 3.46 (2H, s, $-CH_2-COOMe$). MS m/z (rel. int.): 278 (38), 218 (10), 189 (22), 165 (20), 105 (100).

3.4.3. Stobbe condensation of 4 with piperonal

Compound 4 (400 mg) underwent Stobbe condensation (following the above mentioned procedure)

with piperonal (350 mg) to produce a solid which was recrystallized from EtOH to yield **5** as light-yellow crystals, mp 106–107°. IR $\nu_{\text{max}}^{\text{KBr}}$ cm^{-1} : 3448, 1700, 1673, 1619. ^1H NMR (200 MHz, CDCl_3): δ 7.81 and 7.79 (1H each, s, $2 \times$ vinylic-H), 7.05–6.96 (3H, m, Ar-H), 6.80–6.67 (3H, m, Ar-H), 5.94 (4H, s, $2 \times -\text{OCH}_2\text{O}-$), 3.73 (3H, s, $-\text{COOMe}$). MS m/z (rel. int.): 396 (12), 364 (100), 292 (65), 243 (50), 165 (95).

4.3.5. Methylation of **5** with CH_2N_2

Compound **5** (200 mg) in Et_2O (20 ml) was methylated with CH_2N_2 – Et_2O (following the above mentioned procedure) and the resulting solid was recrystallized from EtOH to obtain a product as light-yellow crystals, 187 mg, mp 179–180°, which was found to be identical to the naturally occurring gossypidien (**1**) in all respects (R_f , IR, ^1H NMR and MS).

Acknowledgements

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