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MINOR XANTHONES OF *GARCINIA MANGOSTANA*

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Key Word Index—*Garcinia mangostana*; Guttiferae; xanthones; 1,5-dihydroxy-2-(3-methylbut-2-enyl)-3-methoxyxanthone; 1,7-dihydroxy-2-(3-methylbut-2-enyl)-3-methoxyxanthone

Abstract—Two new trioxygenated xanthones with a 3,3-dimethyl allyl side chain have been isolated from the fruit hulls of *Garcinia mangostana*. The structures were established from spectral and chemical data.

INTRODUCTION

In the course of our studies on minor xanthones of *Garcinia mangostana* the isolation of a new 1,3,6,7-tetra oxygenated xanthone (**1**) has already been reported [1]. In the present paper we report the isolation and characterization of two new 1,3,5- and 1,3,7-trioxygenated xanthones which are possibly the biogenetic precursors of 1,3,6,7- and 1,3,5,8-tetraoxygenated xanthones reported earlier [1–5] from the fruit hulls of the same species. The co-occurrence of 1,3,5- and 1,3,7-trioxygenated xanthones in the same fruit hull source suggests [6] that these xanthones are derived from the same benzophenone precursor **2** by oxidative cyclization at two alternative positions.

RESULTS AND DISCUSSION

Petrol extraction of the dried and powdered fruit hulls followed by column chromatographic separation afforded two new xanthones in addition to the xanthones reported [1] earlier. The minor xanthone **3a**, $C_{19}H_{18}O_5$ (M^+ 326) showed UV and IR spectra characteristic of 1,3,5-trioxygenated xanthones [7]. The ^{1}H NMR spectrum of the compound in DMSO-d_6 gave a signal at δ 13.1 (1H, *s*) for the C-1 OH and signals at δ 5.2 (1H, *t*), 3.3–3.6 (2H, *d*), 1.76 (3H, *s*) and 1.66 (3H, *s*) confirming the presence of an isopentenyl side chain at a position other than *ortho* to the xanthone carbonyl. Moreover, the NMR splitting pattern of the aromatic proton signals resembled those of 1,2,3,5-tetrasubstituted xanthones [7, 8] having a downfield quartet at δ 7.65 (H-8) and a multiplet at δ 7.35 (H-6 and H-7) indicating an ABX system. The one proton singlet at δ 6.74 (H-4) and the upfield shift of the last signal in comparison with the chemical shift of the same proton of the C-3 unoxygenated xanthones suggests the presence of OMe substitution at C-3 if not OH in **3a**. A positive Gibbs' test and the absence of a NaOAc induced shift in the UV also support the above OMe substitution. In the mass spectra the presence of two characteristic peaks, in addition to the M^+, arising from the loss of 43 and 55 amu from the M^+ strongly suggested [9] the presence of C-1 OH and C-3 OMe groups, both *ortho* to the C-2 isopentenyl side chain. Furthermore, the mono-*O*-Me ether **3b** and the di-*O*-Me ether **3c** of the xanthone **3a** were found to be identical (IR, UV and MS) with the mono-*O*-Me and di-*O*-Me ether of 1,3-dihydroxy-2-(3-methylbut-2-enyl)-5-methoxyxanthone [7, 10]. Whereas the cyclodehydrogenation of the xanthone **3a** by DDQ followed by methylation afforded **5** this was different from 5-*O*-Me-6-desoxyjacareubin [11], but identical with the cyclodehydrogenation product of **3b**, finally confirming the structure **3a** for the xanthone.

IR and UV spectra of the second minor xanthone **4a**, $C_{19}H_{18}O_5$ (M^+ 326) clearly indicated it to be a 1,3,7-trioxygenated xanthone [12] whereas the mass spectra showed a close similarity to the xanthone **3a** suggesting the xanthone **4a**, also a dihydroxy-monomethoxy-monoisopentenyl substituted xanthone where one methoxyl and one hydroxyl is *ortho* to the isopentenyl side chain. Moreover, the ^{1}H NMR spectra of the compound in DMSO-d_6 suggested that both **4a** and **3a** have a similar substitution pattern in ring B of the xanthone nucleus. The NMR splitting pattern of the downfield aromatic protons, which clearly differs from **3a**, showed a complex 3 proton multiplet at δ 7.3–7.6 indicating a typical ABC system [13] suggesting the position of the OH substituent at C-6 or C-7. Whereas in the ^{1}H NMR spectra of the diacetate of **3a** the 3 proton multiplet of this downfield aromatic region had been resolved to a one proton broad singlet at δ 7.95 (H-8), a two proton multiplet at δ 7.42 (H-5 and H-6) confirmed the presence of the C-7 OH. This assignment is also supported by the absence of a fused NaOAc shift in the UV spectrum. The structure **4a** was finally confirmed by direct comparison of its mono-*O*-Me ether **4b** with 1-hydroxy-3,7-dimethoxy-2-(3-methylbut-2-enyl) xanthone [6].

EXPERIMENTAL

Mps are uncorr. UV spectra were in EtOH and MeOH soln. IR spectra were determined in nujol, MS were recorded at 70 eV, ^{1}H NMR spectra were taken at 90 MHz in $CDCl_3$/DMSO-d_6 and chemical shifts are given in δ (ppm) scale relative to TMS. ^{13}C NMR measurements were made with a Fourier transform

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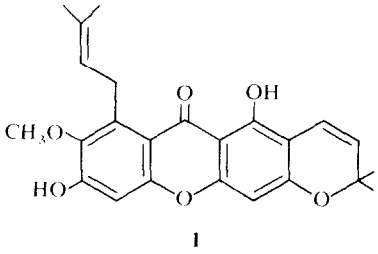

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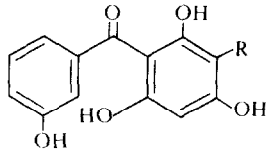

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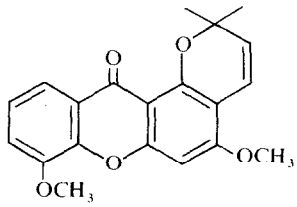

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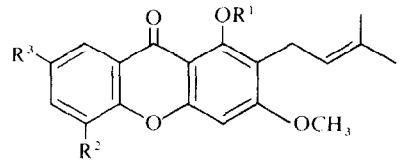

	R^1	R^2	R^3
3a	H	OH	H
3b	H	OCH_3	H
3c	CH_3	OCH_3	H
4a	H	H	OH
4b	H	H	OCH_3
4c	CH_3	H	OCH_3

accessory and signal multiplicity was determined by off resonance decoupling after proton noise decoupling. The solvent D_2O provided the lock signal, chemical shifts are given in δ (ppm) scale relative to the TMS ^{13}C signal. Chemical shifts are accurate to within ± 0.02 ppm. The xanthones after TLC were detected both by I_2 and Dragendorff's reagent.

Plant material. Fully ripe fruits of *G. mangostana* L. were collected in Madras (India) in July 1978.

Isolation. Hulls of 200 fruits were dried, powdered (2 kg) and extracted with petrol (bp 60–80°) for 48 hr. On concentration of the extract and after TLC (Si gel) the presence of a few more yellow coloured pigments in addition to the earlier reported mangostin and gartanin was observed. The crude extract (6 g) was chromatographed over Si gel (400 g). Fractions eluted with petrol–C_6H_6 (4:1), petrol–C_6H_6 (1:1) and with C_6H_6 were rechromatographed and further purified by prep. TLC to yield xanthone **1** (125 mg), xanthone **3a** (60 mg) along with xanthone **4a** (25 mg) and mangostin (2 g) from the above 3 fractions, respectively.

Xanthone **1**. Recrystallization from C_6H_6 as bright yellow fine crystals (100 mg), mp 152–154°; UV λ_{max}^{MeOH} nm (log ε) 238 (3.95), 286 (4.51), 333 (4.11), 357 (4.16); $\lambda_{max}^{MeOH-NaOAc}$ nm (log ε) 238 (4.27), 274 (4.54), 300 (4.32), 360 (4.49); IR ν_{max}^{nujol} cm^{-1} 3500 (OH), 1650 (γ-pyrone C=O); MS *m/e* (rel. int.): 408 (M^+, 40), 393 ($M^+ - 15$), 365 ($M^+ - 43$, 30%); ^1H NMR (80 MHz, $CDCl_3$): δ 13.55 (1H, *s*), 6.73 (1H, *s*), 6.64 (1H, *d*, $J = 10$ Hz), 6.27 (1H, *s*), 6.15 (1H, *s*), 5.47 (1H, *d*, $J = 10$ Hz), 5.18 (1H, *t*, $J = 6.5$ Hz), 4.01 (2H, *d*, $J = 6.5$ Hz), 3.73 (3H, *s*), 1.76 (3H, *s*), 1.62 (3H, *s*), 1.4 (6H, *s*); ^{13}C NMR (15.1 MHz, $CDCl_3$); δ 18.1 (C-4'), 25.6 (C-3 $\underline{C}H_3$), 26.5 (C-1'), 28.3 (C-2 $\underline{C}H_3$), 61.8 (C-8 O$\underline{C}H_3$), 77.8 (C-2), 94.0 (C-12), 101.6 (C-10), 103.6 (C-5a), 104.4 (C-4a), 112.1 (C-6a), 115.6 (C-4), 123.1 (C-2'), 126.9 (C-3), 131.8 (C-3'), 136.9 (C-7), 142.7 (C-8), 154.5 (C-9), 155.6 (C-10a), 156.1 (C-11a), 157.8 (C-5), 159.8 (C-12a), 181.8 (C-6). (Found: C, 71.0; H, 5.6%. $C_{24}H_{24}O_6$ requires: C, 70.6; H, 5.9%). The diacetate crystallized from MeOH as white microcrystals, mp 171–172°; MS *m/e* (rel. int.): 492 (M^+, 20), 450 ($M^+ - 42$, 30), 408 ($M^+ - 2 \times 42$, 10).

Xanthone **3a**. The solid from prep. TLC on recrystallization from MeOH afforded yellow flakes (60 mg), mp 242–244°, UV λ_{max}^{EtOH} nm (log ε), 245 (4.53), 256 (4.48), 313 (4.21), 375 sh (3.51); IR ν_{max}^{nujol} cm^{-1}: 3350 (chelated OH), 1650 (γ-pyrone C=O); MS *m/e* (rel. int.): 326 (M^+, 27), 311 ($M^+ - 15$, 25), 283 ($M^+ - 43$, 63), 271 ($M^+ - 55$, 100); ^1H NMR (90 MHz, DMSO-d_6): 13.10 (1H, *s*), 7.65 (1H, *q*), 7.35 (2H, *m*), 6.75 (1H, *s*), 5.2 (1H, *t*, $J = 6.5$ Hz), 3.99 (3H, *s*), 3.2–3.6 (2H, masked by H_2O–DMSO signals), 1.76 (3H, *s*), and 1.66 (3H, *s*). (Found: C, 70.1; H, 5.8%. $C_{19}H_{18}O_5$ requires: C, 69.9; H, 5.5%). The diacetate prepared in the usual way was crystallized from petrol–C_6H_6 as white needles, mp 153–154°, MS *m/e* (rel. int.): 410 (M^+, 25), 368 ($M^+ - 42$, 50), 326 ($M^+ - 2 \times 42$, 15).

Mono-O-Me *ether of* **3a**. Xanthone **3a** (10 mg) on methylation with CH_2N_2–Et_2O afforded **3b** as yellow plates from MeOH, mp 168–169° (lit. [7], mp 172–173°); MS *m/e* (rel. int.): 340 (M^+, 40).

Di-O-Me *ether of* **3a**. Xanthone **3a** (10 mg) on methylation with K_2CO_3/MeI in Me_2CO afforded **3c** as white fine needles from EtOH, mp 158–159° (lit. [7], mp 162–163°); MS *m/e* (rel. int.) 354 (M^+, 60) and was found to be identical with 1,3,5-trimethoxy-2-(methylbut-2-enyl) xanthone by mmp, co-TLC and superimposable IR.

Cyclodehydrogenation of **3b** *and* **3a**. Xanthone **3b** (20 mg) in C_6H_6 (10 ml) was refluxed with DDQ (10 mg) for 3 hr. The reaction mixture was filtered hot and the filtrate after evaporation and chromatographic purification afforded **5** as fine yellow crystals from C_6H_6 (16 mg), mp 226–228° (dec.), MS *m/e* (rel. int.) 338 (M^+, 100), 323 ($M^+ - 15$, 68), 307 (28) and 297 (30%). Following the same method as above the xanthone **3a** (10 mg) was cyclodehydrogeneated by DDQ in C_6H_6 and on methylation afforded fine yellow needles from petrol–C_6H_6, mp 224–227° (dec.), identical with **5** mmp, superimposable IR.

Xanthone **4a**. On prep. TLC after purification from **3a** followed by recrystallization from C_6H_6–MeOH, yellow fluffy crystals (25 mg), mp 220–222°C. UV λ_{max}^{EtOH} nm (log ε) 240 (4.10), 265 (4.32), 309 (4.15) and 378 (3.90); IR ν_{max}^{nujol} cm^{-1}: 3250 (chelated OH), 1642 (γ-pyrone C=O); MS *m/e* (rel. int.) 326 (M^+, 20), 311 ($M^+ - 15$, 18), 283 ($M^+ - 43$, 50), 271 ($M^+ - 55$, 100), 258 (6), 241 (7%); ^1H NMR (90 MHz, DMSO-d_6): 13.14 (1H, *s*), 7.3–7.6 (3H, *m*), 6.7 (1H, *s*), 5.16 (1H, *t*, $J = 6.5$ Hz), 3.91 (3H, *s*), 3.2–3.4 (2H, masked by H_2O–DMSO signals), 1.73 (3H, *s*), 1.63 (3H, *s*). (Found: C, 70.19; H, 5.77%. $C_{19}H_{18}O_5$ requires: C, 69.9; H,

5.5%). The diacetate prepared in the usual way was crystallized from MeOH as white flakes, mp 171–172°, MS *m/e* (rel. int.): 410 (M^+, 40), 368 ($M^+ - 42$, 70), 326 ($M^+ - 2 \times 42$, 45); ^1H NMR (90 MHz, $CDCl_3$): 7.95 (1H, *br. s*), 7.42 (2H, *m*), 6.80 (1H, *s*), 5.15 (1H, *t*, $J \sim 6$ Hz), 3.96 (3H, *s*), 3.30 (2H, *d*, $J \sim 6$ Hz), 2.5 (3H, *s*), 2.30 (3H, *s*), 1.73 (3H, *s*), 1.55 (3H, *s*).

Mono-O-Me *ether of* **4a**. Xanthone **4a** (10 mg) on methylation with CH_2N_2–Et_2O afforded **4b** as yellow needles from petrol, mp 143–144° (lit. [6], mp 140°); MS *m/e* (rel. int.): 340 (M^+, 45), identical with 1-hydroxy-3,7-dimethoxy-2-(3-methylbut-2-enyl) xanthone (mmp, co-TLC, and superimposable IR).

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