Pertanika J. Sci. & Technol. 15(1): 77 - 83 (2007)
ISSN: 0128-7680
© Universiti Putra Malaysia Press

Xanthones and Xanthone Derivatives from *Garcinia nitida*

G. C. L. Ee*, C. K. Lim, Y. H. Taufiq-Yap, M. A. Sukari & M. Rahmani
Department of Chemistry, Faculty of Science,
Universiti Putra Malaysia, 43400, UPM,
Serdang, Selangor, Malaysia

Received: 27 February 2006

ABSTRAK

Satu kajian kimia terperinci ke atas kulit kayu *Garcinia nitida* telah menghasilkan lima xanton dan dua triterpenoid. Sebatian-sebatian ini adalah 1,3,7-trihidroksi-2,4-*bis*(3-metilbut-2-enil)xanthone; (**1**) osajaxanthone, (**2**) inophyllin B (**3**) 3-isomangostin, (**4**) rubraxanthone, (**5**) stigmasterol and stigmasterol acetate. Struktur sebatian-sebatian ini telah dikenalpasti dengan menggunakan spektroskopi RMN 1D and 2D. Tindak balas pengasitilan rubraxanthone telah menghasilkan dua sebatian baru rubraxanthone monoasitat (**6**) dan rubraxanthone diasitat (**7**) dan juga rubraxanthone triasitat (**8**).

ABSTRACT

A detailed chemical study on the stem bark extracts of *Garcinia nitida* has led to the isolation of five xanthones and two triterpenoids. They are 1,3,7-trihydroxy-2,4-*bis*(3-methylbut-2-enyl)xanthone (**1**) osajaxanthone, (**2**) inophyllin B, (**3**) 3-isomangostin, (**4**) rubraxanthone, (**5**) stigmasterol and stigmasterol acetate. The structures of these compounds were established using mainly 1D and 2D NMR spectroscopy. Acetylation of rubraxanthone resulted in two new compounds, rubraxanthone monoacetate (**6**) and rubraxanthone diacetate (**7**), along with rubraxanthone triacetate (**8**).

Keywords: Garcinia nitida, guttiferae, xanthones, triterpenoids

INTRODUCTION

Garcinia species are widely distributed in Malaysia. Plants from this genus are known to have plenty of uses. Many species yield products that are useful to the native populations, while some have special economic importance (Heywood, 1982). The fruit of many species like *Garcinia mangostana, Garcinia xanthochymus* and *Garcinia multiflora* are edible and have a pleasant flavour. Some species like *Garcinia picrorrhiza* are used as medicament in curing diseases due to their medicinal properties (Burkill, 1966). Plants from the genus *Garcinia* have been reported to be rich in xanthones and triterpenoids (Peres *et al.*, 2000; Nguyen and Harrison, 2000; Vieira *et al.*, 2004; Rukachaisirikul *et al.*, 2000; Merza *et al.*, 2004; Kosela *et al.*, 2000). In our continuing interest on the Malaysian *Garcinia* plants, we carried out detail chemical studies on the stem bark of *Garcinia nitida* which was collected from Sri Aman, Sarawak, Malaysia. This study has led to the isolation and identification of five xanthones and two triterpenoids from the stem bark extracts of the species and the identification of three rubraxanthone derivatives from the acetylation of rubraxanthone. This paper reports the isolation and characterization of these compounds.

* Corresponding Author:
E-mail: *gwen@fsas.upm.edu.my*

MATERIALS AND METHODS

Plant Material – The stem bark of *Garcinia nitida* was collected from Sri Aman Sarawak, Malaysia. The plant materials were identified by Miss Runi Sylvester from the Herbarium of Sarawak Forestry Department, Kuching, Sarawak, Malaysia.

General – Infrared spectra were measured in KBr/NaCl pellet on a Perkin-Elmer FTIR Spectrum BX spectrometer. EIMS were recorded on a Shimadzu GCMS-QP5050A spectrometer. NMR spectra were obtained using a Unity INOVA 500MHz NMR/ JEOL 400MHz FT NMR spectrometer using tetramethylsilane (TMS) as the internal standard. Ultra violet spectra were recorded in $CHCl_3$ on a Shimadzu UV-160A, UV-Visible Recording Spectrophotometer.

Extraction and Isolation – The air-dried and powdered stem bark of *Garcinia nitida* (2.0 kg) was extracted successively with hexane, chloroform and acetone at the room temperature. The extracts were evaporated to dryness under a reduced pressure to yield 102.0 g of crude hexane extract, 101.5 g of crude chloroform extract and 85.3 g of crude acetone extract. The crude hexane extract (20.0 g) was chromatographed on a silica gel column using a stepwise gradient system (hexane/$CHCl_3$, $CHCl_3$/Me_2CO and Me_2CO/MeOH) to give 25 fractions (*Frs.*). The *Frs. 2-4* were combined and separated over a silica gel column (hexane/$CHCl_3$ and $CHCl_3$/Me_2CO gradient) to give stigmasterol acetate (8 mg). *Frs. 8-10* were combined and subjected to column chromatography (CC) (SiO_2; hexane/$CHCl_3$ and $CHCl_3$/Me_2CO gradient) to yield stigmasterol (10 mg). *Fr. 11* was purified by repeated CC (SiO_2; hexane/EtOAc and $CHCl_3$/Me_2CO gradient) to give inophyllin B (**3**) (8 mg). The crude chloroform extract (20.0 g) was fractionated by vacuum CC (SiO_2; hexane-EtOAc and $CHCl_3$-Me_2CO gradient) to give 15 fractions. *Frs. 2-3* were combined and purified by CC (SiO_2; hexane/EtOAc and $CHCl_3$/Me_2CO gradient) to furnish the 5 subfractions. Subfractions 1-3 were combined and further purified by CC (SiO_2; hexane/EtOAc and $CHCl_3$/Me_2CO gradient) and finally by CC (*Sephadex LH-20*; MeOH) to yield 1,3,7-trihydroxy-2,4-*bis*(3-methylbut-2-enyl)xanthone (**1**) (9 mg) and osajaxanthone (8 mg) (**2**). On the other hand, fractionation of the crude acetone extract (20.0 g) over a silica gel column (hexane-$CHCl_3$, $CHCl_3$-EtOAc and EtOAc-MeOH gradient) provided 25 fractions. *Frs. 11* afforded rubraxanthone (**5**) (230 mg) and *Fr. 8* was rechromatographed on a silica gel column (hexane-$CHCl_3$, $CHCl_3$-EtOAc and EtOAc-MeOH gradient) to give 20 subfractions. Subfraction 9 yielded 3-isomangostin (**4**) (10 mg).

Acetylation of rubraxanthone (5) – A solution of rubraxanthone (100 mg) in pyridine (15 ml) was added to 15 ml of acetic anhydride (Ac_2O). The mixture was heated at 80°C for 2 hours and poured into ice water and left in the refrigerator overnight. The precipitate formed was filtered, washed with water and dried. The precipitate was then purified by column chromatography to yield rubraxanthone monoacetate (**6**) (8 mg), rubraxanthone diacetate (**7**) (20 mg) and rubraxanthone triacetate (**8**) (10 mg).

1,3,7-Trihydroxy-2,4-bis(3-methylbut-2-enyl)xanthone (1) – Yellow needles, mp 128-129°C. UV (EtOH) λ_{max} nm (log e): 217.5 (0.85), 234.0 (1.14), 270.0 (1.23), 285.0 (1.07), 386.5 (0.23). IR ν_{max} cm^{-1} (KBr): 3378, 1644, 1480, 1230. EI-MS m/z (rel. int.): 380 (39), 363 (34), 337 (22), 325 (31), 309 (68), 295 (18), 281 (62), 269 (100), 257 (9), 41 (11). ^1H NMR and ^{13}C NMR (see text).

Osajaxanthone (2) – Yellow needles, mp 247-248°C. UV (EtOH) λ_{max} nm (log e): 237.5 (0.39), 285.5 (0.96), 339.0 (0.16), 381.0 (0.11). IR ν_{max} cm^{-1} (KBr): 3446, 1650, 1478, 1232. EI-MS m/z (rel. int.): 310 (19), 295 (100), 155 (4), 147 (21), 93 (4), 77 (5), 65 (6), 53 (5). ^{1}H NMR (400 MHz, acetone-d_6): δ 13.38 (1H, s, 1-OH), 8.99 (1H, s, 7-OH), 7.60 (1H, d, J = 2.8 Hz, H-8), 7.49 (1H, d, J = 9.2 Hz, H-5), 7.40 (1H, dd, J = 9.2, 2.8 Hz, H-6), 6.72 (1H, d, J = 10.1 Hz, H-4'), 6.38 (1H, s), 5.79 (1H, d, J = 10.1 Hz, H-5'), 1.51 (3H, s, H-7'), 1.51 (3H, s, H-8'). ^{13}C NMR (100 MHz, acetone-d_6): δ 180.2 (C-9), 160.4 (C-3), 157.2 (C-1), 156.9 (C-4a), 153.7 (C-7), 149.5 (C-10a), 127.7 (C-5'), 124.1 (C-6), 120.6 (C-8a), 118.7 (C-5), 114.4 (C-4'), 108.1 (C-8), 103.8 (C-2), 102.8 (C-9a), 94.3 (C-4), 77.9 (C-6'), 27.3 (C-7'), 27.3 (C-8').

Inophyllin B (3) – Yellow needles, mp 174-175°C. UV (EtOH) λ_{max} nm (log e): 213.0 (0.89), 241.0 (0.98), 281.0 (1.99), 336.5 (0.93). IR ν_{max} cm^{-1} (KBr): 3444, 2968, 1632, 1464, 1290, 1264, 1186, 1128. EI-MS m/z (rel. int.): 394 (100), 380 (93), 365 (30), 353 (42), 339 (10), 325 (9), 309 (8), 182 (32), 168 (12), 162 (42), 153 (10), 139 (8), 115 (9), 53 (9), 41 (9). ^{1}H NMR (400 MHz, acetone-d_6): d 13.85 (1H, s, 1-OH), 7.50 (1H, d, J = 8.2, H-8), 6.79 (1H, d, J = 8.2 Hz, H-7), 6.64 (1H, d, J = 10.1 Hz, H-11), 6.52 (1H, dd, J = 18.3, 11.0 Hz, H-19), 5.51 (1H, d, J = 10.1 Hz, H-12), 5.04 (1H, d, J = 18.3 Hz, H_a-20), 4.89 (1H, d, J = 11.0 Hz, H_b-20), 1.56 (3H, s, H-17), 1.56 (3H, s, H-18), 1.39 (3H,s, H-14), 1.39 (3H,s, H-15). ^{13}C NMR (100 MHz, acetone-d_6): d 180.1 (C-9), 157.8 (C-3), 155.6 (C-1), 154.3 (C-4a), 151.0 (C-19), 150.1 (C-6), 145.0 (C-10a), 132.0 (C-5), 126.6 (C-12), 115.4 (C-8), 114.6 (C-11), 112.6 (C-2), 112.5 (C-8a), 112.0 (C-7), 105.6 (C-20), 103.9 (C-4), 101.9 (C-9a), 77.3 (C-13), 40.1 (C-16), 28.2 (C-17), 28.2 (C-18), 26.2 (C-14), 26.2 (C-15).

3-Isomangostin (4) – Yellow solid, mp 154-156°C. UV (EtOH) λ_{max} nm (log e): 212.5 (1.10), 242.5 (1.04), 289.5 (1.42). IR ν_{max} cm^{-1} (KBr): 3440, 1602, 1464, 1286. EI-MS m/z (rel. int.): 408 (43), 393 (100), 365 (53), 335 (27), 295 (18), 201 (11), 175 (20), 115 (26), 69 (10). ^{1}H NMR (300 MHz, $CDCl_3$): δ 13.72 (1H, s, 1-OH), 6.85 (1H, s, H-5), 6.75 (1H, d, J = 9.9 Hz, H-4'), 6.26 (1H, s, H-4), 5.59 (1H, d, J = 9.9 Hz, H-5'), 5.27 (1H, t, J = 5.1 Hz, H-5''), 4.10 (2H, d, J = 5.1 Hz, H-4''), 3.82 (3H, s, 7-OCH_3), 1.85 (3H, s, H-7''), 1.71 (3H, s, H-8''), 1.49 (3H, s, H-7'), 1.49 (3H, s, H-8'). ^{13}C NMR (75 MHz, $CDCl_3$): d 181.2 (C-9), 159.9 (C-3), 157.9 (C-1), 156.3 (C-4a), 155.7 (C-10a), 154.6 (C-6), 142.6 (C-7), 137.0 (C-8), 132.2 (C-6''), 127.2 (C-5'), 123.1 (C-5''), 115.7 (C-4'), 112.1 (C-8a), 104.5 (C-2), 103.7 (C-9a), 101.7 (C-5), 94.2 (C-4), 77.9 (C-6'), 62.1 (7-OCH_3), 28.3 (C-7'), 28.3 (C-8'), 26.5 (C-4''), 25.9 (C-8''), 18.3 (C-7'').

Rubraxanthone (5) – Orange crystals, mp 201-202°C. UV (EtOH) λ_{max} nm (log e): 211.0 (0.97), 241.5 (1.12), 312.0 (0.76). IR ν_{max} cm^{-1} (KBr): 3428, 1608, 1466, 1162. EI-MS m/z (rel. int.): 410 (16), 341 (100), 311 (24), 299 (30), 288 (14), 271 (10), 69 (29), 41 (39). ^{1}H NMR (400 MHz, acetone-d_6): d 13.48 (1H, s, 1-OH), 6.82 (1H, s, H-5), 6.28 (1H, d, J = 1.8 Hz, H-4), 6.17 (1H, d, J = 1.8 Hz, H-2), 5.26 (1H, t, J = 6.4 Hz, H-12), 5.02 (1H, t, J = 6.9 Hz, H-16), 4.09 (2H, d, J = 6.4 Hz, H-11), 3.78 (3H, s, 7-OCH_3), 2.03 (2H, m, H-15), 1.96 (2H, m, H-14), 1.81 (3H, s, H-18), 1.54 (3H, s, H-19), 1.50 (3H, s, H-20). ^{13}C NMR (100 MHz, acetone-d_6): d 182.7 (C-9), 165.3 (C-3), 164.8 (C-1), 157.9 (C-6), 157.5 (C-10a), 156.2 (C-4a), 144.5 (C-7), 138.2 (C-8), 135.1 (C-13), 131.5 (C-17), 125.1 (C-16), 124.7 (C-12), 111.9 (C-8a), 103.7 (C-9a), 102.8 (C-5), 98.7 (C-2), 93.8 (C-4), 61.4 (7-OCH_3), 40.4 (C-14), 27.2 (C-11), 26.7 (C-15), 25.7 (C-19), 17.6 (C-20), 16.5 (C-18).

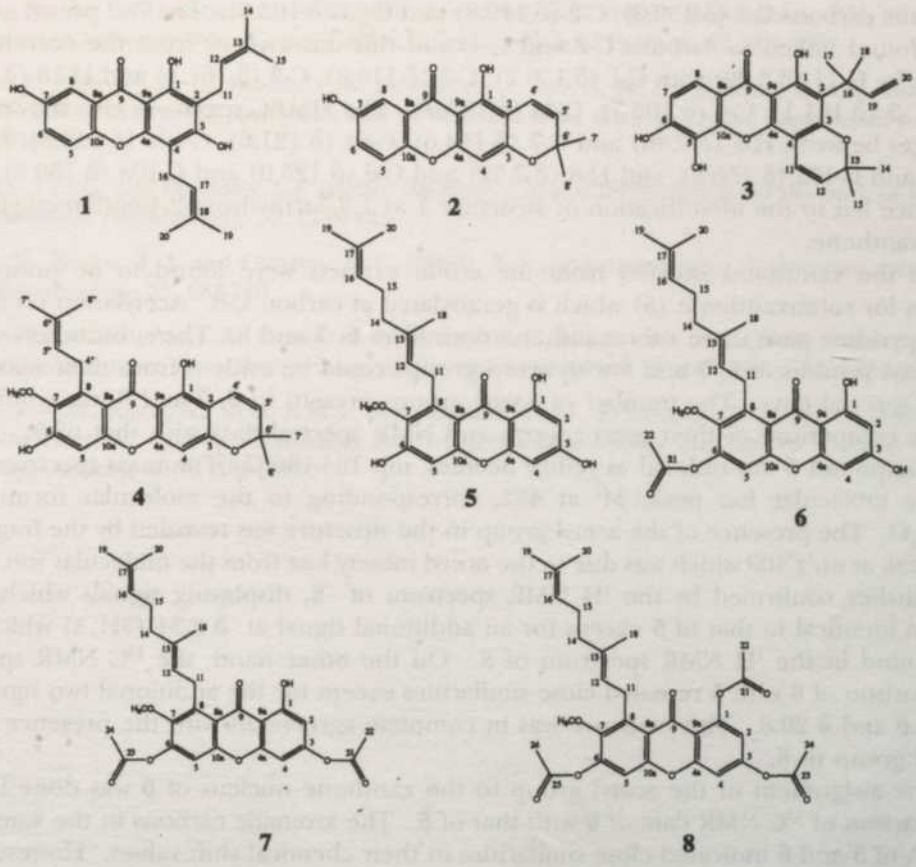
Rubraxanthone monoacetate (6) – Yellow crystals, mp 164-166°C. UV (EtOH) λ_{max} nm (log e): 213.0 (0.98), 239.0 (1.51), 256.5 (1.36), 311.0 (0.87), 434.5 (0.05). IR ν_{max} cm^{-1} (KBr): 3422, 2922, 1768, 1606, 1462, 1176. EI-MS m/z (rel. int.): 452 (7), 425 (5), 409 (7), 383 (35), 341 (100), 330 (11), 311 (19), 299 (25), 288 (13), 271 (9), 153 (6), 123 (7), 69 (27). ^{1}H NMR (400 MHz, acetone-d_6): d 13.17 (1H, s, 1-OH), 7.24 (1H, s, H-5), 6.32 (1H, d, J = 1.8 Hz, H-4), 6.20 (1H, d, J = 1.8 Hz, H-2), 5.22 (1H, t, J = 7.3 Hz, H-12), 4.99 (1H, t, J = 6.9 Hz, H-16), 4.11 (2H, d, J = 7.3 Hz, H-11), 3.76 (3H, s, 7-OCH_3), 2.34 (3H, s, H-22), 2.03 (2H, m, H-15), 1.96 (2H, m, H-14), 1.79 (3H, s, H-18), 1.52 (3H, s, H-19), 1.48 (3H, s, H-20). ^{13}C NMR (100 MHz, acetone-d_6): δ 182.9 (C-9), 168.6 (C-21), 166.0 (C-3), 164.9 (C-1), 158.1 (C-4a), 154.6 (C-6), 150.4 (C-10a), 147.9 (C-7), 139.2 (C-8), 135.6 (C-13), 131.6 (C-17), 125.1 (C-16), 124.2 (C-12), 117.3 (C-8a), 111.7 (C-5), 104.1 (C-9a), 99.0 (C-2), 94.0 (C-4), 62.0 (7-OCH_3), 40.4 (C-14), 27.2 (C-15), 26.7 (C-11), 25.7 (C-19), 20.8 (C-22), 17.7 (C-20), 16.5 (C-18).

Rubraxanthone diacetate (7) – Yellow gum. UV (EtOH) λ_{max} nm (log e): 210.5 (0.81), 236.0 (0.99), 256.5 (1.13), 292.0 (0.40), 361.5 (0.21). IR ν_{max} cm^{-1} (KBr): 1776, 1600, 1460, 1188. EI-MS m/z (rel. int.): 494 (2), 451 (5), 425 (12), 383 (44), 341 (69), 311 (16), 299 (23), 285 (11), 123 (15), 69 (53), 41 (100). ^{1}H NMR (400 MHz, $CDCl_3$): δ 13.09 (1H, s, 1-OH), 7.13 (1H, s, H-5), 6.64 (1H, δ, J = 1.8 Hz, H-4), 6.50 (1H, δ, J = 1.8 Hz, H-2), 5.18 (1H, t, J = 6.4 Hz, H-12), 5.01 (1H, t, J = 6.0 Hz, H-16), 4.11 (2H, d, J = 6.4 Hz, H-11), 3.75 (3H, s, 7-OCH_3), 2.38[a] (3H, s, H-24), 2.30[a] (3H, s, H-22), 2.03 (2H, m, H-15), 1.98 (2H, m, H-14), 1.81 (3H, s, H-18), 1.59 (3H, s, H-19), 1.53 (3H, s, H-20). ^{13}C NMR (100 MHz, $CDCl_3$): d 182.6 (C-9), 168.2[b] (C-21), 167.9[b] (C-23), 163.2 (C-1), 156.6 (C-3), 155.9 (C-4a), 154.0 (C-6), 149.5 (C-10a), 146.9 (C-7), 139.2 (C-8), 135.9 (C-13), 131.3 (C-17), 124.2 (C-16), 122.5 (C-12), 116.9 (C-8a), 110.6 (C-5), 107.1 (C-9a), 104.4 (C-2), 100.0 (C-4), 61.6 (7-OCH_3), 39.7 (C-14), 26.5 (C-15), 26.3 (C-11), 25.6 (C-19), 21.2[c] (C-22), 20.8[c] (C-24), 17.6 (C-20), 16.4 (C-18). [a, b, c] Interchangeable.

Rubraxanthone triacetate (8) – Yellow gum. UV (EtOH) λ_{max} nm (log e): 211.5 (0.90), 240.0 (1.39), 271.0 (0.51), 341.0 (0.25). IR ν_{max} cm^{-1} (KBr): 1760, 1610, 1450, 1186. EI-MS m/z (rel. int.): 536 (5), 493 (2), 467 (12), 451 (4), 425 (30), 383 (49), 341 (58), 311 (15), 299 (17), 284 (13), 69 (46), 43 (100). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.14 (1H, d, J = 1.8 Hz, H-4), 7.10 (1H, s, H-5), 6.76 (1H, d, J = 1.8 Hz, H-2), 5.16 (1H, t, J = 6.4 Hz, H-12), 5.03 (1H, t, J = 6.0 Hz, H-16), 4.06 (2H, d, J = 6.4 Hz, H-11), 3.74 (3H, s, 7-OCH_3), 2.42[a] (3H, s, H-22), 2.37[a] (3H, s, H-24), 2.32[a] (3H, s, H-26), 2.02 (2H, m, H-15), 1.95 (2H, m, H-14), 1.80 (3H, s, H-18), 1.59 (3H, s, H-19), 1.54 (3H, s, H-20). ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.8 (C-9), 169.4[b] (C-21), 168.1[b] (C-23), 168.0[b] (C-25), 156.7 (C-4a), 154.2 (C-1), 153.2 (C-6), 151.0 (C-3), 148.6 (C-10a), 146.9 (C-7), 139.2 (C-8), 135.4 (C-13), 131.2 (C-17), 124.4 (C-16), 122.8 (C-12), 118.9 (C-8a), 113.4 (C-9a), 112.5 (C-2), 110.3 (C-5), 108.1 (C-4), 61.6 (7-OCH_3), 39.7 (C-14), 26.7 (C-15), 26.1 (C-11), 25.6 (C-19), 21.2[c] (C-24 & C-26), 20.9[c] (C-22), 17.7 (C-20), 16.4 (C-18). [a, b, c] Interchangeable.

RESULTS AND DISCUSSIONS

Compound **1** was isolated as yellow needles, mp 128-129°C. This compound reacted positively with the methanolic ferric chloride test, indicating it to be a phenolic compound. The UV spectrum exhibited characteristic absorption bands of a hydroxylated xanthone at 217.5, 234.0, 270.0, 285.0, 386.5 nm. The IR spectrum exhibited strong



bands due to phenolic hydroxyls (3378 cm^{-1}), a chelated carbonyl (1644 cm^{-1}), conjugated C=C (1480 cm^{-1}) and carbinol functionalities (1230 cm^{-1}). The molecular formula was deduced to be $C_{23}H_{24}O_5$ from its mass spectrum, which showed a molecular ion, M^+ at m/z 380.

The ^1H NMR spectrum of **1** exhibited a downfield singlet at δ 13.25 for the chelated hydroxyl group attached to C-1. A group of signals consisting of a triplet at δ 5.20 (2H, J = 7.3 Hz), two doublets at δ 3.53 (2H, J = 7.3 Hz) and δ 3.39 (2H, J = 7.3 Hz) and three singlets at δ 1.60 (6H, s), δ 1.74 (3H, s) and δ 1.83 (3H, s) indicated the presence of two 3-methylbut-2-enyl groups. A doublet of doublet at δ 7.29 (1H, dd, J = 9.2, 3.7 Hz) was assigned to proton H-6 which was found to be *ortho*-coupled with proton H-5 [d 7.40 (1H, δ, J = 9.2 Hz)] and *meta*-coupled with proton H-8 [δ 7.52 (1H, δ, J = 3.7 Hz)].

The ^{13}C NMR spectrum of **1** showed signals for three protonated aromatic carbons, C-5 (δ 119.8), C-6 (δ 125.0) and C-8 (δ 109.2) as well as nine substituted aromatic carbons, C-1 (δ 159.2), C-2 (δ 110.8), C-3 (δ 161.1), C-4 (δ 106.7), C-4a (δ 153.9), C-7 (δ 154.6), C-8a (δ 121.6), C-9a (δ 103.6) and C-10a (δ 150.6). The chelated carbonyl carbon gave signals at δ 181.6 (C-9) and the existence of two 3-methylbut-2-enyl groups were revealed by the signals at δ 132.5 (C-13), 123.0 (C-12), 25.8 (C-14), 22.1 (C-11), 18.0 (C-15), and at δ 132.3 (C-18), 123.0 (C-17), 25.8 (C-19), 22.4 (C-16) and 18.1 (C-20).

The structure of **1** was further confirmed by the HMBC spectral data. In the HMBC spectrum, the chelated hydroxyl group (δ 13.25) was correlated to three quaternary

aromatic carbons C-1 (δ 159.2), C-2 (δ 110.8) and C-9a (δ 103.6). The two prenyl groups were found linked to carbons C-2 and C-4, and this was evident from the correlations shown by H-11 (δ 3.39) with C-1 (δ 159.2), C-2 (δ 110.8), C-3 (δ 161.1) and H-16 (δ 3.53) with C-3 (δ 161.1), C-4 (δ 106.7), C-4a (δ 153.9). The HMBC spectrum also showed the linkages between H-5 (δ 7.40) and C-7 (δ 154.6), C-8a (δ 121.6), C-10a (δ 150.8); H-6 (δ 7.29) and C-10a (δ 150.8), and H-8 (δ 7.52) and C-6 (δ 125.0) and C-10a (δ 150.8). This evidence led to the identification of structure **1** as 1,3,7-trihydroxy-2,4-*bis*(3-methylbut-2-enyl)xanthone.

All the xanthones isolated from the crude extracts were found to be prenylated except for rubraxanthone (**5**) which is geranylated at carbon C-8. Acetylation on **5** with Ac_2O-pyridine gave three rubraxanthone derivatives **6**, **7** and **8**. The substitution of the hydroxyl protons in **6**, **7** and **8** with acetyl groups could be evident from their mass and NMR spectral data. The number of acetyl groups present in **6**, **7** and **8** was confirmed by the comparison of their mass spectra and NMR spectral data with that of **5**.

Compound **6** was isolated as yellow needles, mp 164-166°C. The mass spectrum of **6** gave a molecular ion peak, M^+ at 452, corresponding to the molecular formula of $C_{26}H_{28}O_7$. The presence of the acetyl group in the structure was revealed by the fragment ion peak at m/z 409 which was due to the acetyl moiety loss from the molecular ion. This was further confirmed by the ^1H NMR spectrum of **6**, displaying signals which were almost identical to that of **5** except for an additional signal at δ 2.34 (3H, s) which was not found in the ^1H NMR spectrum of **5**. On the other hand, the ^{13}C NMR spectral comparison of **6** with **5** revealed close similarities except for the additional two signals at δ 168.6 and δ 20.8. This evidence was in complete agreement with the presence of an acetyl group in **6**.

The assignment of the acetyl group to the xanthone nucleus of **6** was done by the comparison of ^{13}C NMR data of **6** with that of **5**. The aromatic carbons in the xanthone ring A of **5** and **6** indicated close similarities in their chemical shift values. However, for xanthone ring B, the aromatic carbons C-5, C-6 and C-7 gave signals at δ 102.8, δ 157.9 and δ 144.5, respectively for **5**, and δ 111.7, δ 154.6 and δ 147.9, respectively for **6**. The C-5 carbon signals of **5** and **6** were found to be significantly different by 8.9 ppm, indicating the presence of an acetoxyl group at carbon C-6, inducing a deshielding effect on the adjacent carbon C-5. Therefore, compound **6** was deduced to be rubraxanthone monoacetate that was monoacetylated at position C-6.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support provided by the Malaysian Government IRPA programme and we are grateful to Mr Mohd Johadi Iskandar for recording the NMR spectra.

REFERENCES

Burkill, I. H. (1966). *Garcinia*. In W. Birtwistle, F.W. Foxworthy, J. B. Scrivenor, J. G. Watson, (Eds.), *A Dictionary of the Economic Products of the Malay Peninsula* (p. 1063-1074). Kuala Lumpur: Malaya Nature Society.

Heywood, V. H. (1982). In S.R. Chant (Eds.), *Popular Encyclopedia of Plants*. England: Press Syndicate of the University of Cambridge.

KOSELA, S., HU, L. H., RACHMATIA, T., HANAFI, M. and SIM, K. Y. (2000). Dulxanthone F-H, three new pyranoxanthones from *Garcinia dulcis*. *Journal of Natural Products, 63,* 406-407.

MERZA, J., AUMOND, M. C., RONDEAU, D., DUMONTET, V., RAY, A. M. L., SERAPHIN, D. and RICHOMME, P. (2004). Prenylated xanthones and tocotrienols from *Garcinia virgata*. *Phytochemistry, 65(21),* 2915-2920.

NGUYEN, L.H.D. and HARRISON, L.J. (2000). Xanthones and triterpenoids from the bark of *Garcinia vilersiana*. *Phytochemistry, 53,* 111-114.

PERES, V., NAGEM, T. J. and OLIVEIRA, F. F. (2000). Tetraoxygenated natural occurring xanthones. *Phytochemistry, 55,* 683-710.

RUKACHAISIRIKUL, V., ADAIR, A., DAMPAWAN, P., TAYLOR, W. C. and TURNER, P. C. (2000). Lanostanes and friedolanostanes from the pericarp of *Garcinia hombroniana*. *Phytochemistry, 55,* 183-188.

VIEIRA, L.M.M., KIJJOA, A., SILVA, A.M.S., MONDRANONDRA, I.O., KENGTHONG, S., GALES, L., DAMAS A.M. and HERZ, W. (2004). Lanostanes and friedolanostanes from the bark of *Garcinia speciosa*. *Phytochemistry, 65(4),* 393-398.