Xanthones and Xanthone Derivatives from *Garcinia nitida*

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**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) osajaxonanthone, (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.

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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 CHCl₃ 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/CHCl₃, CHCl₃/Me₂CO and Me₂CO/MeOH) to give 25 fractions (Fr.s.). The Frs. 2-4 were combined and separated over a silica gel column (hexane/CHCl₃ and CHCl₃/Me₂CO gradient) to give stigmasterol acetate (8 mg). Frs. 8-10 were combined and subjected to column chromatography (CC) (SiO₂; hexane/CHCl₃ and CHCl₃/Me₂CO gradient) to yield stigmasterol (10 mg). Fr. 11 was purified by repeated CC (SiO₂; hexane/EtOAc and CHCl₃/Me₂CO gradient) to give inophyllin B (3) (8 mg). The crude chloroform extract (20.0 g) was fractionated by vacuum CC (SiO₂; hexane-EtOAc and CHCl₃/Me₂CO gradient) to give 15 fractions. Frs. 2-3 were combined and purified by CC (SiO₂; hexane/EtOAc and CHCl₃/Me₂CO gradient) to furnish the 5 subfractions. Subfractions 1-3 were combined and further purified by CC (SiO₂; hexane/EtOAc and CHCl₃/Me₂CO 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-CHCl₃, CHCl₃-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-CHCl₃, CHCl₃-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 (Ac₂O). 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 ε): 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, 1250. 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 ¹³C NMR (see text).
Osajaxonanthone (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 v_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). ¹H NMR (400 MHz, acetone-d₆): 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'). ¹³C NMR (100 MHz, acetone-d₆): 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 v_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), 155 (10), 139 (5), 93 (4), 77 (5). ¹H NMR (400 MHz, acetone-d₆): δ 13.85 (1H, s, 1-OH), 7.50 (1H, d, J = 8.2 Hz, 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, d, J = 18.3 Hz, H-12), 5.51 (1H, d, J = 11.0 Hz, H-12), 5.04 (1H, d, J = 8.2 Hz, H-8), 4.89 (1H, d, J = 11.0 Hz, H-12), 1.56 (3H, s, H-17), 1.56 (3H, s, H-18), 1.39 (3H, s, H-14), 1.39 (3H, s, H-15). ¹³C NMR (100 MHz, acetone-d₆): δ 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 v_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). ¹H NMR (300 MHz, CDCl₃): 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-12), 5.04 (1H, d, J = 18.3 Hz, H-12), 4.89 (1H, d, J = 11.0 Hz, H-12), 1.56 (3H, s, H-17), 1.56 (3H, s, H-18), 1.39 (3H, s, H-14), 1.39 (3H, s, H-15). ¹³C NMR (100 MHz, CDCl₃): δ 181.2 (C-9), 159.9 (C-3), 157.9 (C-1), 156.3 (C-4a), 154.6 (C-7), 138.2 (C-8), 135.1 (C-13), 131.5 (C-17), 125.1 (C-16), 124.7 (C-12), 112.1 (C-8), 104.5 (C-2), 103.7 (C-9a), 101.7 (C-5), 94.2 (C-4), 77.9 (C-6), 62.1 (7-OCH₃), 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 v_max cm⁻¹ (KBr): 3428, 1608, 1466, 1162. EI-MS m/z (rel. int.): 408 (43), 393 (100), 365 (53), 335 (27), 295 (18), 201 (11), 175 (20), 115 (26), 69 (10). ¹H NMR (400 MHz, acetone-d₆): δ 13.48 (1H, s, 1-OH), 6.82 (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-OCH₃), 1.85 (3H, s, H-7'''), 1.71 (3H, s, H-8'''), 1.49 (3H, s, H-7'''), 1.49 (3H, s, H-8''). ¹³C NMR (75 MHz, CDCl₃): δ 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-OCH₃), 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<sub>max</sub> 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<sub>max</sub> cm<sup>-1</sup> (KBr): 3422, 2922, 1766, 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). <sup>1</sup>H NMR (400 MHz, acetone-<sup>d</sup>6): δ 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<sub>3</sub>), 2.34 (3H, s, H-22), 2.03 (2H, m, H-15), 1.77 (3H, s, H-18), 1.52 (3H, s, H-19), 1.48 (3H, s, H-20).<sup>13</sup>C NMR (100 MHz, acetone-<sup>d</sup>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<sub>3</sub>), 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<sub>max</sub> nm (log e): 210.5 (0.81), 236.0 (0.99), 256.5 (1.13), 292.0 (0.40), 363.5 (0.27). IR ν<sub>max</sub> cm<sup>-1</sup> (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). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 13.09 (1H, s, 1-OH), 7.13 (1H, s, H-5), 6.64 (1H, d, J = 1.8 Hz, H-4), 6.50 (1H, d, 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<sub>3</sub>), 2.38 (3H, s, H-22), 2.30 (3H, s, H-24), 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).<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>): δ 182.6 (C-9), 168.2 (C-21), 167.9 (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), 135.6 (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<sub>3</sub>), 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). abc Interchangeable.

Rubraxanthone triacetate (8) – Yellow gum. UV (EtOH) λ<sub>max</sub> nm (log e): 211.5 (0.90), 240.0 (1.39), 271.0 (0.51), 341.0 (0.25). IR ν<sub>max</sub> cm<sup>-1</sup> (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). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): 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), 4.06 (2H, d, J = 6.4 Hz, H-11), 3.74 (3H, s, 7-OCH<sub>3</sub>), 2.42 (3H, s, H-22), 2.37 (3H, s, H-24), 2.32 (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).<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>): δ 175.8 (C-9), 169.4 (C-21), 168.1 (C-23), 168.0 (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<sub>3</sub>), 39.7 (C-14), 26.7 (C-15), 26.3 (C-11), 25.6 (C-19), 21.2 (C-22), 20.8 (C-24), 17.6 (C-20), 16.4 (C-18). abc 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 $^1$H NMR spectrum of 1 exhibited a downfield singlet at $\delta$ 13.25 for the chelated hydroxyl group attached to C-1. A group of signals consisting of a triplet at $\delta$ 5.20 (2H, $J$ = 7.3 Hz), two doublets at $\delta$ 3.53 (2H, $J$ = 7.3 Hz) and $\delta$ 3.39 (2H, $J$ = 7.3 Hz) and three singlets at $\delta$ 1.60 (6H, s), $\delta$ 1.74 (3H, s) and $\delta$ 1.83 (3H, s) indicated the presence of two 3-methylbut-2-enyl groups. A doublet of doublet at $\delta$ 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 [$\delta$ 7.40 (1H, $\delta$, $J$ = 9.2 Hz)] and meta-coupled with proton H-8 [$\delta$ 7.52 (1H, $\delta$, $J$ = 3.7 Hz)].

The $^{13}$C NMR spectrum of 1 showed signals for three protonated aromatic carbons, C-5 ($\delta$ 119.8), C-6 ($\delta$ 125.0) and C-8 ($\delta$ 109.2) as well as nine substituted aromatic carbons, C-1 ($\delta$ 159.2), C-2 ($\delta$ 110.8), C-3 ($\delta$ 161.1), C-4 ($\delta$ 106.7), C-4a ($\delta$ 153.9), C-7 ($\delta$ 154.6), C-8a ($\delta$ 121.6), C-9a ($\delta$ 103.6) and C-10a ($\delta$ 150.6). The chelated carbonyl carbon gave signals at $\delta$ 181.6 (C-9) and the existence of two 3-methylbut-2-enyl groups were revealed by the signals at $\delta$ 132.5 (C-13), 123.0 (C-12), 25.8 (C-14), 22.1 (C-11), 18.0 (C-15), and at $\delta$ 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 ($\delta$ 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 Ac₂O-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 C₂₆H₂₈O₇. 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 ¹³C 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 ¹³C 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 acetoxy 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.

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