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# γ-Mangostin and Rubraxanthone, Two Potential Lead Compounds for Anti-cancer Activity against CEM-SS Cell Line

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**Abstract** – Our continuing interest on *Garcinia* and *Mesua* species has led us to carry out a detail study on the chemistry of the root bark of *Garcinia mangostana* (Guttiferae) since this part of the plant has not been investigated before, and the stem bark of *Mesua corneri* (Guttiferae) an uninvestigated species. This study has yielded six xanthones, α-mangostin (**1**), β-mangostin (**2**), γ-mangostin (**3**), garcinone-D (**4**), mangostanol (**5**) and gartanin (**6**) from *Garcinia mangostana* and two xanthones rubraxanthone (**7**) and inophyllin B (**8**) from *Mesua corneri*. Structural elucidations of these compounds were achieved using $^{1}H$, $^{13}C$ NMR and MS data. The crude hexane and chloroform extracts of the root bark of *Garcinia mangostana* and the hexane extract of the stem bark of *Mesua corneri* were found to be active against CEM-SS cell lines with $IC_{50}$ values less than 30 μg/ml. Moreover, γ-mangostin gave a very low $LC_{50}$ value of 4.7 μg/ml while rubraxanthone gave an $LC_{50}$ value of 5.0 μg/ml indicating these two compounds to be potential lead compounds for anti-cancer activity against the CEM-SS cell line. This paper reports the isolation and identification of these compounds as well as bioassay data for the crude extracts, γ-mangostin and rubraxanthone.
**Keywords** – xanthones, *Garcinia mangostana, Mesua corneri*, cytotoxic activities, CEM-SS cell lines

## Introduction

*Garcinia* species are well known to be rich in prenylated xanthones (Bennett and Lee, 1989, Rukachaisirikul *et al.*, 2003, Merza *et al.*, 2004, Nilar *et al.*, 2005). Extensive research has shown that the *Garcinia* species exhibit a wide range of biological and pharmacological activities such as cytotoxic, antimicrobial, antimalarial and anti-HIV-1 protease inhibitory activity (Kosela *et al.*, 2000). *Garcinia mangostana* L. is known for its medicinal properties. The fruit hulls of this plant are reported to be used as an anti-inflammatory and anti diabetic agents as well as an astringent or in the treatment of diarrhoea (Yates and Stout, 1958, Jefferson *et al.*, 1970).

Mesua species are well known for their good timber properties (Bandaranayake *et al.*, 1975). The flowers and flower buds are used by natives in medicine and in cosmetics.

Previous phytochemical studies on the genus *Mesua* showed the presence of coumarins, xanthones, flavonoids and triterpenoids (Bala and Seshadri, 1971, Bandaranayake *et al.*, 1975, Morel *et al.*, 1999). Investigations by Verotta and co-workers in 2004 revealed the anti-bacterial activities of *Mesua ferea* (Verotta *et al.*, 2004).

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## Experimental

**Plant material** – The root bark of *Garcinia mangostana* (1.8 kg) was collected from Alor Gajah, Melaka, Malaysia. The stem bark of *Mesua corneri* was collected from Frasiers Hill, Kuala Lumpur, Malaysia. Voucher specimens were kept in the Chemistry Department, University Putra 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 500 MHz NMR/JEOL 400 MHz FT NMR spectrometer using tetramethylsilane (TMS) as an internal standard. Ultra violet spectra were recorded in $CHCl_3$ on a Shimadzu UV-160A, UV-Visible Recording Spectrophotometer

**Extraction and isolation** – The finely ground stem bark of *Garcinia mangostana* (1.5 kg) was extracted with n-hexane, chloroform and acetone, twice for each to yield 12 g, 35 g and 64 g of crude extracts, respectively. The

**Table 1.** Cytotoxic activities of plant extract and pure compounds against CEM-SS cell line (T-lymphoblastic leukemia)

| | | $IC_{50}$ (μg/ml) |
|---|---|---|
| *Garcinia mangostana* crude extracts | hexane | 0.3 |
| | chloroform | 14 |
| *Mesua corneri* crude extracts | hexane | 23.5 |
| | chloroform | > 30 |
| | acetone | > 30 |
| pure compounds | γ-mangostin | 4.7 |
| | rubraxanthone | 5.0 |
| | inophyllin B | >30 |

dry crude extracts were purified by silica gel column chromatography using n-hexane, n-hexane/chloroform, chloroform, chloroform/ethyl acetate, ethyl acetate, and chloroform/methanol of increasing polarities as the eluting solvents. Further purifications using silica gel column chromatography and recrystallization gave the pure compounds. The hexane extract provided 4 mg of α-mangostin (**1**), 3 mg of β-mangostin (**2**) while the chloroform extract gave 8 mg of γ-mangostin (**3**) and 5 mg of garcinone D (**4**). Meanwhile, 6 mg of mangostanol (**5**) and 2 mg of gartanin (**6**) were obtained from the acetone extract.

The dried ground stem bark of *Mesua corneri* (1.1 kg) was extracted with n-hexane, ethyl acetate and acetone twice for 48 hours each to give 3.5 g of crude n-hexane extract, 7 g of ethyl acetate extract and 8.5 g of acetone extract. Each of these extracts were chromatographed separately through silica gel using n-hexane, n-hexane/chloroform, chloroform, chloroform/ethyl acetate and chloroform/methanol as eluting solvents. Further purifications of the fractions collected using silica gel column chromatography and recrystallization gave the pure compounds. The n-hexane extract furnished the common triterpenes stigmasterol (3 mg), friedelin (10 mg), friedelan-1,3-dione (8 mg) while the acetone extract gave inophyllin B (**7**) (2 mg) and rubraxanthone (**8**) (3 mg).

**α-Mangostin** (**1**) – Yellow amorphous powder, m.p. 180-182 °C (Lit. 182-183 °C) (Yates and Stout, 1958). UV $\lambda_{max}$ nm: 215, 243, 317. IR $\nu_{max}$: 3422, 2922, 1642, 1610. $^1$H NMR (400 MHz, $CD_3OD$): δ 13.72 (s, 1H, OH-1), δ 6.72 (s, 1H, H-5), δ 6.25 (s, 1H, H-4), δ 5.26 (t, $J$ = 7.3 Hz, 2H, H-12, H-17), δ 4.10 (d, $J$ = 7.3 Hz, 2H, H-11), δ 3.78 (s, 3H, 7-OMe), δ 3.37 (d, $J$ = 7.3 Hz, 2H, H-16), δ 1.83 (s, 3H, H-20), δ 1.82 (s, 3H, H-15), δ 1.71 (s, 3H, H-14) δ 1.68 (s, 3H, H-19). $^{13}$C NMR (100 MHz, $CD_3OD$): δ 181.8 (C-9), δ 161.6 (C-3), δ 160.2 (C-1), δ 155.4 (C-6), δ 155.2 (C-10a), δ 154.8 (C-4a), δ 142.7 (C-7), δ 137.2 (C-8), δ 132.6 (C-18), δ 131.7 (C-13), δ 123.4 (C-17), δ 122.1 (C-12), δ 111.7 (C-8a), δ 109.7 (C-2), δ 103.1 (C-9a), δ 101.6 (C-5), δ 92.4 (C-4), δ 61.2 (7-OMe), δ 26.3 (C-11), δ 25.7 (C-14), δ 25.7 (C-19), δ 21.3 (C-16), δ 18.1 (C-20), δ 17.7 (C-15).

**β-Mangostin** (**2**) – Pale yellow crystals, m.p. 162-163 °C (Lit.162-165 °C) (Yates and Stout, 1958). UV $\lambda_{max}$ nm: 214, 245, 260, 316. IR $\nu_{max}$: 3400, 2930, 1648, 1602. EI-MS m/z: 424, 381, 353, 335, 299. $^1$H NMR (400 MHz, $CDCl_3$): δ 13.42 (s, 1H, OH-1), δ 6.82 (s, 1H, H-5), δ 6.34 (s, 1H, H-4), δ 5.25 (t, $J$ = 7.3 Hz, 2H, H-12, H-17),

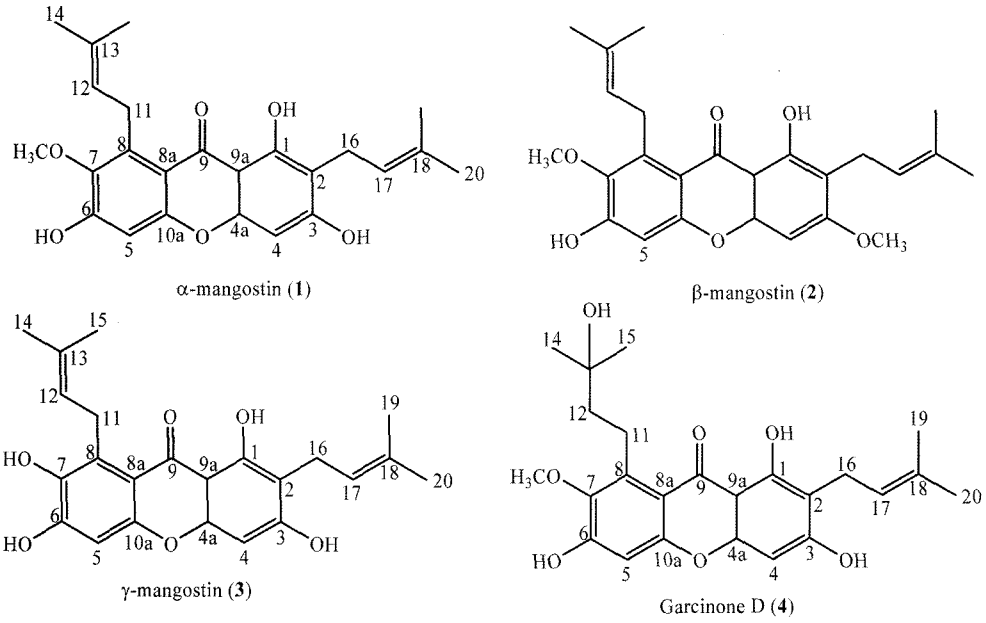


**Fig. 1.** Structures of α-mangostin (**1**), β-mangostin (2), γ-mangostin (**3**) and garcinone D (**4**).

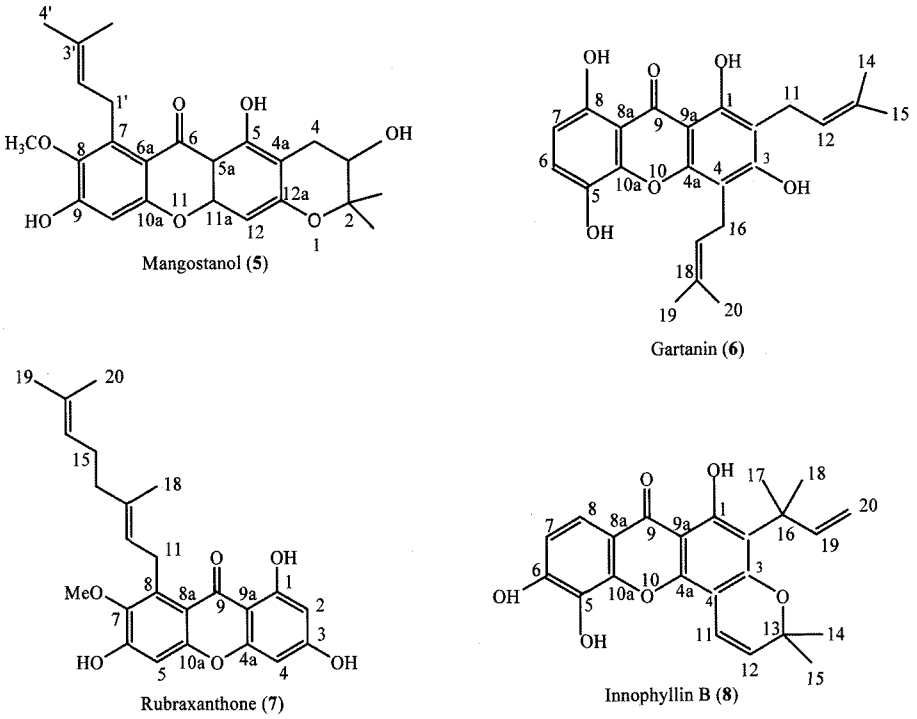


**Fig. 2.** Structures of mangostanol (**5**), gartanin (**6**), rubraxanthone (**7**) and inophyllin B (**8**).

δ 4.10 (d, $J$ = 7.3 Hz, 2H, H-11), δ 3.90 (s, 3H, 7-OMe), δ 3.80 (s, 3H, 3-OMe), δ 3.35 (d, $J$ = 7.3 Hz, 2H, H-16), δ 1.83 (s, 3H, H-20), δ 1.80 (s, 3H, H-15), δ 1.69 (s, 6H, H-14, H-19). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 181.9 (C-9), δ 163.4 (C-3), δ 159.7 (C-1), δ 155.6 (C-6), δ 155.2 (C-10a), δ 154.4 (C-4a), δ 142.5 (C-7), δ 137.0 (C-8), δ 132.1 (C-18), δ 131.7 (C-13), δ 123.2 (C-17), δ 122.3 (C-12), δ 112.3 (C-8a), δ 111.4 (C-2), δ 103.8 (C-9a), δ 101.4 (C-5), δ 88.8 (C-4), δ 62.1 (7-OMe), δ 55.8 (3-OMe), δ 26.5 (C-11), δ 25.8 (C-14), δ 25.8 (C-19), δ 21.3 (C-16), δ 18.2 (C-20), δ 17.7 (C-15).

**γ-Mangostin (3)** – Pale yellow crystals, m.p 200-202 °C (Lit. 207 °C) (Jefferson *et al.*, 1970). UV $\lambda_{max}$ nm: 243.5, 316.5. IR $\nu_{max}$ cm$^{-1}$ (KBr): 3300 (OH), 1640 (C = O), 1610 (C = C). EI-MS m/z (ret. int.): 396 ($M^+$, 55), 353 (44), 325 (87), 341 (42), 311 (10), 297 (100), 285 (30), 269 (9). $^1$H NMR (400 MHz, $CD_3OD$):δ 6.60 (1H, s, H-5), 6.15 (1H,s, H-4), 5.22 (1H, t, $J$ = 6.4 Hz, H-12), 5.22 (1H, t, $J$ = 6.8 Hz, H-17), 4.05 (2H, d, $J$ = 6.4 Hz, H-11), 3.23 (2H, d, $J$ = 6.8 Hz, H-16), 1.80 (3H, s, H-14), 1.75 (3H, s, H-20), 1.63 (3H, s, H-15), 1.63 (3H, s, H-19). $^{13}$C NMR (400 MHz, $CD_3OD$): δ 183.4 (C-9), 163.2 (C-3), 161.4 (C-1), 156.1 (C-10a), 153.9 (C-6), 152.9 (C-4a), 141.9 (C-7), 131.6 (C-13), 131.5 (C-18), 129.4 (C-8), 123.9 (C-17), 112.1 (C-8a), 111.0 (C-2), 111.0 (C-12), 103.8 (C-9a), 100.9 (C-5), 92.9 (C-4), 26.6 (C-11), 26.1 (C-15), 25.9 (C-19), 22.2 (C-16), 18.3 (C-14), 17.9 (C-20).

**Garcinone D (4)** – Brown crystals, m.p. 150-154 °C. UV $\lambda_{max}$ nm: 245, 318. IR $\nu_{max}$ (KBr): 3406, 2968, 1646, 1610. EI-MS m/z (rel. int.): 428 ($M^+$, 28), 410 (29), 367 (50), 355 (54), 339 (100), 323 (19), 313 (70), 285 (16). $^1$H NMR (400 MHz, $CD_6CO$): δ 13.81 (1H, s, OH-1), 6.80 (1H, s, H-5), 6.37 (1H, s, H-4), 5.26 (1H, t, $J$ = 7.2 Hz, H-17), 3.83 (3H,s, OMe-7), 3.45 (2H, m, H-11), 3.33 (2H, d, $J$ = 7.2 Hz, H-16), 1.76 (3H, s, H-19), 1.74 (2H, m, H-12), 1.63 (3H, s, H-20), 1.30 (3H, s, H-14), 1.30 (3H, s, H-15). $^{13}$C NMR (100 MHz, $CD_6CO$) δ 182.8 (C-9), 162.9 (C-3), 161.6 (C-1), 157.5 (C-10a), 156.3 (C-6), 155.7 (C-4a), 144.4 (C-7), 140.0 (C-8), 131.3 (C-18), 123.4 (C-17), 111.9 (C-2), 111.9 (C-8a), 103.6 (C-9a), 102.5 (C-5), 93.1 (C-4), 70.5 (C-13), 61.6 (OMe-7), 45.6 (C-12), 29.2 (C-14), 29.2 (C-15), 25.9 (C-20), 23.2 (C-11), 21.9 (C-16), 17.9 (C-19).

**Mangostanol (5)** – Yellow gum. UV $\lambda_{max}$ nm: 205, 244, 306. IR $\nu_{max}$ (KBr): 3406, 2934, 1604. EI-MS m/z (rel. int.): 426 ($M^+$, 53), 411 (23), 393 (15), 383 (18), 355 (52), 339 (100), 323 (35), 311(22), 321(25). $^1$H NMR (400 MHz, $CD_3OD$): δ 6.62 (1H, s, H-10), 6.30 (1H, s, H-12), 5.24 (1H, brt, $J$ = 7.3 Hz, H-2'), 4.00 (2H, brt, $J$ = 7.3 Hz, H-1'), 3.74 (1H, dd, $J$ = 5.5, 7.3 Hz, H-3), 3.70 (3H, s, OMe-8), 2.88 (1H, dd, $J$ = 5.5, 17.4 Hz, H-4), 2.52 (1H, dd, $J$ = 7.3, 17.4 Hz, H-4), 1.77 (3H, s, H-4'), 1.62 (3H, s,

H-5'), 1.41 (3H, s, Me-2), 1.30 (3H, s, Me-2). $^{13}$C NMR (100 MHz, $CD_3OD$): δ 178.9 (C-6), 162.2 (C-12a), 158.3 (C-11a), 156.8 (C-10a), 156.1 (C-5), 155.7 (C-9), 144.8 (C-8), 138.3 (C-7), 131.4 (C-3'), 125.7 (C-2'), 114.9 (C-6a), 107.5 (C-5a), 105.4 (C-4a), 102.3 (C-10), 94.4 (C-12), 79.5 (C-2), 69.6 (C-3), 61.3 (OMe-8), 27.0 (C-4), 27.0 (C-1'), 25.9 (C-5'), 25.6 (Me-2), 20.6 (Me-2), 18.3 (C-4').

**Gartanin (6)** – Yellow crystals, m.p. 164-166 °C (Lit. 167 °C) (Govindachari *et al.*, 1971). UV $\lambda_{max}$ nm: 249, 282, 325, 351. IR $\nu_{max}$ cm$^{-1}$ (KBr): 3200, 2934, 1610. EI-MS m/z (rel. int.): 396 ($M^+$, 60), 341 (77), 325 (90), 297 (65), 285(100). $^1$H NMR (400 MHz, $CD_3OD$): δ 12.34 (1H, s, OH-1), 11.26 (1H, s, OH-8), 7.22 (1H, d, $J$ = 9.2 Hz, H-6), 6.66 (1H, d, $J$ = 9.2 Hz, H-7), 5.26 (2H, m, H-12), 5.26 (2H, m, H-17), 3.51 (2H, d, $J$ = 6.4 Hz, H-16), 3.45 (2H, d, $J$ = 8.2 Hz, H-11), 1.86 (3H, s, H-15), 1.86 (3H, s, H-19), 1.79 (3H, s, H-14), 1.75 (3H, s, H-20). $^{13}$C NMR (100 MHz, $CD_3OD$): δ 184.8 (C-9), 161.7 (C-3), 158.2 (C-1), 153.9 (C-8), 152.5 (C-4a), 142.9 (C-10a), 136.4 (C-13), 135.8 (C-5), 134.1 (C-18), 123.0 (C-6), 121.9 (C-17), 121.1 (C-12), 109.8 (C-7), 109.6 (C-2), 107.2 (C-8a), 105.9 (C-4), 102.3 (C-9a), 26.0 (C-14), 25.8 (C-20), 22.1 (C-16), 21.7 (C-11), 18.1 (C-15), 18.1 (C-19).

**Rubraxanthone (7)** – Yellow powder, m.p. 207-209 °C (Lit. 205-206 °C) (Ampofo and Waterman, 1986). UV (EtOH) $\lambda_{max}$ nm: 211.0, 241.5, 312.0. IR $\nu_{max}$ cm$^{-1}$ (KBr): 3428, 1608, 1466, 1162. EI-MS m/z (rel. int.): 410 (16), 341 (100), 311 (24), 299 (30), 287 (14), 271 (10), 69 (29), 41 (39). $^1$H NMR (400 MHz, acetone-$d_6$): δ 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-$d_6$): 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-$OCH_3$), 40.4 (C-14), 27.2 (C-11), 26.7 (C-15), 25.7 (C-19), 17.6 (C-20), 16.5 (C-18).

**Inophyllin B (8)** – Yellow crystals, m.p. 175-176 °C (Lit. 176 °C) (Ee *et al.*, 2004). UV (EtOH) $\lambda_{max}$ nm: 213.0, 241.0, 281.0, 336.5. IR $\nu_{max}$ 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-$d_6$): δ 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-$d_6$): 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).

**Cytotoxicity Assay** – The stock solution of sample (compound) was prepared at a concentration of 5 μg/ml in dimethylsulfoxide (DMSO). Serial dilution of the stock solution in the growth medium provided seven sample solutions at concentrations of 2.5, 5.0, 7.5, 10.0, 20.0, 30.0 and 40.0 μg/ml. CEM-SS cell line was obtained from The National Cancer Institute in Maryland, USA. Cells were grown in a 96 well microliter plate by filling each well with 100 μl of stock culture ($1 \times 10^5$ cells/ml) and incubated at 37 °C for 24 hours. Growth medium was removed from the wells and each well was then treated with 100 μl of varying concentrations of sample solution. Controls were made containing only untreated cell population in 100 μl of growth medium. The assay for each concentration of sample was performed in triplicate and the culture plate was incubated for 3 days at 37 °C, 5% $CO_2$ and 90% humidity. After 3 days, 10 μl of the MTT reagent (0.5 mg/ml) (Roche Diagnostics, USA) was added to each well. The plate was then incubated for a further 4 hours at 37 °C with 5% $CO_2$. After that, 100 μl of the solubilization solution was added to each well and the plate was allowed to stand overnight in the incubator at 37 °C with 5% $CO_2$. Cell viability was measured using ELISA spectrophotometer ($EL_x$ 800) at a wavelength of 550 nm. The inhibitory concentration that killed cells by 50% ($IC_{50}$) was determined from absorbance (OD) versus concentration curve (Rahmat *et al.*, 2002).

## Results and Discussion

The compound γ-mangostin (**3**) was obtained as pale yellow crystals with a melting point of 200-202 °C (Lit. 207 °C) (Jefferson *et al.*, 1970). The EIMS spectrum showed the presence of a molecular ion peak at m/z 396. The IR spectrum gave an absorption at 3300 cm$^{-1}$ and 1640 cm$^{-1}$ which were due to the chelated carbonyl function and the phenolic hydroxyl. The UV absorptions at 239.5, 262.5, 313.5 and 377.0 nm indicated it to be a hydroxylated xanthone.

The two singlet signals at δ 6.15 and δ 6.60 in the $^1$H-NMR spectrum belong to the aromatic protons H-4 and H-5, respectively. The presence of two prenyl moiety was confirmed by the following characteristics: two 2-Hdoublets at δ 3.23 ($J$ = 6.8 Hz) and δ 4.05 ($J$ = 6.4 Hz) were assigned to the methylene groups at C-11 and C-16; a one proton triplet at δ 5.22 ($J$ = 6.4 Hz, 6.8 Hz) was due to the vinylic proton at C-12 and C-17, while four singlets at δ 1.80, δ 1.63, δ 1.63 and δ 1.75 were attributed to H-14, H-15, H-19 and H-20, respectively.

The COSY spectrum showed clearly the correlation for benzylic methylene proton (H-11) and vinylic proton (H-12) thus suggesting the presence of a prenyl moiety. The same correlation pattern was also shown by another prenyl unit in the COSY analysis in which H-16 coupled to H-17.

The $^{13}$C-NMR spectrum gave a total of 23 carbon resonances which corresponds to a molecular formula $C_{23}H_{24}O_6$. The downfield signal at δ 183.4 was due to the carbonyl group in the molecule. Other protonated carbons were assigned by the HSQC analysis. The DEPT experiment showed the molecule to consist of four methines, two methylenes, four methyls and thirteen quarternary carbons.

Conclusive proof for the substitution pattern of the molecule was the same from the HMBC analysis. In the HMBC analysis, the methylene proton signal at δ 4.05 (H-11) showed long range correlation with the carbon signals at δ 129.4 (C-8), thus suggesting the location of the prenyl unit to be at C-8. Another prenyl unit was confirmed to be at C-2 since the methylene proton at δ 3.23 (H-16) correlated with the carbon signals at δ 111.0 (C-2).

Rubraxanthone (**7**) was obtained as a yellow powder, mp: 207-209 °C (Lit. 205-206 °C) (Ampofo *et al.*, 1986). The [M$^+$] at *m/z* 410 in the EI-MS spectrum corresponds to the molecular formula $C_{24}H_{26}O_6$. The prominent fragmentation ion at [M-69]$^+$ and [M-123]$^+$ implied the presence of a geranyl unit in the structure. The UV absorptions at 211, 241 and 312 nm suggested that (**7**) was a xanthone derivative. The IR spectrum showed bands at 3428 and 1608 cm$^{-1}$ characteristic of a xanthone with a hydroxyl group chelated to the carbonyl group. The $^1$H and $^{13}$C NMR data are in agreement with published data (Ampofo *et al.*, 1986).

The rest of the compounds, α-mangostin (**1**) (Yates and Stout, 1958), β-mangostin (**2**) (Yates and Stout, 1958), garcinone D (**4**) (Chairungrisleld *et al.*, 1996), mangostanol (**5**) (Chairungrisleld *et al.*, 1996), gartanin (**6**) (Govindachari *et al.*, 1971), and inophyllin B (**8**) (Ee *et al.*, 2004) were identified by spectral data and by comparison with literature data.

The crude hexane and chloroform extracts of the root bark of *Garcinia mangostana* and the hexane extract of the stem bark of *Mesua corneri* were found to be active against CEM-SS cell lines with $IC_{50}$ values less than 30 μg/ml. The hexane extract gave a very low $IC_{50}$ value of 0.3 μg/ml while the chloroform extract gave a slightly higher $IC_{50}$ value of 14 μg/ml. Moreover, γ-mangostin gave a very low $IC_{50}$ value of 4.7 μg/ml while rubraxanthone gave an $IC_{50}$ value of 5.0 μg/ml indicating these two compounds to be potential lead compounds for anti-cancer activity against the CEM-SS cell line.

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