

Short Note

5,5'-Oxybis(1,3,7-trihydroxy-9H-xanthen-9-one): A New Xanthone from the Stem Bark of *Garcinia porrecta* (Clusiaceae)

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Abstract: A new polyoxygenated dimer-type xanthone, namely 5,5'-oxybis(1,3,7-trihydroxy-9H-xanthen-9-one) (**1**), has been isolated from the stem bark of *Garcinia porrecta*. The structure of **1** was determined based on spectroscopic data, including 1D and 2D-NMR as well as high resolution mass spectroscopy analysis.

Keywords: *Garcinia porrecta*; Clusiaceae; xanthone

1. Introduction

The famous *Garcinia* genus, representing a major source of triterpenes, flavonoids, xanthones, and phloroglucinols which have pharmacological activities as antioxidants, antibacterial, antiviral, anti-HIV, and significant anticancer activity [1].

The genus *Garcinia* belongs to the Clusiaceae family, which consists of more than 400 species widely distributed in the Polinesia mainland, India, Indochina, Indonesia, West and Central Africa, and Brazil [2]. Indonesia is known as one of the countries rich in diversity of *Garcinia*, there are 64 species of *Garcinia* scattered across several islands in Indonesia [3]. Various parts of *Garcinia* plants have been used in traditional medicine for the treatment of sprue (mouth ulcer), diarrhea, dysentery and skin disease [4]. Investigations into biologically active compounds from Indonesia *Garcinia* plants have resulted in some bioactive compounds being isolated from *G. mangostana* [5–7], *G. celebica* [8,9] and *G. cowa* [10]. Previous investigation on the stem bark of *G. porrecta* had led to the isolation of dulxanthone E–G, which showed strong cytotoxic activity against murine leukemia L1210 cells [6]. In this paper, we reported the isolation and structure elucidation of new polyoxygenated dimer-type xanthone, 5,5'-Oxybis(1,3,7-trihydroxy-9H-xanthen-9-one) (**1**) (Figure 1).

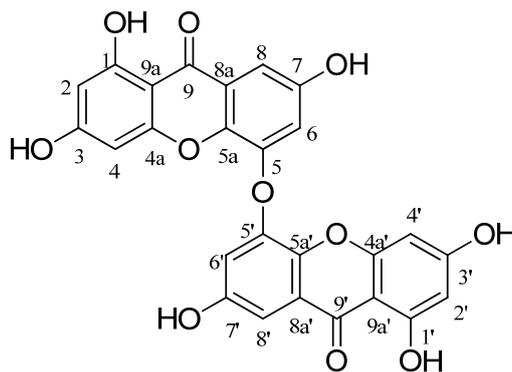


Figure 1. Chemical structure of compound 1.

2. Results

Extraction and Isolation

The chopped dried stem bark of *G. porrecta* (2 Kg) was macerated at room temperature with *n*-hexane (5 × 2 L), ethyl acetate (5 × 2 L), and methanol (5 × 2 L). The solvents were removed by a rotary evaporator to give a crude *n*-hexane extract (21 g), ethyl acetate (12.5 g), and methanol (25 g). The ethyl acetate extract (12.5 g) was fractionated by vacuum liquid chromatography on silica gel using a gradient of *n*-hexane-ethyl acetate-methanol solvent to give eight fractions (A–H). Fraction E (1.93 g) was separated with silica gel column chromatography using *n*-hexane:methylene chloride:acetone (5:3:2) as the solvent system to give nine subfractions (E1–E9). Subfraction E8 (140.7 mg) was purified by column chromatography on RP-18 silica using 10% gradient MeOH:H₂O to give **1** (30.6 mg).

5,5'-Oxybis(1,3,7-trihydroxy-9H-xanthen-9-one) (**1**), yellow amorphous powder, $[\alpha]_D^{20} +12.4$ (*c* 0.1, MeOH); UV (MeOH) λ_{\max} : 322 and 262 nm; HR-TOFMS m/z 503.0667 $[M + H]^+$ (calcd. for C₂₆H₁₅O₁₁, 503.0614); IR (KBr) ν_{\max} : 3412, 2962, 1755, 1484, 1174 cm⁻¹; ¹H-NMR (acetone-*d*₆, 600 MHz) δ_H : 6.2 (1H, s, H-2, H-2'), 6.3 (1H, s, H-4, H-4'), 6.9 (1H, s, H-8, H-8'), 7.5 (1H, s, H-6, H-6'), 13.2 (1H, s, OH-1); ¹³C-NMR and DEPT-135 (acetone-*d*₆, 150 MHz), δ_C : 179.6 (C-9), 179.5 (C-9'), 164.8 (C-3'), 164.7 (C-1'), 163.5 (C-1), 163.2 (C-3), 157.9 (C-4a, C-4a'), 153.5 (C-5a, C-5a'), 151.6 (C-7, C-7'), 143.3 (C-5, C-5'), 122.7 (C-8a'), 112.8 (C-8a), 108.2 (C-6, C-6'), 102.5 (C-8, C-8'), 102.2 (C-9a), 102.1 (C-9a'), 97.7 (C-2), 97.6 (C-2'), 93.5 (C-4), 93.4 (C-4').

3. Discussion

Compound **1** was isolated as a yellow amorphous powder. The UV spectrum showed absorption bands at λ_{\max} 322 and 262 nm attributable to a conjugated system [11,12]. Its molecular composition was established to be C₂₆H₁₄O₁₁ with twenty degrees of unsaturation from HR-TOFMS m/z 503.0667 $[M + H]^+$, calculated for C₂₆H₁₅O₁₁ (m/z 503.0614) and NMR spectral data (Table 1). The IR spectrum exhibited bands at ν_{\max} 3412 cm⁻¹ (hydroxyl), 2962 cm⁻¹ (C-H stretching of aliphatic) and 1755 cm⁻¹ (carbonyl).

The ¹³C-NMR spectrum demonstrated the presence of a total of 26 carbon signals, which were classified by their chemical shifts, DEPT, and HSQC spectra (Figures S3 and S4) as eight sp² methine carbons, two carbonyl carbon at δ_C 179.53 and 179.53, 16 sp² quaternary carbons (including two sp² carbons and 14 sp² oxygenated carbons). These functionalities accounted for 14 out of the total 20 degrees of unsaturations. The remaining of six degrees of unsaturation were consistent with six cyclics of bixanthenes [13,14].

The ¹H-NMR and HSQC spectra of **1** (Figures S1 and S4), showed proton signals indicative of a tetrasubstituted aromatic group δ_H 6.2 (2H, s, H-2, H-2'), 6.3 (2H, s, H-4, H-4'), 6.9 (2H, s, H-8, H-8') and 7.5 (2H, s, H-6, H-6') and showed a hydroxyl proton at δ_H 13.2 (1H, s, OH-1). Low shimming quality could explain the missing splitting of H-2/H-2', H-4/H-4'/H-6/H-6', and H-8/H-8' signals in the ¹H-NMR spectrum.

A comparison of the NMR data of **1** with 1,3,7-trihydroxyxanthone, gentisein, isolated from *Gentiana lutea* [14] indicated that the structure of compound **1** is very similar to gentisein. The main difference was the presence of dimer skeleton at C-5. The substitution of the xanthone skeleton was determined by HSQC and HMBC spectra (Figures S4 and S5). The HMBC correlations (Figure 2) from H-6 (δ_{H} 108.2) with C-5a (δ_{C} 153.5), C-5' (δ_{C} 143.3), C-5 (δ_{C} 143.3) and C-7 (δ_{C} 151.6), and of H-6' (δ_{H} 108.2) with C-5a' (δ_{C} 153.5), C-5 (δ_{C} 143.3), (δ_{C} 143.3) and C-7' (δ_{C} 151.6) suggested that the substituent of dimer xanthone with the xanthone at C-5 or C-5'. The hydroxyl group was located at C-1 based on HMBC correlations from OH-1 (δ_{H} 13.2) to C-1 (δ_{C} 163.5), C-2 (δ_{C} 97.7) and C-9a (δ_{C} 102.2) (Figure 2 and Figure S5). Therefore, the structure of **1** was assigned as 5,5'-Oxybis(1,3,7-trihydroxy-9H-xanthen-9-one).

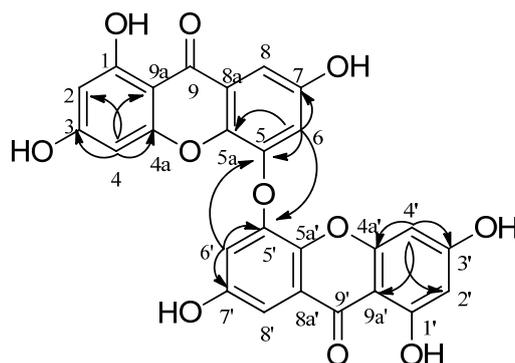


Figure 2. Selected HMBC correlations for **1**.

Table 1. NMR data of compound **1** and gentisein acetone- d_6 .

Position	1		Gentisein [14]	
	δ_{H} [Σ H, mult., J (Hz)]	δ_{C} (mult.)	δ_{H} [Σ H, mult., J (Hz)]	δ_{C}
1		163.53 (s)		162.5
2	6.22 (1H, s)	97.69 (d)	6.2 (1H, d, 1.7)	97.8
3		163.22 (s)		165.5
4	6.37 (1H, s)	93.55 (d)	6.3 (1H, d, 1.7)	93.8
4a		157.97 (s)		157.6
5		143.38 (s)	7.4 (1H, d, 9.0)	119.1
5a		153.58 (s)		149.1
6	7.53 (1H, s)	108.21 (d)	7.3 (1H, dd, 9.0, 2.8)	124.5
7		151.67 (s)		153.8
8	6.91 (1H, s)	102.51 (d)	7.4 (1H, d, 2.8)	108.0
8a		112.81 (s)		120.5
9		179.60 (s)		179.7
9a		102.19 (s)		102.0
1'		164.74 (s)		
2'	6.22 (1H, s)	97.63 (d)		
3'		164.79 (s)		
4'	6.37 (1H, s)	93.48 (d)		
4a'		157.96 (s)		
5'		143.38 (s)		
5a'		153.55 (s)		
6'	7.53 (1H, s)	108.2 (d)		
7'		151.65 (s)		
8'	6.91 (1H, s)	102.51 (d)		
8a'		122.77 (s)		
9'		179.53 (s)		
9a'		102.16 (s)		
1,1'-OH	13.21 (1H, s)			

4. Materials and Methods

4.1. General Experimental Procedures

UV spectra were recorded on Vilber Lourmat UV/VIS spectrophotometer. Mass spectra were measured with a Waters Xevo QTOFMS instrument (Waters, Milford, MA, USA). IR spectra were measured on a One Perkin Elmer infrared-100. NMR data were recorded on a Bruker Avance-600 spectrometer at 600 MHz for ^1H and 150 MHz for ^{13}C using Tetramethylsilane (TMS) as an internal standard (Billerica, MA, USA). Chromatographic separations were carried out on silica gel G60 (0.063–0.200 mm) (Merck, Darmstadt, Germany), RP18 (0.04–0.063 mm) (Merck, Darmstadt, Germany). Precoated silica gel GF₂₅₄ plates (0.25 mm, Merck, Darmstadt, Germany) were used for Thin Layer Chromatography (TLC), and detection was achieved by spraying with 5% AlCl_3 in ethanol, followed by heating.

4.2. Plant Material

The stem bark of *G. porrecta* was collected from Bogor Botanical Garden, Bogor, Indonesia in April 2018. The plant was identified and deposited in the Herbarium Bogoriense (No. IV.K.78a), Center of Biological Research and Development, National Institute of Science, Bogor, Indonesia.

5. Conclusions

A new polyoxygenated dimer-type xanthone, namely 5,5'-Oxybis(1,3,7-trihydroxy-9*H*-xanthen-9-one) (**1**), was isolated from the stem bark of *G. porrecta*, belonging to Clusiaceae family. This polyoxygenated dimer-type xanthone was found in the *Garcinia* genus for the first time.

Supplementary Materials: The following are available online, Figure S1. ^1H -NMR spectrum of **1** (600 MHz in acetone-*d*₆), Figure S2. ^{13}C -NMR spectrum of **1** (150 MHz in acetone-*d*₆), Figure S3. DEPT-135° spectrum of **1** (150 MHz in acetone-*d*₆), Figure S4. HSQC Spectrum of **1**, Figure S5. HMBC spectrum of **1**, Figure S6. Infrared Spectrum of **1** (in KBr), Figure S7. HR-TOF-MS Spectrum of **1**, Figure S8. TLC Profile of **1**.

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Conflicts of Interest: The authors declare no conflict of interest.

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