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by Tjitjik Srie Tjahjandarie

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Chromanone Acid Derivatives from the Stem Bark of *Calophyllum incrassatum*

U Hasanah¹, T S Tjahjandarie¹, M Tanjung¹

¹Natural Products Chemistry Research Group, Organic Chemistry Division, Department of Chemistry, Faculty of Science and Technology, Universitas Airlangga, Surabaya, Indonesia.

ulfalunks15@gmail.com; mulyadi-t@fst.unair.ac.id

Abstract. Two chromanone acid derivatives, calofolic acid B (**1**) and apetalic acid (**2**) were isolated from the stem bark of *Calophyllum incrassatum*. The structures of both compounds were elucidated by UV, IR, HRESIMS, 1D and 2D NMR spectroscopies and comparison of their data with literatures. Compounds **1-2** were evaluated for their cytotoxic activity against P-388 cells, compound (**1**) showing value IC₅₀ 1.14 µg/mL.

Keywords: *Calophyllum incrassatum*, Calofolic acid B, Apetalic acid, P-388 cells.

1. Introduction

The genus *Calophyllum* (Calophyllaceae) comprises approximately 150 species that grow in the restrictive area of South East Asia. In Indonesia, the plants has many advantages, used as traditional treatment for rheumatism, inflammation, eye disease, and skin disease [1]. This genus is well known to produce a variety secondary metabolites such as xanthenes [2], 4-phenylcoumarins [3], benzofuran-3-ones [4], biflavonoids [5] and chromanone acid [6-8], which have some biological activities such as anticancer, antibactery, and antitumor. Xanthone and 4-phenylcoumarin derivatives containing a isoprenyl side chain in aromatic region revealed as a key element to enhance their biological activities. In continuation of our work on phytochemical examination of chromanone acid on *Calophyllum* from West Kalimantan, we report the isolation of calofolic acid B (**1**), and apetalic acid (**2**) from the methanol extract of the stem bark of *Calophyllum incrassatum*. Compounds **1** and **2** were established by UV, IR, HRESIMS, 1D and 2D NMR, as well as by comparison with those related compounds previously reported. The cytotoxic activity against murine leukemia P-388 cells of isolated compounds from this species is also briefly described.

2. Experimental Methode

2.1 General experimental

UV spectra was measured by Shimadzu series 1800 UV-VIS spectrophotometer with methanol (Kyoto, Japan). IR spectra was recorded in KBr on a One Perkin Elmer instrument (Waltham, MA, USA). Mass spectra was recorded on Synapt G2 mass spectrometer (Manchester, UK). NMR spectra (¹H-NMR, ¹³C-NMR, HMQC, and HMBC) was obtained with a JEOL JNM-ECA 400 MHz FTNMR spectrophotometer (Tokyo, Japan) with CDCl₃ as the solvent and internal standard. Column chromatography and planar radial chromatography was carried out using Si gel 60 Cat. No. 1.07734.1000 and Si gel 60 PF₂₅₄ No. 1.07749.1000 (Merck, Darmstadt, Germany).

2.2 Plant Material

The stem bark of *C. incrassatum* was collected from Mandor sub-district, Landak regency, West Kalimantan, Indonesia. The sampel was identified by Mr. Ismail Rachman from the Herbarium Bogoriense, Bogor, Center of Biological Research and Development.

2.3 Extraction and isolation

The dried stem bark of *C. incrassatum* (3.0 kg) was macerated in methanol twice at room temperature for 24 h. The solvent was evaporated under reduced pressure to obtain a dark brown residue (280 g). The methanol extract was then partitioned with *n*-hexane and ethyl acetate. The ethyl acetate fraction (43 gr) was subjected to vacuum liquid chromatography over silica gel and eluted with *n*-hexane-ethyl acetate (from 9:1 to 7:3) to give fractions A-C. Fraction C (5.44 g) was applied to column chromatography and eluted with *n*-hexane-ethyl acetate (from 9:1 to 8:2) to produce subfractions C₁-C₂. Subfraction C₂ (1.2 g) was purified by planar radial chromatography using *n*-hexane-chloroform (from 9:1 to 3:7) yielded compound **1** (76 mg).

The *n*-hexane fraction (30 gr) was subjected to vacuum liquid chromatography over silica gel and eluted with *n*-hexane-ethyl acetate (from 9:1 to 8:2) to give fractions D and E. Fraction D (20 g) was re-fractionated using column chromatography and eluted with *n*-hexane-ethyl acetate (from 9:1 to 8:2) gave sub-fractions D₁-D₂. Subfraction D₁ (2.84 g) was purified by planar radial chromatography using *n*-hexane-ethyl acetate (9:1) to yielded sub-fraction D₁₁-D₁₃. Sub-fraction D₁₂ (487 mg) was purified by planar radial chromatography using *n*-hexane-ethyl acetate (9:1) to give D₁₂₁-D₁₂₅. Subfraction D₁₂₅ (227.2 mg) was purified by planar radial chromatography using *n*-hexane-ether (9:1) to yielded compound **2** (30 mg).

2.4 Cytotoxic assay

Compounds **1-2** were tested to *in vitro* evaluating against murine leukemia P-388 cells by using MTT colorimetric method as previously reported [9-11]. Artonin E was used as the positive control.

3. Result and Discussion

Calofolic acid B (1), a yellow solid, m.p. 117-118 °C, showed a quasimolecular ion [M+H]⁺ at *m/z* 359.1538 corresponding to the molecular formula C₂₀H₂₄O₆. The UV absorption at λ_{max} (nm) (log ε) = 225 (3.35), 274 (3.89), 289 (3.27), 305 (3.33), 312 (3.35), and 338 (2.60) typical for a chromanone acid [5]. The IR spectrum of **1** indicated absorptions for hydroxyl (3423 cm⁻¹), conjugated carbonyl (1620 cm⁻¹), aromatic (1577 and 1545 cm⁻¹) and ether (1188 cm⁻¹) groups, respectively. The ¹H NMR spectrum of **1** (Table 1) showed the presence of a 2,3-dimethylchromanone ring which represent by a pair of methine signals [δ_H 4.51 (1H, *dq*, *J* = 6.5 and 3.2 Hz) and 2.55 (1H, *dq*, *J* = 7.2 and 3.2 Hz)] and two proton signals of methyl [δ_H 1.35 (3H, *d*, *J* = 6.5 Hz) and δ_H 1.13 (3H, *d*, *J* = 7.3 Hz)], a chelated hydroxyl group (δ_H 12.37 (*s*, 5-OH), a dimethylpyrano ring group [δ_H 6.60 (1H, *d*, *J* = 10.0 Hz), δ_H 5.46 (1H, *d*, *J* = 10.0 Hz), and *gem* dimethyl group at δ_H 1.38 (3H, *s*), δ_H 1.45 (3H, *s*), and an alkyl carboxylic group consist of a methine [δ_H 3.77 (1H, *m*), a methylene [δ_H 2.67 (1H, *dd*, *J* = 7.4, 15.2 Hz), δ_H 2.82 (1H, *dd*, *J* = 8.3, 15.2 Hz)], and a methyl [δ_H 1.26 (3H, *d*, *J* = 7.2 Hz)]. The ¹³C NMR spectrum of **1** showed 20 carbon signals and the structure of **1** were confirmed by HMQC and HMBC spectra (Figure 1). The ¹³C NMR spectrum of **1** corresponding to the chromanone acid. The 1D and 2D NMR spectra data are consistent with the previous published data [8].

Apetic acid (2), a yellow solid, m.p. 117-118 °C, [α]_D²⁰ +56° (*c* = 0.0005, MeOH). The UV spectrum λ_{max} (nm) (log ε) = 227 (3.39), 274 (3.96), 300 (3.41), 305 (3.39), 311 (3.41) and 336 (2.48) and IR spectrum gave absorptions of 3436, 1622, 1598, 1496, 1446 and 1157 cm⁻¹ similar to those of **1**. The ¹H NMR spectrum of **2** very similar with **1** and the main difference is alkyl carboxylic group at C-10. The ¹H NMR spectrum of **2** (Table 1) showed the presence of a 2,3-dimethylchromanone ring consist of a pair of methine [δ_H 4.50 (1H, *dq*, *J* = 6.5 and 3.2 Hz) and 2.53 (1H, *dq*, *J* = 7.3 and 3.2 Hz)] and two proton signals of methyl [δ_H 1.35 (3H, *d*, *J* = 6.6 Hz) and δ_H 1.13 (3H, *d*, *J* = 7.2 Hz)], a chelated hydroxyl group (δ_H 12.39, *s*, 5-OH), a dimethylpyrano ring group [δ_H 6.60 (1H, *d*, *J* = 10.0 Hz), δ_H 5.45 (1H, *d*, *J* = 10.0 Hz), and *gem* dimethyl group δ_H 1.37 (3H, *s*), δ_H 1.44 (3H, *s*), and an alkyl carboxylic group consist of a methine [δ_H 3.68 (1H, *m*), three methylene [δ_H 2.66 (1H, *dd*, *J* = 6.9, 15.2 Hz), δ_H 2.82 (1H, *dd*, *J* = 8.7, 15.2 Hz), δ_H 1.54 (1H, *m*), δ_H 1.82 (1H, *m*), δ_H 1.19 (2H, *m*), and a methyl [δ_H 0.85 (3H, *t*, *J* = 7.3 Hz)]. The ¹³C NMR (Table.1) of **2** showed 22 carbon signals. The assignment of ¹³C NMR spectrum was

confirmed by ²⁶HMQC and HMBC spectra (Figure 1). The 1D and 2D NMR spectra data are consistent with those of published data [12].

²⁵Table-1. NMR spectroscopic data of compounds 1-2 in CDCl₃

No	¹⁶ Calofolic acid B (1)			Apetalic acid (2)		
	δ_H (mult, J in Hz)	δ_c	HMBC	δ_H (mult, J in Hz)	δ_c	HMBC
1	-	-	-	-	-	-
2	4.51 (dq, 3.2; 6.5)	76.1	C-4; C-16	4.50 (dq, 3.2; 6.5)	76.1	C-4, C-16
3	2.55 (dq, 3.2; 7.2)	44.2	C-4; C-16	2.53 (dq, 3.2; 7.3)	44.3	C-4; C-16
4	-	20.1	-	-	20.1	-
5	-	15.7	-	-	15.7	-
6	6.60 (d, 10.0)	11.5	C-8; C-13; C-14	6.60 (d, 10.0)	11.5	C-8; C-13; C-14
7	5.46 (d, 10.0)	12.5	C-8; C-13; C-17; C-18	5.45 (d, 10.0)	12.5	C-8; C-13; C-17; C-18
8	-	78.2	-	-	78.2	-
9	-	-	-	-	-	-
10	-	11.0	-	-	10.8	-
11	-	15.9	-	-	15.7	-
12	-	10.1	-	-	10.3	-
13	-	10.2	-	-	10.6	-
14	-	15.9	-	-	15.9	-
15	1.35 (d, 6.5)	16.2	C-2; C-3	1.35 (d, 6.6)	16.3	C-2; C-3
16	1.13 (d, 7.3)	9.4	C-2; C-3; C-4	1.13 (d, 7.2)	9.4	C-2; C-3; C-4
17	1.38 (s)	28.1	C-7; C-8; C-18	1.44 (s)	28.6	C-7; C-8; C-18
18	1.45 (s)	28.5	C-7; C-8; C-17	1.37 (s)	28.1	C-7; C-8; C-17
19	3.77 (m)	25.6	C-10; C-14; C-20; C-22	3.68 (m)	30.2	C-10; C-14; C-20; C-21; C-22
20	2.67 (dd, 7.4;	39	C-10; C-19; C-	2.66 (dd, 6.9; 15.2)	38	C-10; C-19;

	15.2) 2.82 (<i>dd</i> , 8.3; 15.2)	.5	21; C-22	2.82 (<i>dd</i> , 8.7; 15.2)	.6	C-21; C-22
21	-	17 9. 6	-	-	17 9. 5	-
22	1.26 (<i>d</i> , 7.2)	19 .3	C-10; C-19; C-20	1.54 (<i>m</i>) 1.82 (<i>m</i>)	35 .5	C-10; C-19; C-20; C-23; C-24
23	-	-	-	1.19 (<i>m</i>)	20 .8	C-19; C-22; C-24
24	-	-	-	0.85 (<i>t</i> , 7.3)	14 .1	C-22; C-23
5-OH	12.37 (<i>s</i>)	-	C-5; C-12; C-13	12.39	-	C-5; C-12; C-13

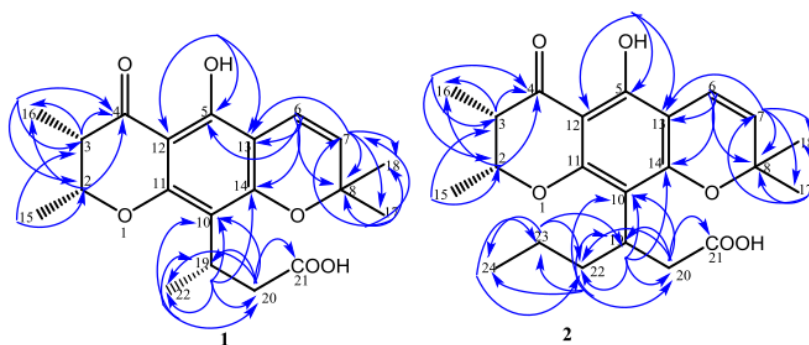


Figure 1. HMBC correlations for compounds 1 and 2

The cytotoxic activity of compounds 1-2 was evaluated for their cytotoxicity by MTT assay against murine leukemia P-388 (Table. 2). Artonin E was used as the positive control. Those cytotoxic data for chromanone acid suggested that compound 1 has active and compound 2 was inactive.

Table-2. Cytotoxic activity data of compounds 1-2 by MTT assay.

N	Compound	IC ₅₀ (µg/mL)
1	Calofolic acid B (1)	1.14
2	Apetalic acid (2)	> 100
3	Artonin E	1.33

4. Conclusions

Chemical study on the stem bark of *C. incrassatum* yielded two chromanone acid derivatives, calofolic acid B (1) and apetalic acid (2). Calofolic acid B (1) showed very active against murine leukemia P-388 cells.

References

- [1] Heyne, K., 1987, The useful Indonesian plants research and development agency. Jakarta: Ministry of forestry.

- [2] Kar, W.L., Zamakshshari, N.H., Ee, G.C.L., Mah, S.H., and Mohd, N.S.M., 2018, Isolation and structural modification of ananixanthone from *Calophyllum teysmannii* and their cytotoxic activities, *J. Nat. Prod.*, **32**(18), 2147-2151.
- [3] Daud, S.B., Ee G.C.L., Malek, E.A., Teh, S.S., See, I., 2014, A new coumarin from *Calophyllum hosei*, *Nat. Prod. Res.*, **28**(19), 1534-1538.
- [4] Tanjung, M., Rachmadiarti, F., Prameswari, A., Agyani, V.U.W., Saputri, R.D., Tjahjandarie, T.S., and Syah, Y.M. 2018 Airlangin A-B, two new isoprenylated benzofuran-3-ones from the stem bark of *Calophyllum soulattri*, *Nat. Prod. Res.*, **32**(13), 1493-1498.
- [5] Ferchichi, L., Derbre, S., Mahmood, K., Toure, K., Guilet, D., Litaudon, M., Awang, K., Hadi, A.H., A., Le Ray, A.M., Richomme, P. 2012, Bioguided fraction and isolation of natural inhibitors of advance glycation end-products (AGEs) from *Calopyllum flavoramulum* *Phytochem.*, **78**, 98-106.
- [6] Lim, C.K., Subramaniam, H., Say, Y.H., Jong, V.Y., Khaledi, H., Chee, C.F., 2015, A New chromanone acid from the stem bark of *Calophyllum teysmannii*, *Nat. Prod. Res.*, **29** (21) 1970-1977.
- [7] Ha, L.D., Hansen, P. E., Duus, F., Pham, H.D., Nguyen, L.D., 2012, A New chromanone acid from the bark of *Calophyllum dryobalanoides*, *Phytochem. Lett.*, **5**(2), 287-291.
- [8] Nugroho, A.E., Sasaki, T., Kaneda, T., Hadi, A.H.A., Morita, H., 2017 Calofolic acids A-F chromanones from the bark of *Calophyllum scriblitifolium* with vasorelaxation activity, *Bioorg. Med. Chem. Lett.*, **27**(10), 2124-2128.
- [9] Tanjung, M., Hakim, E.H., Syah, Y.M., 2017, Prenylated dihydrostilbenes from *Macaranga rubiginosa*. *Chem Nat. Compd.*, **53**(2), 215-218.
- [10] Tanjung, M., Saputri, R.D., Wahjoedi, R.A., Tjahjandarie, T.S., 2017, 4-Methoxy-3-(3-methylbut-2-en-1-yl)-7-((3-methylbut-2-en-1-yl)oxy) quinolin-2(1H)-one from *Melicope moluccana* T.G. Hartley, *Molbank*, **2**, M939.
- [11] Tanjung, M., Rachmadiarti, F., Saputri, R.D., Tjahjandarie, T.S., 2018, Mesucalophylloidin, a new isoprenylated 4-phenylcoumarin from *Mesua calophylloides* (Ridl.) Kosterm., *Nat. Prod. Res.*, **32**(9), 1062-1067.
- [12] Shen, Y., Wang, L., Khalil, A. T., Kuo, Y. 2004 Chromanones and dihydrocoumarins from *Calophyllum blancoi* *Chem. Pharm. Bull* **52** (4) 402-405.

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