

Calodioscurins A and B, two
new isoprenylated xanthenes
from the stem bark of
Calophyllum dioscurii P.F.
Stevens

by Tjitjik Srie Tjahjandarie

Submission date: 02-Sep-2019 06:39PM (UTC+0800)

Submission ID: 1166208378

File name: ones_from_the_stem_bark_of_Calophyllum_dioscurii_P_F_Stevens.pdf (865.14K)

Word count: 3176

Character count: 14276




Calodioscurins A and B, two new isoprenylated xanthenes from the stem bark of *Calophyllum dioscurii* P.F. Stevens

Tjitjik Srie Tjahjandarie, Mulyadi Tanjung, Dhaniar Farah Rahmania, Churin In Rhidoma & Ratih Dewi Saputri

To cite this article: Tjitjik Srie Tjahjandarie, Mulyadi Tanjung, Dhaniar Farah Rahmania, Churin In Rhidoma & Ratih Dewi Saputri (2019): Calodioscurins A and B, two new isoprenylated xanthenes from the stem bark of *Calophyllum dioscurii* P.F. Stevens, Natural Product Research, DOI: 10.1080/14786419.2019.1643864

To link to this article: <https://doi.org/10.1080/14786419.2019.1643864>

 View supplementary material 

 Published online: 22 Jul 2019.

 Submit your article to this journal 

 Article views: 9

 View Crossmark data 



Calodioscurins A and B, two new isoprenylated xanthenes from the stem bark of *Calophyllum dioscurii*

P.F. Stevens

Tjitjik Srie Tjahjandarie, Mulyadi Tanjung, Dhaniar Farah Rahmania, Churin In Rhidoma and Ratih Dewi Saputri

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

ABSTRACT

Two new isoprenylated xanthenes, calodioscurin A (**1**) and B (**2**) were isolated from the stem bark of *Calophyllum dioscurii* P.F. Stevens along with two known isoprenylated 4-phenylcoumarins, apetalolide (**3**) and methyl inophyllum P (**4**). The structures of two new compounds were determined based on their HRESIMS, IR, UV, 1D and 2D NMR spectral data. Compounds **1–4** were assayed on P-388 cells, compound **2** showed IC₅₀ value 11.5 μM and categorised moderate activity.

ARTICLE HISTORY

Received 11 June 2019
Accepted 4 July 2019

KEYWORDS


Calodioscurins A and B;
isoprenylated xanthone;
Calophyllum dioscurii;
P-388 cell



1. Introduction

Calophyllum dioscurii P.F. Stevens (Calophyllaceae) is one species of endemic plant from Indonesia. The decoction of leaves and stem bark of this plant were used to treat fever and skin disease (Heyne 1987). *Calophyllum* plants were known to yield phenolic

CONTACT Tjitjik Srie Tjahjandarie [✉ tjitjiktjahjandarie@fst.unair.ac.id](mailto:tjitjiktjahjandarie@fst.unair.ac.id)

 Supplemental data for this article can be accessed at <https://doi.org/10.1080/14786419.2019.1643864>.

© 2019 Informa UK Limited, trading as Taylor & Francis Group

compounds especially isoprenylated benzofurans, isoprenylated xanthenes (Tanjung et al. 2018a, 2018b) and isoprenylated 4-phenylcoumarins (Zou et al. 2010). Isoprenylation of xanthenes as a major compound on *Calophyllum* genus shows to increase cytotoxic activities toward variety of human cancer cells (Mah et al. 2015). Based on literature study, no isoprenylated xanthone from *C. dioscurii* was reported yet. In continuation of our research on *Calophyllum* plants from Indonesia, two new isoprenylated xanthenes (calodioscurins A and B) were isolated from the stem bark of *C. dioscurii*. All of isolated compounds also reported the cytotoxic assayed toward murine leukemia cells P-388.

2. Result and discussion

Calodioscurin A (**1**) showed positive ion peak $[M + H]^+$ at m/z 477.2268 corresponding to the molecular formula $C_{29}H_{32}O_6$ based on the information provided at HRESIMS spectrum. Four absorption bands at λ_{max} 217 (3.03), 269 (3.08), 289 (3.20) and 325 (2.81) nm showed that of **1** possesses xanthone chromophore (Ito et al. 2002). The IR spectrum of **1** indicated absorptions for hydroxyl (3411 cm^{-1}), conjugated carbonyl (1649 cm^{-1}), aromatic (1604 and 1579 cm^{-1}) and ether (1159 cm^{-1}) groups. A signal of aromatic in the ^1H NMR spectrum of **1** at δ_H 7.58 (H-8) is typical for 1,2,3,4,5,6,7-heptasubstituted xanthone (Iinuma et al. 1997). Additionally, compound **1** showed the proton signals of hydroxyl group, methoxyl group, isoprenyl, and 2,2-dimethylpyrano ring that confirmed by 2D-NMR spectrum. Two signals of hydroxyl group demonstrated at δ_H 13.19 (1-OH), δ_H 5.64 (5-OH), and a methoxyl signal at δ_H 3.99 (6-OCH₃). Furthermore, compound **1** also showed a 2,2-dimethylpyrano ring signal at δ_H 6.74 (1H, d, $J = 10.0$ Hz, H-4), 5.60 (1H, d, $J = 10.0$ Hz, H-3), 1.48 (6H, s, H-5/H-6) as well as two isoprenyl signals at δ_H 5.29 (1H, t, $J = 7.2$ Hz, H-2), 5.26 (1H, t, $J = 7.6$ Hz, H-2), 3.51 (2H, t, $J = 7.2$ Hz, H-1), 3.41 (2H, t, $J = 7.6$ Hz, H-1), 1.87 (3H, s, H-5), 1.76 (3H, s, H-5), 1.74 (3H, s, H-4), and 1.71 (3H, s, H-4). The ^{13}C NMR (APT experiment) spectrum, compound **1** showed the existence of seven methyl carbon signals (including one methoxyl carbon), two methylene carbon signals, five methine carbon signals and 15 quaternary carbon signals (including one carbonyl carbon, one oxycarbon and six oxyaryl carbons). The location of two hydroxyls, a methoxyl, two isoprenyl, and a 2,2-dimethylpyrano ring was established by HMQC and HMBC spectra. A signal of hydroxyl at δ_H 13.19 (1-OH) demonstrated correlation to C-1 (δ_C 156.1), C-2 (δ_C 104.6), C-9a (δ_C 103.3), whilst a vinyl signal of a 2,2-dimethylpyrano ring at δ_H 6.74 (H-4) correlated to C-3 (δ_C 158.1), C-2' (δ_C 78.2) and a vinyl signal at δ_H 5.60 (H-3) correlated to C-2 (δ_C 104.6), C-2' (δ_C 78.2) showing that 2,2-dimethylpyrano ring fused at C-2 and C-3. The appearance of long-range correlations of a methylene at δ_H 3.51 (H-1) to C-3 (δ_C 158.1), C-4 (δ_C 107.3), C-4a (154.2), C-2' (δ_C 122.6), C-3' (δ_C 131.7), and the signal of a gem dimethyl at δ_H 1.87 (H-5) and δ_H 1.71 (H-4) correlated to C-2' (δ_C 122.6), C-3' (δ_C 131.7) obviously located the isoprenyl side chain at C-4. A signal of hydroxyl group at δ_H 5.64 (5-OH) showed correlation with three oxyaryl carbons [C-5 (δ_C 137.0), C-6 (δ_C 149.9), C-10a (δ_C 143.3)], and a signal of methoxyl at δ_H 3.99 (6-OCH₃) correlated to C-6 (δ_C 149.9) supported that a hydroxyl attached at C-5 and a methoxyl at C-6. A signal of a methylene at δ_H 3.41 (H-1) correlated to C-6 (δ_C 149.9), C-7 (δ_C 116.5), C-2' (δ_C

121.8), C-3' (δ_C 131.7) indicating that isoprenyl located at C-7. A signal of aromatic at δ_H 7.58 (H-8) correlated to C-6 (δ_C 149.9), C-9 (δ_C 180.9), C-10a (δ_C 143.3), and C-1' (δ_C 28.5) was supported the location of isoprenyl at C-7. From HRESIMS, 1D and 2D-NMR spectra, compound **1** was established as calodioscurin A.

Calodioscurin B (**2**) was established the molecular formula $C_{28}H_{33}O_5$ deduced from a positive ion peak $[M + H]^+$ at 449.2327 of HRESIMS spectrum. From IR spectrum revealed the presence of hydroxyl (3448 cm^{-1}), conjugated carbonyl (1651 cm^{-1}), aromatic (1627 and 1579 cm^{-1}) and ether (1186 cm^{-1}). Five absorption bands at λ_{\max} 217 (3.33), 234 (3.12), 255 (3.02), 263 (2.98) and 299 (2.69) nm, indicated that compound **2** was a typical for a modified xanthone (Ito et al. 2002). The ^1H NMR spectrum, compound **2** showed a signal of aromatic at δ_H 6.34 (H-4), and a signal of methylene at δ_H 2.91 (H-5) as well as a methylene splitted into two signals at δ_H 2.88 (H-6a), and δ_H 2.53 (H-6b) confirmed a modified xanthone. Additionally, compound **2** showed signals of two hydroxyl groups, two isoprenyl side chains, and a 2-methyl-1,3-butadienyl side chain that were confirmed by 2D-NMR spectrum. Two hydroxyl signals showed at δ_H 13.27 (1-OH), and δ_H 6.24 (3-OH). Two isoprenyl side chain signals showed two methylene signals at δ_H 3.45 (2H, d, $J = 7.0\text{ Hz}$, H-1), a methylene splitted into two signals [δ_H 3.24 (1H, dd, $J = 8.0$; 14.0 Hz , H-1a), δ_H 3.04 (1H, dd, $J = 8.0$; 14.0 Hz , H-1b)]; two vinylic signals [δ_H 5.28 (1H, tm, $J = 7.0\text{ Hz}$, H-2), δ_H 4.68 (1H, tm, $J = 7.9\text{ Hz}$, H-2)], and four methyl signals [δ_H 1.78 (3H, s, H-4), 1.84 (3H, s, H-5), δ_H 1.52 (3H, s, H-4), 1.50 (3H, s, H-5)]. The presence of 2-methyl-1,3-butadienyl side chain showed two vinylic signals [δ_H 5.81 (1H, dd, $J = 8.0$; 14.0 Hz , H-1), δ_H 6.06 (1H, dd, $J = 8.0$; 14.0 Hz , H-2)], a methylene terminal splitted into two signals [δ_H 4.94 (1H, s, H-4a), δ_H 4.88 (1H, s, H-1b)] and a methyl signal at δ_H 1.82 (3H, s, H-5). The ^{13}C NMR spectrum, compound **2** showed 28 carbon signals completely separated. Compound **2** showed 13 carbon signals of a modified xanthone nucleus [δ_C 206.7, δ_C 180.8, δ_C 164.2, δ_C 161.4, δ_C 159.5, δ_C 155.4, δ_C 117.7, δ_C 109.7, δ_C 105.0, δ_C 93.6, δ_C 56.1, δ_C 35.1, δ_C 27.5], 10 carbon signals of two isoprenyl side chains [δ_C 136.5, δ_C 135.2, δ_C 121.1, δ_C 119.5), δ_C 33.1, δ_C 26.1, δ_C 26.0, δ_C 21.6, δ_C 18.0, δ_C 17.9] and five carbon signals of a 2-methyl-1,3-butadienyl side chain (δ_C 141.4, δ_C 133.6, δ_C 131.3, δ_C 117.5, δ_C 18.7). The placement of two hydroxyl groups, a carbonyl of cyclohexanone, a 2-methyl-1,3-butadienyl side chain, and two isoprenyl side chains on a modified xanthone was confirmed by HMQC and HMBC spectra. A hydroxyl group signal at δ_H 13.27 (1-OH) correlated to C-1 (δ_C 159.5), C-2 (δ_C 109.7), C-9a (δ_C 105.0), and a methylene signal of isoprenyl side chain at δ_H 3.45 (H-1) showed correlation to C-1 (δ_C 159.5), C-2 (δ_C 109.7), C-3 (δ_C 161.4), C-2' (δ_C 121.1), C-3' (δ_C 136.5), consequently an isoprenyl side chain located at C-2. A hydroxyl group signal at δ_H 6.24 (3-OH) correlated to C-3 (δ_C 161.4), and C-4 (δ_C 93.6) indicated that a hydroxyl group placed at C-3. Long-range correlations of a signal of aromatic at δ_H 6.34 (H-4) to C-2 (δ_C 109.7), C-3 (δ_C 161.4), C-4a (δ_C 155.4), C-9a (δ_C 105.0) were confirmed a isoprenyl at C-2 and a hydroxyl at C-3. A methylene of cyclohexanone signal on a modified xanthone at δ_H 2.91 (H-5) showed long-range correlations to C-6 (δ_C 35.1), C-7 (δ_C 206.7), C-8a (δ_C 117.7), and C-10a (δ_C 164.2) indicated that a carbonyl placed at C-7. The methylene signal of another isoprenyl at δ_H 3.24 (H-1a) and δ_H 3.04 (H-1b) correlated to carbonyl at C-7 (δ_C 206.7), a quaternary carbon at C-8 (δ_C 56.1), and C-2' (δ_C 119.5), C-3' (δ_C 135.2) was assigned the isoprenyl side chain

at C-8. A vinyl signal of 2-methyl-1,3-butadienyl at δ_{H} 5.81 (H-1) correlated to quaternary carbon at C-8 (δ_{C} 56.1), C-3' (δ_{C} 141.4), C-4' (δ_{C} 117.5), and C-5' (δ_{C} 18.7) confirmed a 2-methyl-1,3-butadienyl side chain at C-8. Therefore, the structure of compound **2** was assigned as calodioscurin B.

Two known 4-phenylcoumarins, apetalolide (**3**) and methyl inophyllum P (**4**) from HRESIMS, 1D and 2D-NMR spectra identically with available spectra data (Zou et al. 2010).

Compounds (**1–4**) (Figure 1), the cytotoxic effect against P-388 cells were assessed by MTT method, showing IC_{50} values of 11.5 ± 0.78 , 26.38 ± 0.92 , 53.9 ± 0.36 , and $83.9 \pm 1.12 \mu\text{M}$, respectively (Tanjung et al. 2018a, 2018b). The structure-activity relationship against P-388 cells of compounds (**1–4**) were discussed based on the type of compounds. Those cytotoxic effects for isoprenylated xanthenes (**1–2**) more than active compared to isoprenylated 4-phenylcoumarins (**3–4**). The cytotoxic effect suggested that compound **2** showed moderate activity, compound **1** displayed weak activity, and compounds (**3–4**) were inactive. The structure of **2** is a modified xanthone undergoes a keto-enol tautomerism reaction which is suggested to increase the cytotoxic effect of P-388 cells (Ito et al. 2002).

3. Experimental

3.1. Plant material

Collecting fresh sample of *C. dioscurii* was obtained from the Batam conserved forest, Riau Island, Indonesia on Dec 2015 by Mr. Ismail Rachman. The specimen (CD 00025) was identified in Herbarium Bogoriense, Center of Biological Research and Development, National Institute of Science, Bogor, Indonesia.

3.2. Extraction and isolation

The dried powdered stem bark of *C. dioscurii* (2.1 kg) was extracted with MeOH two times (each 5 L, 3 days) at room temperature. Evaporation of the solvent with rotavapor gave the MeOH extract (430 g). The MeOH extract was suspended in water (9:1 v/v), and then partitioned with *n*-hexane (18 g) and EtOAc (13.5 g) respectively. A part of EtOAc extract (13 g) was chromatographed on polyamide and then eluted with *n*-hexane- EtOAc (from 9:1 to 3:7) to give three fractions. Fraction B (435 g) was chromatographed with the same method and eluted with *n*-hexane- EtOAc (from 9:1 to 4:1) gave four subfractions B₁-B₄. Compound **1** (8 mg) was isolated from subfraction B₂ by radial planar chromatography using *n*-hexane-CHCl₃ (from 9:1 to 7:3). Subfraction C (610 mg) was purified by planar radial chromatography using *n*-hexane-acetone (from 19:1 to 4:1) to yield compound **2** (9 mg), compound **3** (11 mg), and compound **4** (7 mg).

3.3. Spectral data

Calodioscurin A (**1**): yellow solid, UV/Vis (MeOH) λ_{max} (nm) (log ϵ): 217 (3.03), 269 (3.08), 289 (3.20) and 325 (2.81) nm. IR (KBr) ν (cm⁻¹): 3411, 2972, 2925, 2852, 1649,

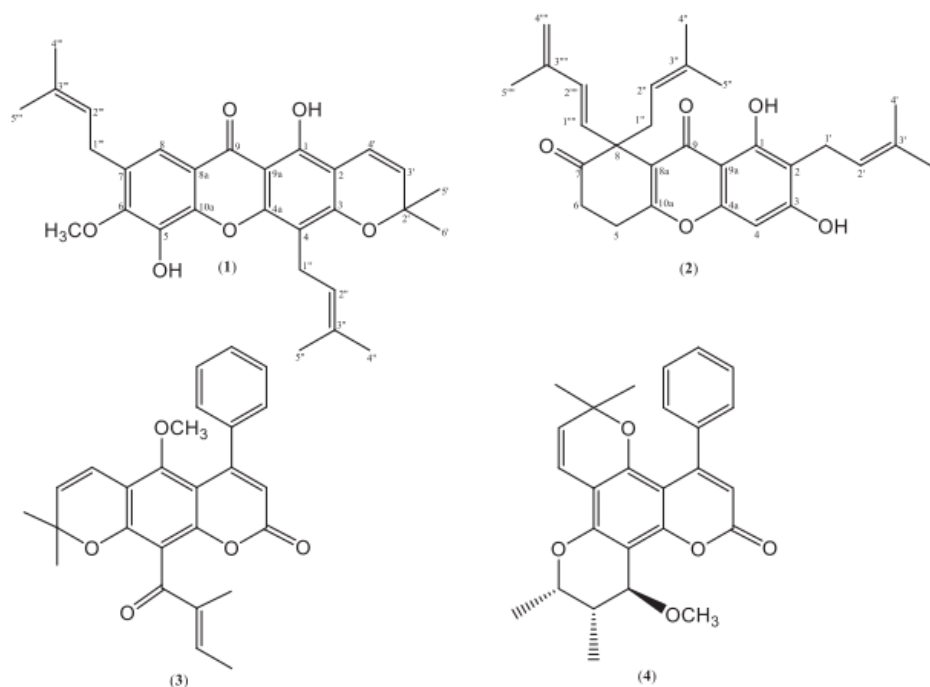


Figure 1. Xanthenes and 4-phenylcoumarins from *C. dioscurii*.

1604, 1579 and 1159. ¹H-NMR (400 MHz, CDCl₃) δ_H ppm: 7.58 (1H, s, H-8), 13.19 (1H, s, 1-OH), 5.64 (1H, s, 5-OH), 3.99 (3H, s, 6-OCH₃), 5.60 (1H, d, J = 10.0 Hz, H-3), 6.74 (1H, d, J = 10.0 Hz, H-4), 1.48 (6H, s, H-5'/H-6'), 3.51 (2H, d, J = 7.2 Hz, H-1), 5.29 (1H, d, J = 7.2 Hz, H-2), 1.71 (3H, s, H-4'), 1.87 (3H, s, H-5'), 3.41 (2H, d, J = 7.2 Hz, H-1'), 5.26 (1H, d, J = 7.6 Hz, H-2'), 1.74 (3H, s, H-4') and 1.76 (3H, s, H-5'). ¹³C-NMR (100 MHz, CDCl₃), δ_C ppm: 156.1 (C-1), 104.6 (C-2), 158.1 (C-3), 107.3 (C-4), 154.2 (C-4a), 137.0 (C-5), 149.9 (C-6), 61.1 (6-OCH₃), 116.5 (C-7), 116.2 (C-8), 120.8 (C-8a), 180.9 (C-9), 103.3 (C-9a), 143.3 (C-10a), 78.2 (C-2), 127.4 (C-3), 115.8 (C-4), 28.4 (C-5/C-6), 21.7 (C-1), 122.6 (C-2), 131.5 (C-3), 25.8 (C-4), 18.0 (C-5), 28.5 (C-1), 121.8 (C-2), 131.7 (C-3), 25.9 (C-4) and 17.9 (C-5). HRESIMS: m/z [M + H]⁺ calcd. for C₂₉H₃₃O₆ 477.2277, found 477.2268.

4. Calodioscurin B (2): yellow solid, UV/Vis (MeOH) λ_{max} (nm) (log ε): 217 (3.33), 234 (3.12), 255 (3.02), 263 (2.98) and 299 (2.69) nm. IR (KBr) ν (cm⁻¹): 3448, 2966, 2923, 2854, 1651, 1627, 1460, and 1186. ¹H-NMR (400 MHz, CDCl₃) δ_H ppm: 6.34 (1H, s, H-4), 2.91 (2H, m, H-5), 2.88 (1H, m, H-6a), 2.53 (1H, m, H-6b), 13.27 (1H, s, 1-OH), 6.24 (1H, s, 3-OH), 3.45 (2H, d, J = 7.0 Hz, H-1), 5.28 (1H, d, J = 7.0 Hz, H-2), 1.78 (3H, s, H-4), 1.84 (3H, s, H-5), 3.24 (1H, dd, J = 8.0; 14.0 Hz, H-1'a), 3.04 (1H, dd, J = 8.0; 14.0 Hz, H-1'b), 4.68 (1H, d, J = 7.9 Hz, H-2), 1.52 (3H, s, H-4), 1.50 (3H, s, H-5), 5.81 (1H, d, J = 16.0 Hz, H-1), 6.06 (1H, d, J = 16.0 Hz, H-2), 4.94 (1H, s, H-4'a), 4.88 (1H, s, H-4'b), and 1.82 (3H, s, H-5). ¹³C-NMR (100 MHz, CDCl₃), δ_C ppm: 159.5 (C-1), 109.7 (C-2), 161.4 (C-3), 93.6 (C-4), 155.4 (C-4a), 27.5 (C-5), 35.1 (C-6), 206.7 (C-7), 56.1 (C-8), 117.7 (C-8a), 180.8 (C-9), 105.0 (C-9a), 164.2 (C-10a), 21.6 (C-1), 121.1 (C-2), 136.5 (C-3), 26.1 (C-4), 18.0 (C-5), 33.1 (C-1), 119.5 (C-2), 135.2 (C-3), 26.0 (C-4), 17.9 (C-5), 131.3 (C-1), 133.6 (C-2), 141.4 (C-3), 117.5 (C-4), and 18.7 (C-5). HRESIMS: m/z [M + H]⁺ calcd. for C₂₈H₃₃O₅ 449.2328, found 449.2327.

3.4. Cytotoxic assay

Effect of compounds (1–4) against P-388 cells (human murine leukaemia) were evaluated in pursuance of the MTT colorimetric method as anteriorly described (Saputri et al. 2018).

4. Conclusions

In this research, two new isoprenylated xanthenes, calodioscurin A (1) and B (2) were found the first time on natural compounds from the stem bark of *C. dioscurii*.

Disclosure statement

No conflict of interest on author's team.

Funding

This research was supported by Research Grant of Universitas Airlangga, Indonesia (Penelitian Hibah Mandat, Universitas Airlangga, 2019).

References

- Heyne K. 1987. The useful Indonesian plants. Jakarta (Indonesia): Research and Development Agency, Ministry of Forestry.
- linuma M, Ito T, Tosa H, Tanaka T, Miyake R, Chelladurai V. 1997. Prenylated xanthonoids from *Calophyllum apetalum*. *Phytochem.* 46(8):1423–1429.
- Ito C, Itoigawa M, Mishina Y, Filho VC, Mukainaka T, Tokuda H, Nishino H, Furukawa H. 2002. Chemical constituents of *Calophyllum brasiliensis*: structure elucidation of seven xanthenes and their cancer chemopreventive activity. *J Nat Prod.* 65(3):267–272.
- Mah SH, Ee GCL, Teh SS, Sukari MA. 2015. *Calophyllum inophyllum* and *Calophyllum soulattri* source of anti-proliferative xanthenes and their structure-activity relationships. *Nat Prod Res.* 29(1):98–101.
- Saputri RD, Tjahjandarie TS, Tanjung M. 2018. Meliglabrin, a new flavonol derivative from the leaves of *Melicope glabra* (Blume) T.G. Hartley. *Nat Prod Sci.* 24(3):155–158.
- Tanjung M, Rachmadiarti F, Prameswari A, Agyani VUW, Saputri RD, Tjahjandarie TS, Syah YM. 2018a. Airlanggins A-B, two new isoprenylated benzofuran-3-ones from the stem bark of *Calophyllum soulattri*. *Nat Prod Res.* 32(13):1493–1498.
- Tanjung M, Rachmadiarti F, Saputri RD, Tjahjandarie TS. 2018b. Mesuacalophylloidin, a new isoprenylated 4-phenylcoumarin from *Mesua calophylloides* (Ridl.) Kosterm. *Nat Prod Res.* 32(9):1062–1067.
- Zou J, Wu J, Liu S-Z, Zhao WM. 2010. New coumarins and triterpenes from *Calophyllum inophyllum*. *Helv Chim Acta.* 93(9):1812–1821.

Calodioscurins A and B, two new isoprenylated xanthenes from the stem bark of *Calophyllum dioscurii* P.F. Stevens

ORIGINALITY REPORT

19%

SIMILARITY INDEX

14%

INTERNET SOURCES

18%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

- 1 Nicholas J Lawrence, Stephen Brown. "The asymmetric synthesis of β -aryl- α -hydroxy esters from β -aryl- α,β -dihydroxy esters", *Tetrahedron*, 2002
Publication 1%
- 2 repositorio.ufpa.br
Internet Source 1%
- 3 Carlos M Cerda-García-Rojas, César A Flores-Sandoval, Luisa U Román, Juan D Hernández, Pedro Joseph-Nathan. "A regioselective Wagner–Meerwein rearrangement directed towards the six-membered ring of the longipinane skeleton", *Tetrahedron*, 2002
Publication 1%
- 4 digital.bl.fcen.uba.ar
Internet Source 1%
- 5 www.nricm.edu.tw
Internet Source 1%
- 6 Hamid, Hinna, S. Tarique Abdullah, Mohammed Ali, and M. Sarwar Alam. "New 1%

Phytoconstituents from the Aerial Parts of
Uraria lagopoides.", Pharmaceutical Biology,
2007.

Publication

7	doaj.org Internet Source	1 %
8	www.ncshm.re.kr Internet Source	1 %
9	Chihiro Ito, Takuya Matsui, Takashi Kobayashi, Harukuni Tokuda, Sivabalan Shanmugam, Masataka Itoigawa. " Cancer Chemopreventive Activity of Xanthones from ", Natural Product Communications, 2018 Publication	1 %
10	Vilailak Prachyawarakorn. "NMR Study Of Seven Coumarins From Mammea Siamensis", Pharmaceutical Biology, 12/1/2000 Publication	1 %
11	proj3.sinica.edu.tw Internet Source	1 %
12	wrap.warwick.ac.uk Internet Source	1 %
13	www.thieme-connect.de Internet Source	1 %
14	Ya-Ching Shen, Chia-Ching Liaw, Jing-Ren Ho, Ashraf Taha Khalil, Yau-Haur Kuo. "	1 %

Isolation of aureol from sp. and cytotoxic activity of some aureol derivatives ", Natural Product Research, 2006

Publication

15 www.tandfonline.com 1 %
Internet Source

16 Mah, Siau Hui, Gwendoline Cheng Lian Ee, Soek Sin Teh, and Mohd Aspollah Sukari. "Calophyllum inophyllum and Calophyllum soulattri source of anti-proliferative xanthenes and their structure–activity relationships", Natural Product Research, 2015. 1 %
Publication

17 Sasa Ponguschariyagul, Jirapast Sichaem, Suttira Khumkratok, Pongpun Siripong, Kiattisak Lugsanangarm, Santi Tip-pyang. "Caloinophyllin A, a new chromanone derivative from roots ", Natural Product Research, 2018 <1 %
Publication

18 impactfactor.org <1 %
Internet Source

19 Benoit Pinel, Anne Landreau, Denis Seraphin, Gerald Larcher, Jean-Philippe Bouchara, Pascal Richomme. " Synthesis of reduced xanthatin derivatives and evaluation of their antifungal activity ", Journal of Enzyme Inhibition and Medicinal Chemistry, 2008 <1 %

- 20 Javidnia, K., R. Miri, H. Rezai, A. Jafari, A. Azarmehr, and Z. Amirghofran. "Biological Activity and Aryltetraline Lignans of *Linum persicum*.", *Pharmaceutical Biology*, 2005.

Publication

- 21 Giovanni Appendino, Giancarlo Cravotto, Giovanni Palmisano, Rita Annunziata. "Oxidative Addition of 4-Hydroxycoumarin to Alkenes. An Expeditious Entry to 2,3-Dihydro-4-furo-[3,2-][1]benzopyran-4-ones", *Synthetic Communications*, 1996

Publication

- 22 Chihiro Ito, Masataka Itoigawa, Yoshitaka Mishina, Valdir Cechinel Filho et al. "Chemical Constituents of : Structure Elucidation of Seven New Xanthones and Their Cancer Chemopreventive Activity ", *Journal of Natural Products*, 2002

Publication

- 23 Lenta, B.N.. "Anthraquinones from the stem bark of *Stereospermum zenkeri* with antimicrobial activity", *Phytochemistry*, 200706

Publication

- 24 Meffo Yemele Bouberte, Karsten Krohn, Hidayat Hussain, Etienne Dongo, Barbara Schulz, Qunxiu Hu. " Tithoniamarin and tithoniamide: a structurally unique

isocoumarin dimer and a new ceramide from ", Natural Product Research, 2006

Publication

-
- | | | |
|----|--|------|
| 25 | eldorado.tu-dortmund.de
Internet Source | <1 % |
| 26 | eprints.whiterose.ac.uk
Internet Source | <1 % |
| 27 | www.hjbc.hacettepe.edu.tr
Internet Source | <1 % |
| 28 | www.jove.com
Internet Source | <1 % |
| 29 | Bao-Ning Su, Rosana Misico, Eun Jung Park, Bernard D Santarsiero et al. "Isolation and characterization of bioactive principles of the leaves and stems of <i>Physalis philadelphica</i> ", <i>Tetrahedron</i> , 2002
Publication | <1 % |
| 30 | Michal Česnek, Antonín Holý, Milena Masořídková. "6-Guanidinopurine nucleosides and their analogues", <i>Tetrahedron</i> , 2002
Publication | <1 % |
| 31 | Okram M. Singh, K. Subharani, N. I. Singh, N. Babita Devi, L. Nevidita. " Isolation of steroidal glycosides from and studies on their antifungal activities ", <i>Natural Product Research</i> , 2007
Publication | <1 % |
-

32	Srinivasa Rao Jada. "* Semisynthesis and cytotoxic activities of andrographolide analogues", Journal of Enzyme Inhibition and Medicinal Chemistry, 4/1/2006 Publication	<1 %
33	Y.-B. Liu. "Two eudesmane sesquiterpenes from Laggera pterodonta", Journal of Asian Natural Products Research, 4/2007 Publication	<1 %
34	hal.archives-ouvertes.fr Internet Source	<1 %
35	jurnal.kimia.fmipa.unmul.ac.id Internet Source	<1 %
36	pergamos.lib.uoa.gr Internet Source	<1 %
37	www.beilstein-journals.org Internet Source	<1 %
38	www.google.com Internet Source	<1 %
39	Boonsri, S.. "Antibacterial and cytotoxic xanthenes from the roots of Cratoxylum formosum", Phytochemistry, 200604 Publication	<1 %
40	Di GENG, Ding-Xiang LI, Yao SHI, Jing-Yu LIANG, Zhi-Da MIN. "A New Benzophenanthridine Alkaloid from Zanthoxylum nitidum", Chinese Journal of Natural Medicines, 2009	<1 %

41 Luisa Pistelli, Cecilia Noccioli, Alessandra Bertoli, Giorgia Scapecchi, Donatella Potenza. " Chemical composition and volatile constituents of ", *Natural Product Research*, 2007 <1 %
Publication

42 Xiang-Hai Cai. "A New Pregnane from *Munronia delavayi* Franch (Meliaceae)", *Journal of Integrative Plant Biology*, 9/2006 <1 %
Publication

43 Zhan, Z.J.. "Novel diterpenoids with potent inhibitory activity against endothelium cell HMEC and cytotoxic activities from a well-known TCM plant *Daphne genkwa*", *Bioorganic & Medicinal Chemistry*, 20050201 <1 %
Publication

44 Wimal Herath, Daneel Ferreira, Ikhlas A. Khan. "Microbial metabolism. Part 7: Curcumin", *Natural Product Research*, 2007 <1 %
Publication

Exclude quotes Off

Exclude matches Off

Exclude bibliography On

Calodioscurins A and B, two new isoprenylated xanthenes from the stem bark of *Calophyllum dioscurii* P.F. Stevens

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7
