

# Phenolic compounds from the stem bark of *Saccopetalum horsfieldii* Benn

*by* Alfinda Novi Kristanti

---

**Submission date:** 09-Mar-2020 05:19PM (UTC+0800)

**Submission ID:** 1272165125

**File name:** 2015-Der\_Pharmacia\_Lettre\_-7-3-149-152.pdf (114.76K)

**Word count:** 2495

**Character count:** 12139



Scholars Research Library

Der Pharmacia Lettre, 2015, 7 (3):149-152  
(<http://scholarsresearchlibrary.com/archive.html>)



## Phenolic compounds from the stem bark of *Saccopetalumhorsfieldii* Benn

Alfinda Novi Kristanti<sup>\*</sup>, Nanik Siti Aminah and Mulyadi Tanjung

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

### ABSTRACT

Column chromatographic separation of the methanol extract from the *Saccopetalumhorsfieldii* Benn's stem bark yielded four phenolic components including three flavonoids, kaempferol-3,4'-dimethylether(1), quercetin-3,7-dimethylether(2), quercetin-3,7,4'-trimethylether(3), and one alkaloid, liriodenine (4). The structures of these compounds were determined based on UV, IR, HRESIMS, 1D and 2D NMR data.

**Keywords:** flavonoid, alkaloid, *Saccopetalumhorsfieldii* Benn, Annonaceae.

### INTRODUCTION

Annonaceae is a family of plants which grows in tropical and subtropical regions. This family consists of 130 genus and more than 2000 species. In Indonesia, there are more than 20 genus. Genus which have been researched are *Annona*, *Guatteria*, *Artabotrys*, *Goniothalamus*, *Polyalthia*, *Uvaria*, *Asimia* and *Xylophia*. [1]. *Saccopetalum* is one genus that has not been much studied. There was only a small amount of research investigated the species belonged to *Saccopetalum* genus, especially *Saccopetalumhorsfieldii* Benn., a plant with a synonym name *Miliosahorsfieldii* [2].

As a result of our research for phenolic compound in this Indonesian plant, we report the isolation of phenolic compounds, kaempferol 3,4'-dimethylether(1), quercetin 3,7-dimethylether(2), quercetin 3,7,4'-trimethylether(3), and liriodenine (4). from the methanol extract of the stem bark of *Saccopetalumhorsfieldii* Benn. The phytochemical data of this species has not been yet reported.

### MATERIALS AND METHODS

#### General

UV and IR spectrum were measured with a Beckman DU-7500 and Perkin Elmer Spectrum FTIR Shimadzu 5300 spectrometer, respectively. <sup>1</sup>H and <sup>13</sup>C NMR spectrum were recorded with a JEOL 400 spectrometer operating at 400 (<sup>1</sup>H) and 100 (<sup>13</sup>C) MHz in DMSO-d<sub>6</sub> using TMS as the internal standard. Mass spectrum was obtained with a Waters LCT Premier XE. Vacuum liquid chromatography (VLC) and column chromatography were carried out using Si gel 60 GF<sub>254</sub> and Si gel 60. For TLC analysis, pre-coated silica gel plates (Merck Kieselgel 60 GF<sub>254</sub>, 0,25 mm thickness) were used.

#### Plant material

The stem bark of *Saccopetalumhorsfieldii* Benn was collected from Purwodadi Botanical Garden, Center of Biological Research and Development, National Institute of Science, Pasuruan District, East Java, Indonesia.

34

**Extraction and isolation**

Milled drystem bark of *Saccopatumhorsfieldii* Benn (3.0kg) were macerated with methanol three times at room temperature, and then concentrated under reduced pressure. The residue was suspended in water and partitioned with *n*-hexane. The methanol extract was concentrated and shaken repeatedly with 5% aqueous citric acid (pH 3-4) and partitioned with dichloromethane. The dichloromethane extract (28.4 g) was fractionated on silica gel by VLC eluting with mixtures *n*-hexane-acetone (19:1, 8:1, 4:1, and 7:3) to give three major fractions A-C. Fraction B (3.6 g), purified using column chromatography eluted with mixture *n*-hexane-ethylacetate (9:1, and 4:1) to give compounds **2** (28 mg) and **3** (80 mg). Furthermore, fraction C (5.6 g) eluted with mixture *n*-hexane-acetone (9:1, 4:1 and 7:3) yielded compounds **2** (18 mg). The acid fraction was basified with 28% ammoniac solution (pH 8-9) and partitioned with ethylacetate to yield of crude alkaloids. The crude alkaloids (5.0 g) was fractionated on silica gel by column chromatography eluting with mixture *n*-hexane-chloroform (4:1 and 7:3), chloroform, and mixtures of chloroform-methanol (9:1, and 4:1) to give four major fractions A-D. Fraction D (800mg), purified using column chromatography eluted with *n*-hexane-acetone (9:1, 4:1, and 7:3), to give compounds **4** (26 mg).

**Kaempferol 3,4'-dimethyl ether (1)**: Pale yellow solid; m.p. 237°C; UV (MeOH)  $\lambda_{\max}$  (nm) (log  $\epsilon$ ): 203 (4.68), 264 (4.28), 346 (3.80); LC-ESI-MS  $m/z$  314 [M]<sup>+</sup>; <sup>1</sup>H NMR (400 MHz, acetone-d<sub>6</sub>)  $\delta_{\text{H}}$  (ppm): 6.23 (1H, d,  $J = 2.4$ Hz, H-6), 6.47 (1H, d,  $J = 2.4$ Hz, H-8), 8.05 (2H, d,  $J = 9.2$ Hz, H-2'/6'), 7.05 (2H, d,  $J = 9.2$ Hz, H-3'/5'), 3.84 (3H, s, 3-OCH<sub>3</sub>), 3.87 (3H, s, 4'-OCH<sub>3</sub>), 12.75 (1H, s, 5-OH); <sup>13</sup>C NMR (100 MHz, acetone-d<sub>6</sub>)  $\delta_{\text{C}}$  (ppm): 156.5 (C-2), 139.4 (C-3), 179.5 (C-4), 106.3 (C-4a), 169.0 (C-5), 97.0 (C-6), 164.8 (C-7), 94.6 (C-8), 157.8 (C-8a), 126.0 (C-1'), 131.1 (C-2'/6'), 115.3 (C-3'/5'), 162.7 (C-4'), 60.4 (3-OCH<sub>3</sub>), 55.8 (4'-OCH<sub>3</sub>).

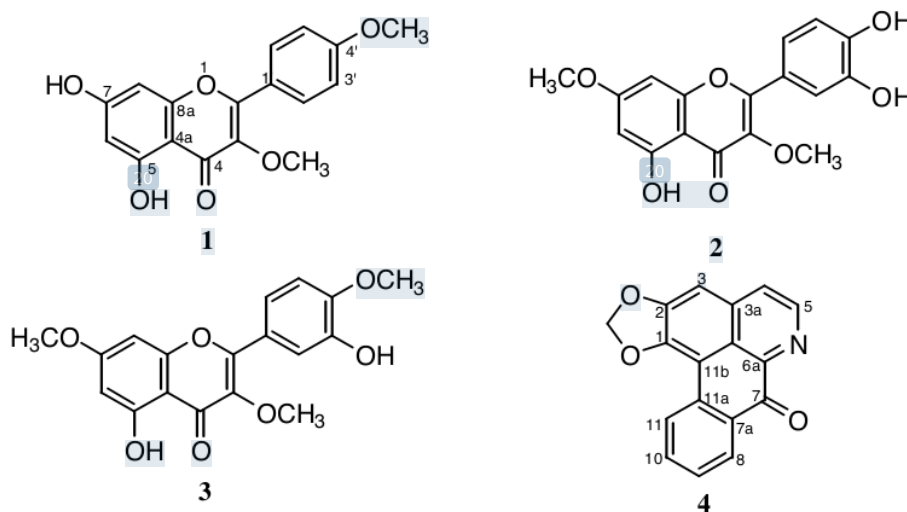


Figure 1. Structures of phenolic compounds

**Quercetin 3,7-dimethyl ether (2)**: Pale yellow solid; m.p. 224-226°C; UV (MeOH)  $\lambda_{\max}$  (nm) (log  $\epsilon$ ): 203 (4.62), 257 (4.25), 359 (3.78); IR (KBr)  $\nu_{\max}$  (cm<sup>-1</sup>): 3204 (OH), 2928, 2921 (CH alkyl), 1643 (conj. C=O), and 1545, 1390 C=C aromatic). <sup>1</sup>H NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta_{\text{H}}$  (ppm): 6.35 (1H, d,  $J = 2.2$ Hz, H-6), 6.68 (1H, d,  $J = 2.2$ Hz, H-8), 7.58 (1H, d,  $J = 2.2$ Hz, H-2'), 6.91 (1H, d,  $J = 8.4$ Hz, H-5'), 7.47 (1H, dd,  $J = 8.4, 2.2$ Hz, H-6'), 3.80 (3H, s, 3-OCH<sub>3</sub>), 3.86 (3H, s, 7-OCH<sub>3</sub>), 12.67 (1H, s, 5-OH); <sup>13</sup>C NMR (100 MHz, DMSO d<sub>6</sub>)  $\delta_{\text{C}}$  (ppm): 145.0 (C-2), 137.7 (C-3), 177.7 (C-4), 105.0 (C-4a), 160.7 (C-5), 95.5 (C-6), 164.8 (C-7), 92.0 (C-8), 156.0 (C-8a), 120.5 (C-1'), 115.5 (C-2'), 148.6 (C-3'), 155.7 (C-4'), 115.4 (C-5'), 120.4 (C-6'), 59.5 (3-OCH<sub>3</sub>), 55.9 (7-OCH<sub>3</sub>).

**Quercetin 3,7,4'-trimethyl ether (3)**: Pale yellow solid; m.p. 173-175°C; UV (MeOH)  $\lambda_{\max}$  (nm) (log  $\epsilon$ ): 204 (4.62), 255 (4.25), 348 (3.78); IR (KBr)  $\nu_{\max}$  (cm<sup>-1</sup>): 3443 (OH), 1641 (conj. C=O), and 1580, 1421 C=C aromatic). <sup>1</sup>H NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta_{\text{H}}$  (ppm): 6.33 (1H, d,  $J = 2.2$ Hz, H-6), 6.67 (1H, d,  $J = 2.2$ Hz, H-8), 7.54 (1H, d,  $J = 2.0$ Hz, H-2'), 7.09 (1H, d,  $J = 8.2$ Hz, H-5'), 7.55 (1H, dd,  $J = 8.2, 2.0$ Hz, H-6'), 3.88 (3H, s, 3-OCH<sub>3</sub>), 3.86 (3H, s, 7-OCH<sub>3</sub>), 3.81 (3H, s, 4'-OCH<sub>3</sub>), 12.61 (1H, s, 5-OH); <sup>13</sup>C NMR (100 MHz, DMSO d<sub>6</sub>)  $\delta_{\text{C}}$  (ppm): 146.1 (C-2), 137.7 (C-3), 177.8 (C-4), 105.0 (C-4a), 160.7 (C-5), 97.5 (C-6), 164.8 (C-7), 92.0 (C-8), 156.0 (C-8a), 122.0 (C-1'), 115.5 (C-2'), 150.1 (C-3'), 155.3 (C-4'), 111.7 (C-5'), 120.2 (C-6'), 59.6 (3-OCH<sub>3</sub>), 55.9 (7-OCH<sub>3</sub>), 55.6 (4'-OCH<sub>3</sub>).

**Liriodenine(4):** Pale yellow solid: UV (MeOH)  $\lambda_{\max}$  272, 317nm; FAB-MS  $m/z$ 276[M+H]<sup>+</sup>; <sup>1</sup>H NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta_{\text{H}}$  (ppm): 7.58 (1H, s, H-3), 8.05 (1H, d,  $J = 5.2$ , H-4), 8.83 (1H, d,  $J = 5.2$  Hz, H-5), 8.38 (1H, dd,  $J = 8.0$ , 2.0 Hz, H-8), 7.66 (1H, t,  $J = 8.0$  Hz, H-9), 7.90 (1H, t,  $J = 8.0$  Hz, H-10), 8.67 (1H, d,  $J = 8.0$  Hz, H-11), 6.51 (2H, s, -O-CH<sub>2</sub>-O-); <sup>13</sup>C NMR (100 MHz, DMSO d<sub>6</sub>)  $\delta_{\text{C}}$  (ppm): 148.3 (C-1), 151.4 (C-2), 103.1 (C-3), 144.3 (C-3a), 124.3 (C-4), 144.2 (C-5), 135.2 (C-6a), 180.9 (C-7), 132.3 (C-7a), 126.8 (C-8), 127.6 (C-9), 133.9 (C-10), 128.3 (C-11), 130.6 (C-11a), 106.0 (C-11b), 122.4 (C-11c), 103.0 (O-CH<sub>2</sub>-O).

## RESULTS AND DISCUSSION

Four phenolic compounds, namely kaempferol 3,4'-dimethyl ether(1), quercetin 3,7-dimethyl ether(2), quercetin 3,7,4'-trimethyl ether (3), and liriodenine(4) have been isolated from the stem bark of *Saccopatum horsfieldii* Benn.

Kaempferol 3,4'-dimethyl ether(1) was isolated as a pale yellow solid. The UV spectrum of 1 exhibited maximum absorption on 203, 257, and 359 nm typical for a flavonol compound and showed bathochromic shifts on addition of AlCl<sub>3</sub> and NaOAc [3]. In the <sup>13</sup>C NMR spectrum, 15 carbon signals representing 17 carbon atoms were observed. Two of them, namely the signals at  $\delta_{\text{C}}$  139.4 and 179.5, are characteristic for C-3 and C-4 of a flavonol structure [4]. The presence of five oxyaryl signals ( $\delta_{\text{C}}$  156.5, 157.8, 162.7, 164.8, and 169.0) indicated that the flavonol is a derivative of kaempferol. The <sup>1</sup>H NMR spectrum showed the presence of the proton signals of a pair of doublets ( $J = 2.4$  Hz) in the aromatic region at  $\delta_{\text{H}}$  6.23 and 6.47 ppm, characteristic for H-6 and H-8 proton signals of the ring A. Furthermore, in the <sup>1</sup>H NMR spectrum, a pair of doublets ( $J = 9.2$  Hz) was appeared in the aromatic region at  $\delta_{\text{H}}$  8.05 and 7.05 ppm (each 2H) characteristic for a hydroxyl phenyl group of the ring B. The <sup>1</sup>H NMR spectrum of 1 also showed two methoxy groups at  $\delta_{\text{H}}$  3.84 and 3.87 and a proton singlet signal at  $\delta_{\text{H}}$  12.75 that is consistent with the presence of an OH-phenolic at C-5. The placement of methoxy groups in kaempferol structure shown in HMQC and HMBC spectrum. By analysis of HMQC and HMBC spectrum of 1, the methoxy signal ( $\delta_{\text{H}}$  3.87) exhibited <sup>1</sup>H-<sup>13</sup>C long range correlation with an oxyaryl carbon signal ( $\delta_{\text{C}}$  162.7), meanwhile correlation of the signal at  $\delta_{\text{H}}$  8.05 in the ring B correspond to the methoxy group at C-4'. Furthermore, correlation methoxyl signal  $\delta_{\text{H}}$  3.84 with  $\delta_{\text{C}}$  139.4 suggested that the methoxyl was unambiguously located at C-3. From these NMR data analysis, the flavonol isolated was assigned as kaempferol 3,4'-dimethyl ether [5]. Other HMQC and HMBC correlations, as well as <sup>13</sup>C NMR data assignment, that are consistent with the structure 1 are shown in Fig. 2.

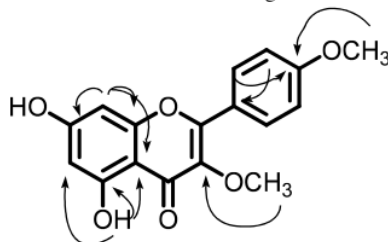


Figure 2. Significant HMBC correlation for 1

Quercetin 3,7-dimethyl ether(2) was isolated as a pale yellow solid, and its UV spectrum exhibited maximum absorption on 203, 257, and 359 nm typical for a flavonol. The IR spectrum indicated absorptions for hydroxyl (3204 cm<sup>-1</sup>), conjugated carbonyl (1643 cm<sup>-1</sup>), and aromatic (1545, 1390 cm<sup>-1</sup>) groups. The <sup>1</sup>H NMR spectrum of 2 showed an ABX system at  $\delta_{\text{H}}$  7.58 (d,  $J = 2.2$  Hz, H-2'), 6.91 (d,  $J = 8.4$  Hz, H-5'), 7.47 (dd,  $J = 8.4$ , 2.2 Hz, H-6') characteristic for aromatic in the ring B. The presence of the proton signals of a pair of doublets ( $J = 2.2$  Hz) in the aromatic region at  $\delta_{\text{H}}$  6.35 and 6.68 ppm, characteristic for H-6 and H-8 in the ring A. The <sup>1</sup>H NMR spectrum of 2 also showed two methoxyl signals ( $\delta_{\text{H}}$  3.80; 3.86) and a proton singlet signal at  $\delta_{\text{H}}$  12.67 that is consistent with an OH-phenolic at C-5. The <sup>13</sup>C NMR spectrum of 2 showed 17 carbon signals were observed. Two of them, namely the signals at  $\delta_{\text{C}}$  137.7 and 177.7 are characteristic for C-3 and C-4 of a flavonol structure [4]. The presence of six oxyaryl signals ( $\delta_{\text{C}}$  145.0, 148.6, 155.7, 156.0, 160.7, and 164.8) indicated that the flavonol is a derivative of quercetin. Further support for the structure 2 was also obtained from the comparison of the NMR data with those reported for quercetin 3,7-dimethyl ether from *Ericameria diffusa* [6].

Quercetin 3,7,4'-trimethyl ether(3) was isolated as a pale yellow solid. The UV and IR spectrum very similar with compound 2. The <sup>1</sup>H NMR spectrum of 3 showed an ABX system at  $\delta_{\text{H}}$  7.54 (d,  $J = 2.0$  Hz, H-2'), 7.09 (d,  $J = 8.2$  Hz, H-5'), 7.55 (dd,  $J = 8.2$ , 2.0 Hz, H-6') and a pair of doublets ( $J = 2.2$  Hz) in the aromatic region at  $\delta_{\text{H}}$  6.33 and 6.67 ppm, three methoxyl signals ( $\delta_{\text{H}}$  3.88; 3.86; 3.81) and an OH-phenolic at C-5 at  $\delta_{\text{H}}$  12.61. The <sup>13</sup>C NMR spectrum of 3 showed 18 carbon signals were observed. Two of them, namely the signals at  $\delta_{\text{C}}$  137.7 and 177.8 are characteristic

flavonol structure and six oxyaryl signals ( $\delta_C$  146.1, 150.1, 155.3, 156.0, 160.7, and 164.8) indicated that the flavonol is a derivative of quercetin. The structure of **3** agreed with those recorded by Urbatsch [6].

Liriodenine (**4**) was obtained as a pale yellow solid. Its UV spectrum ( $\lambda_{max}$  272, 317 nm) indicated characteristic of oxoaporphine alkaloid. The FABMS spectrum showed a molecular ion  $[M+H]^+$  at  $m/z$  276 consistent with the molecular formula  $C_{17}H_{10}NO_3$ . The  $^1H$  NMR spectrum of **4** showed the presence of one methylenedioxy group and seven aromatic protons. In the  $^1H$ -NMR spectrum of **4** showed a proton singlet signal of methylenedioxy signal at  $\delta_H$  6.51, a pair of doublets ( $J = 5.2$  Hz) in the aromatic region at  $\delta_H$  8.05 and 8.83 are characteristic for H-4 and H-5 of a oxoaporphine structure, a proton singlet signal at  $\delta_H$  7.58 characteristic for H-3. In the aromatic region, the four aromatic protons at  $\delta_H$  8.38 (dd,  $J = 8.0, 2.0$  Hz), 7.66 (t,  $J = 8.0$  Hz), 7.90 (t,  $J = 8.0$  Hz), 8.67 (d,  $J = 8.0$  Hz) were assigned to H-8, H-9, H-10 and H-11, respectively. In the  $^{13}C$  NMR spectrum, 17 carbon signals were observed. Two of them, the signals at  $\delta_C$  148.3 and 151.4 are characteristic for ortho oxygenated and one carbonyl group at  $\delta_C$  180.9. Based on  $^1H$  and  $^{13}C$  NMR data were similar to those of the known compound liriodenine [7].

### CONCLUSION

Three flavonoids, kaempferol 3,4'-dimethyl ether (**1**), quercetin 3,7-dimethyl ether (**2**), quercetin 3,7,4'-trimethyl ether (**3**), and alkaloid, liriodenine (**4**) have been isolated from the stem bark of *Saccopata lunghorsfieldii* Benn. Their structures were elucidated on the basis of spectroscopic data.

### Acknowledgements

We would like to thank Purwodadi Botanical Garden, Pasuruan, Indonesia for the availability and identification of the species.

### REFERENCES

- [1] E.H. Hakim; S.A. Achmad; L. Makmur; D. Mujahidin; and Syah, Y.M. *Bull. Indo. Soc. Nat. Prod. Chem.*, **2001**, 1(1), 1-12
- [2] L. Ping-tao; Gilbert, M.G., *Fl. China*, **2011**, 19, 679-681
- [3] T.J. Mabry; Markham, K.R., *Flavonoids: Chemistry, Biochemistry and Applications*, Taylor and Francis, New York, **2006**, pp. 108-109.
- [4] M. Tanjung; E.H. Hakim; Elfahmi; J. Latief; Syah, Y.M., *J. Nat. Prod. Comm.*, **2012**, 7(10), 1309-1310.
- [5] L.E. Urbatsch; J.D. Bacon; Mabry, T.J., *Phytochem.*, **1975**, 14, 2279-2282.
- [6] L.E. Urbatsch; T.J. Mabry; M. Miyakado; N. Ohno; Yoshioka, H., *Phytochem.*, **1976**, 15, 440-441.
- [7] J. Kunitomo; Y. Murakami; M. Oshikata; T. Sengu; M. Akasu; S.T. Lu; Chen, I.S., *Phytochem.*, **1980**, 19, 2735-2739.

# Phenolic compounds from the stem bark of *Saccopetalum horsfieldii* Benn

## ORIGINALITY REPORT

19%

SIMILARITY INDEX

8%

INTERNET SOURCES

16%

PUBLICATIONS

0%

STUDENT PAPERS

## PRIMARY SOURCES

- 1 Ya-Ching Shen, Shao-Ling Lin. " New Secoiridoid Glucosides from ", *Planta Medica*, 2007  
Publication 1%
- 2 [www.google.com](http://www.google.com)  
Internet Source 1%
- 3 [www.scholarsresearchlibrary.com](http://www.scholarsresearchlibrary.com)  
Internet Source 1%
- 4 Hiroaki Okamoto, Yuki Morita, Yoichi Segawa, Shunsuke Takenaka. "Synthesis and Thermal Properties for 4-(4-Alkoxyphenoxy-carbonyl)phenyl 3-Alkoxy-2-X-benzoates", *Molecular Crystals and Liquid Crystals*, 2005  
Publication 1%
- 5 Salma M.Z. Al-Kindy, Nada Al-Sharji, Ahmed F. Al-Harasi, FakhrEldin O. Suliman, Haider J. AL-Lawati, Stephen Schulman. "Synthesis and spectroscopic study of 2,7-diethylamino-2-oxo-2H-chromen-3-yl benzothiazole-6-sulfonyl 1%



chlorides and its derivatives", Arabian Journal of Chemistry, 2017

Publication

---

6

Tanaka, R.. "Studies on chemical modification of monensin VIII. Synthesis of 7-O-substituted-25-carboxymonensins and their Ca<sup>2+</sup> ion transport activity", Tetrahedron, 20010409

Publication

---

1 %

7

V.P. Greer, P. Mason, A.J. Kirby, H.J. Smith, P.J. Nicholls, C. Simons. "Some 1,2-Diphenylethane Derivatives as Inhibitors of Retinoic Acid—Metabolising Enzymes", Journal of Enzyme Inhibition and Medicinal Chemistry, 2008

Publication

---

1 %

8

Eun-Kyung Jung, Nora Dittrich, Lisa I. Pilkington, Claire E. Rye, Euphemia Leung, David Barker. "Synthesis of aza-derivatives of tetrahydrofuran lignan natural products", Tetrahedron, 2015

Publication

---

1 %

9

Ken-ichi Takatsuki, Sumito Ohgushi, Shigeo Kohmoto, Keiki Kishikawa, Makoto Yamamoto. " A simple and efficient synthesis of puromycin, 2,2'-anhydro-pyrimidine nucleosides, cytidines and 2',3'-anhydroadenosine from 3',5'- -sulfinyl -

1 %

nucleosides ", Nucleosides, Nucleotides and Nucleic Acids, 2006

Publication

---

10

[jes.ecsdl.org](http://jes.ecsdl.org)

Internet Source

1 %

---

11

[chemistry.unpad.ac.id](http://chemistry.unpad.ac.id)

Internet Source

1 %

---

12

Eckhard Wollenweber. "Flavonoids from *Alnus crispa*, *A. Japonica*, *A. Koehnei* and *A. Sinuata*", *Phytochemistry*, 1974

Publication

1 %

---

13

Nasser S.A.M. Khalil. " Synthesis of Novel  $\alpha$ - - Arabinopyranosides of  $\beta$ -Lactams with Potential Antimicrobial Activity ", *Nucleosides, Nucleotides and Nucleic Acids*, 2005

Publication

1 %

---

14

Miguel Carda, Florenci González, Richard Sánchez, J.Alberto Marco. "Stereoselective synthesis of (-)-cytoxazone", *Tetrahedron: Asymmetry*, 2002

Publication

1 %

---

15

Peter D. Clark, Nicholas M. Irvine. "PREPARATION OF 3,4-DISUBSTITUTED BENZO[B]THIOPHENES FOR USE IN THIA-ERGOLINE SYNTHESIS", *Phosphorus, Sulfur, and Silicon and the Related Elements*, 1996

Publication

1 %

---



16 Samia A.S. Silva, Janiza C.M. De Castro, Terezinha G. Da Silva, Emidio V.L. Da-cunha et al. " Kramentosan, a New Trinorlignan from the Roots of ", Natural Product Letters, 2006  
Publication

---

17 Wollenweber, E.. "Flavonoid aglycones from the lipophilic exudates of some species of Rosaceae", Biochemical Systematics and Ecology, 200805  
Publication

---

18 Bina S. Siddiqui, Huma Aslam, Sabira Begum, Syed Tariq Ali. " New cinnamic acid esters from ", Natural Product Research, 2007  
Publication

---

19 A. Bak, O.S. Gudmundsson, S. Gangwar, G.J. Friis, T.J. Siahaan, R.T. Borchardt. "Synthesis and evaluation of the physicochemical properties of esterase - sensitive cyclic prodrugs of opioid peptides using an (acyloxy)alkoxy linker", The Journal of Peptide Research, 2008  
Publication

---

20 Feng Zhu. "Three xanthenes from a marine-derived mangrove endophytic fungus", Chemistry of Natural Compounds, 03/2007  
Publication

---

21 Flavonoids of the Sunflower Family (Asteraceae), 2001. <1 %  
Publication

---

22 Yolanda González, M. Blanca Ros, Jose Luis Serrano, Miguel Angel Perez-jubindo. "Naphthyl benzoates versus phenyl benzoates A molecular structure-liquid crystal and ferroelectric behaviour relationship study", Liquid Crystals, 2006 <1 %  
Publication

---

23 theses.gla.ac.uk <1 %  
Internet Source

---

24 Valant-Vetschera, K.M.. "Leaf flavonoids of the Achillea Millefolium group part II: Distribution patterns of free aglycones in leaf exudates", Biochemical Systematics and Ecology, 19881214 <1 %  
Publication

---

25 P. Evans, R. J. K. Taylor. "Conjugate addition reactions of vinyl sulfones with hard nucleophiles", Journal of Sulfur Chemistry, 2005 <1 %  
Publication

---

26 www.mdpi.com <1 %  
Internet Source

---

27 www.xanthoneeducation.com <1 %  
Internet Source

---

28

A. H. Moustafa, R. A. Haggam, M. E. Younes, E. S. H. El Ashry. "Double-headed Acyclo C-Nucleoside Analogues. Functionalized 1,2-bis-(1,2,4-Triazol-3-yl)ethane-1,2-diol", Nucleosides, Nucleotides and Nucleic Acids, 2005

Publication

&lt;1 %

29

Ana Escribano Cuesta. "Chapter 3 Formation of Cyclobutene Compounds via Gold(I)-Catalyzed Cycloisomerization of 1,n-Enynes", Springer Science and Business Media LLC, 2013

Publication

&lt;1 %

30

Hinna Hamid, S. Tarique Abdullah, Mohammed Ali, M. Sarwar Alam. " New Phytoconstituents from the Aerial Parts of . ", Pharmaceutical Biology, 2008

Publication

&lt;1 %

31

[www.heterocycles.jp](http://www.heterocycles.jp)

Internet Source

&lt;1 %

32

Clementina M. M. Santos. "Efficient Syntheses of New Polyhydroxylated 2,3-Diaryl-9H-xanthen-9-ones", European Journal of Organic Chemistry, 04/15/2009

Publication

&lt;1 %

33

Esra Küpeli, Didem Deliorman Orhan, Erdem Yesilada. "Effect of Cistus laurifolius L. leaf extracts and flavonoids on acetaminophen-

&lt;1 %

induced hepatotoxicity in mice", Journal of Ethnopharmacology, 2006

Publication

---

34

Lia Dewi Juliawaty, Mariko Kitajima, Hiromitsu Takayama, Sjamsul Arifin Achmad, Norio Aimi. "A 6-substituted-5,6-dihydro-2-pyrone from *Cryptocarya strictifolia*", Phytochemistry, 2000

Publication

---

35

Muhammad Saleem, Nighat Afza, M. Aijaz Anwar, Muhammad Shaiq Ali. " Aromatic constituents from fruit peels of ", Natural Product Research, 2005

Publication

---

36

Takeshi Kinoshita, Yukiyoishi Tamura, Kenji Mizutani. " Isolation and Synthesis of Two New 3-Arylcoumarin Derivatives from the Root of (Licorice), and Structure Revision of an Antioxidant Isoflavonoid Glabrene ", Natural Product Letters, 1997

Publication

---

<1 %

<1 %

<1 %

---

Exclude quotes Off

Exclude matches Off

Exclude bibliography On

# Phenolic compounds from the stem bark of *Saccopetalum horsfieldii* Benn

---

## GRADEMARK REPORT

---

FINAL GRADE

**/0**

GENERAL COMMENTS

**Instructor**

---

PAGE 1

---

PAGE 2

---

PAGE 3

---

PAGE 4

---