Natural Product Research

Country United Kingdom - SIR Ranking of United Kingdom

Subject Area and Category
Agricultural and Biological Sciences
Plant Science
Biochemistry, Genetics and Molecular Biology
Biochemistry
Chemistry
Analytical Chemistry
Organic Chemistry

Publisher Taylor & Francis

Publication type Journals

ISSN 14786419

Coverage 2003-ongoing

Scope The aim of Natural Product Research is to publish important contributions in the field of natural product chemistry. The journal covers all aspects of research in the chemistry and biochemistry of naturally occurring compounds. The communications include coverage of work on natural substances of land and sea and of plants, microbes and animals. Discussions of structure elucidation, synthesis and experimental biosynthesis of natural products as well as developments of methods in these areas are welcomed in the journal. Finally, research papers in fields on the chemistry-biology boundary, eg. fermentation chemistry, plant tissue culture investigations etc., are accepted into the journal.

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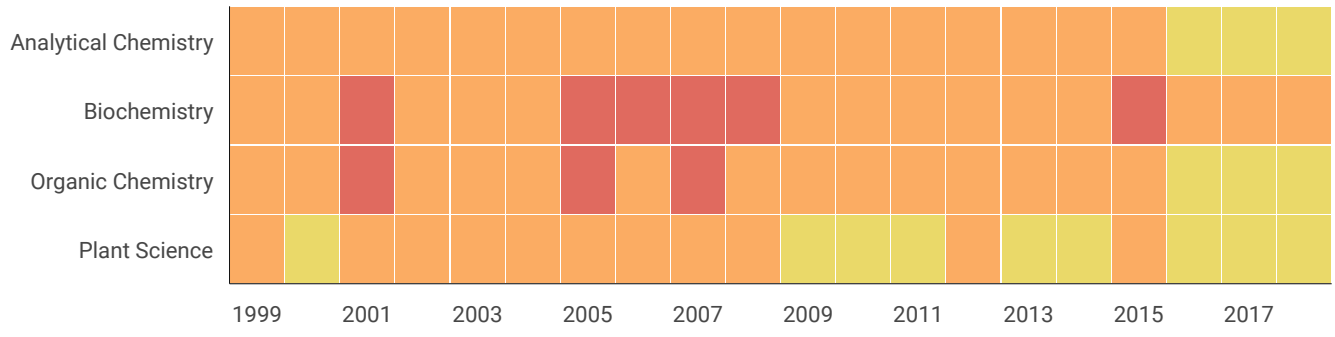

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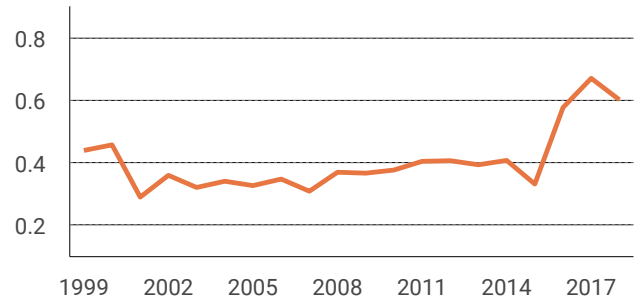

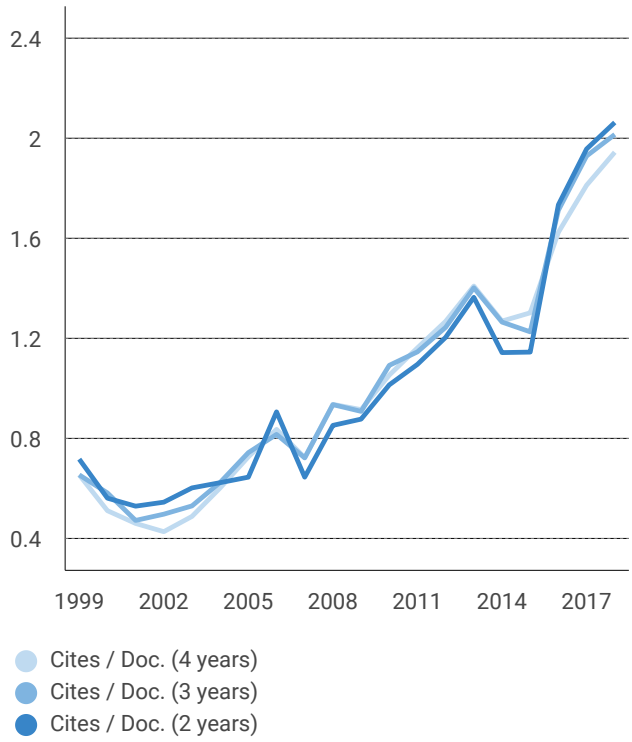

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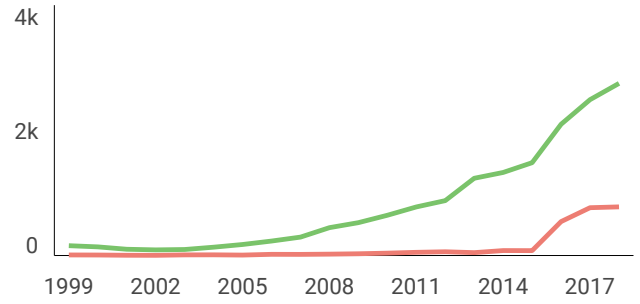

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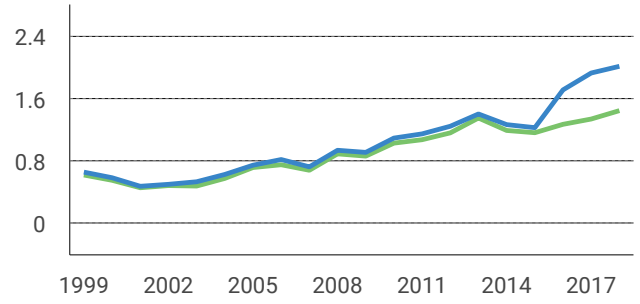

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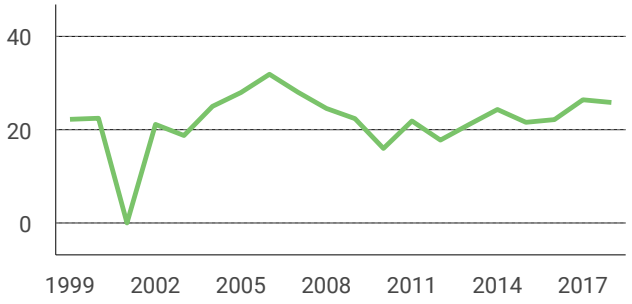

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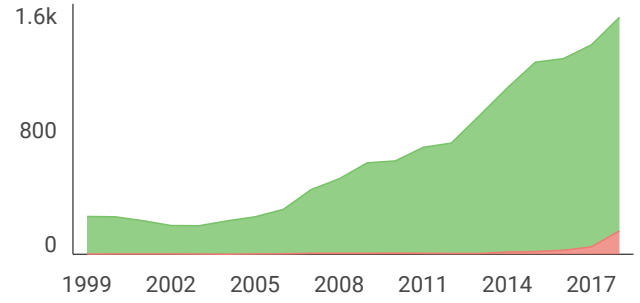

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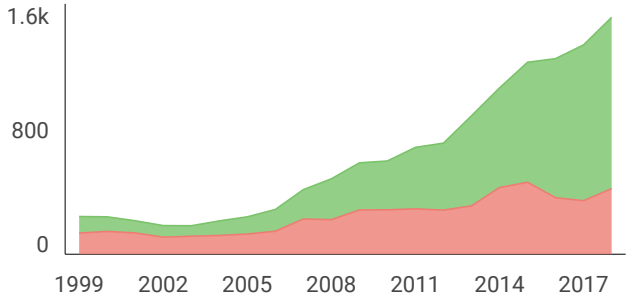

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Journal

Natural Product Research ›
Formerly Natural Product Letters

Aims and scope

The aim of ***Natural Product Research*** is to publish important contributions in the field of natural product chemistry. The journal covers all aspects of research in the chemistry and biochemistry of naturally occurring compounds.

The communications include coverage of work on natural substances of land and sea and of plants, microbes and animals. Discussions of structure elucidation, synthesis and experimental biosynthesis of natural products as well as developments of methods in these areas are welcomed in the journal. Finally, research papers in fields on the chemistry-biology boundary, eg. fermentation chemistry, plant tissue culture investigations etc., are accepted into the journal.

Natural Product Research issues will be subtitled either "Part A - Synthesis and Structure" or "Part B - Bioactive Natural Products". for details on this , see the **forthcoming articles section**.

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Journal

Natural Product Research ›
Formerly Natural Product Letters

Journal information

Print ISSN: 1478-6419 Online ISSN: 1478-6427

24 issues per year

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Publication history

Currently known as:

Natural Product Research: Formerly Natural Product Letters (2003 - current)

Formerly known as

Natural Product Letters (1992 - 2002)

Journal

Natural Product Research ›
Formerly Natural Product Letters

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Journal

Natural Product Research ›

Formerly Natural Product Letters

Latest articles

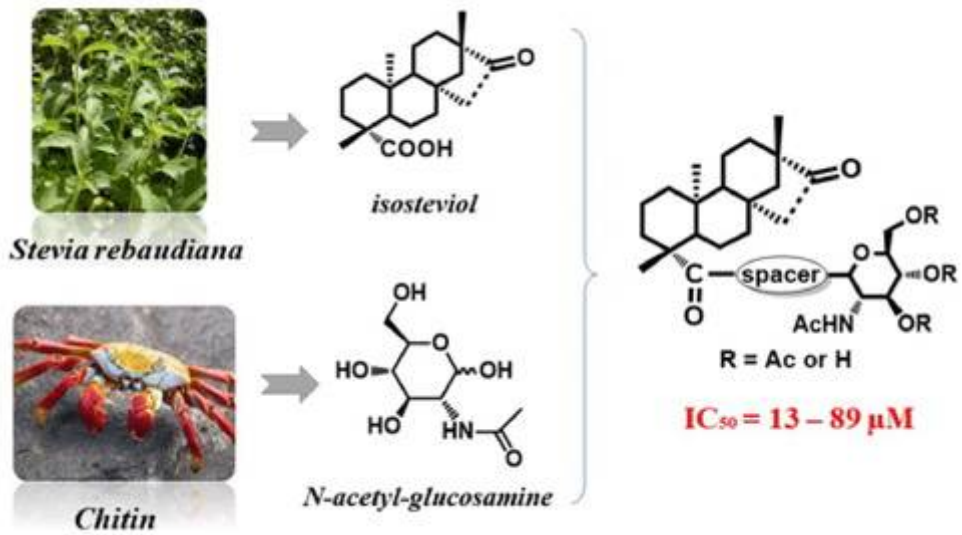
Research Article

Article

Synthesis and cytotoxicity of the conjugates of diterpenoid isosteviol and *N*-acetyl-D-glucosamine ›

Bulat F. Garifullin, Irina Yu. Strobykina, Leysan R. Khabibulina, Anastasiya S. Sapunova, Aleksandra D. Voloshina, Radmila R. Sharipova, Bulat I. Khairutdinov, Yuriy F. Zuev & Vladimir E. Kataev

Published online: 12 Aug 2019



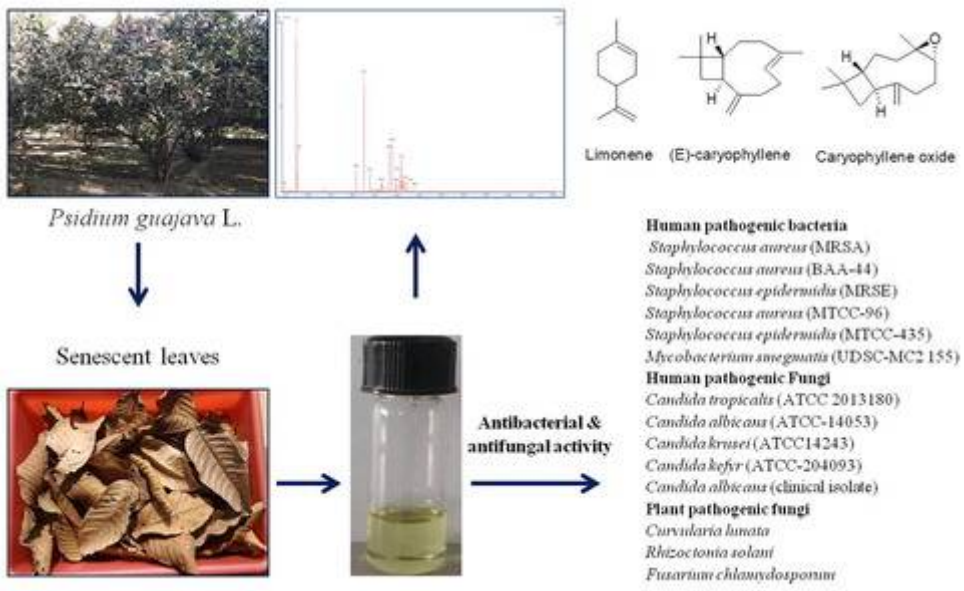
Short Communication

Rapid communication

Chemical composition and antimicrobial activity of the essential oil of senescent leaves of guava (*Psidium guajava* L.) ›

Trishna Chaturvedi, Swati Singh, Indrajeet Nishad, Ajay Kumar, Neha Tiwari, Sudeep Tandon, Dharmendra Saikia & Ram Swaroop Verma

Published online: 12 Aug 2019



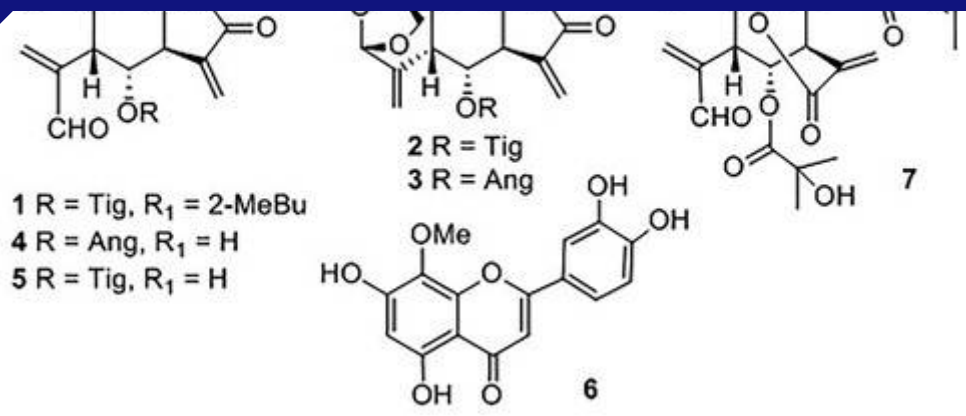
Research Article

Article

Elemenolides from *Zinnia peruviana* and evaluation of their antibacterial and α-glucosidase inhibitory activities ›

Ulises González, Jesús Morales-Jiménez, Antonio Nieto-Camacho, Mahinda Martínez & Emma Maldonado

Published online: 12 Aug 2019



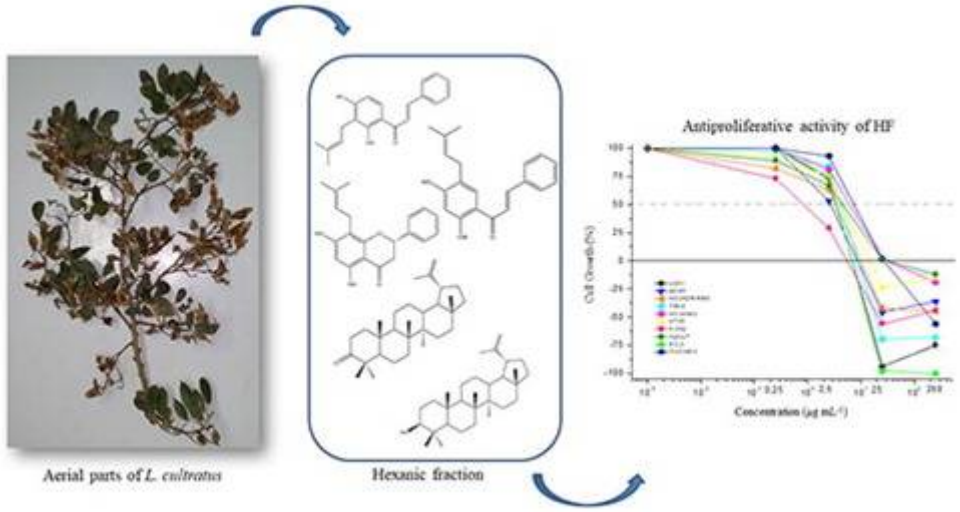
Short Communication

Rapid communication

Antiproliferative activity and chemical constituents of *Lonchocarpus cultratus* (Fabaceae) ›

Emanuelle M. B. M. da Silva Landim, Ana Lúcia T. G. Ruiz, João E. de Carvalho, Armando M. Pomini, Lindamir H. Pastorini & Silvana M. Oliveira Santin

Published online: 12 Aug 2019



Article

New *n*-nonadecanoyl-β-sitosterol and other constituents from the stem-bark of *Anacardium occidentale* ›

Abdullahi Shehu, Mangala Gowri Ponnapalli, M. Mahboob, P. V. Prabhakar & Gabriel Ademola Olatunji

Published online: 09 Aug 2019

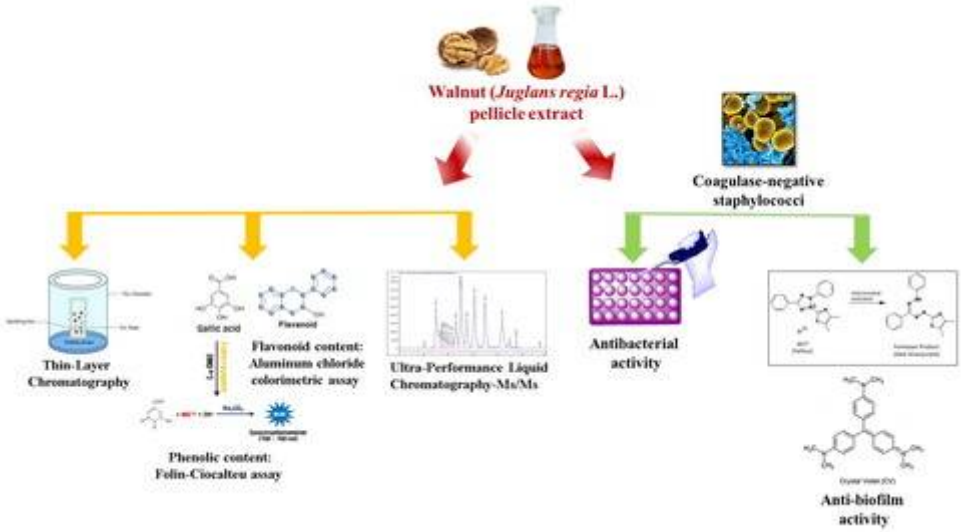
Short Communication

Rapid communication

Antibacterial and anti-biofilm activities of walnut pellicle extract (*Juglans regia* L.) against coagulase-negative staphylococci ›

Rosaria Acquaviva, Floriana D'Angeli, Giuseppe Antonio Malfa, Simone Ronsisvalle, Adriana Garozzo, Aldo Stivala, Salvatore Ragusa, Daria Nicolosi, Mario Salmeri & Carlo Genovese

Published online: 09 Aug 2019



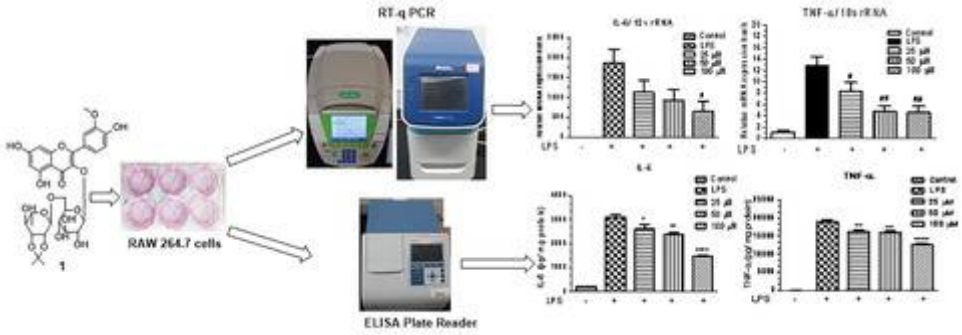
Research Article

Article

A new anti-inflammatory flavonoid glycoside from *tetraena aegyptia* ›

Ahmed A. Zaki, Xiaoqian Xu, Yuewen Wang, Pei-Hsin Shie & Longxin Qiu

Published online: 09 Aug 2019

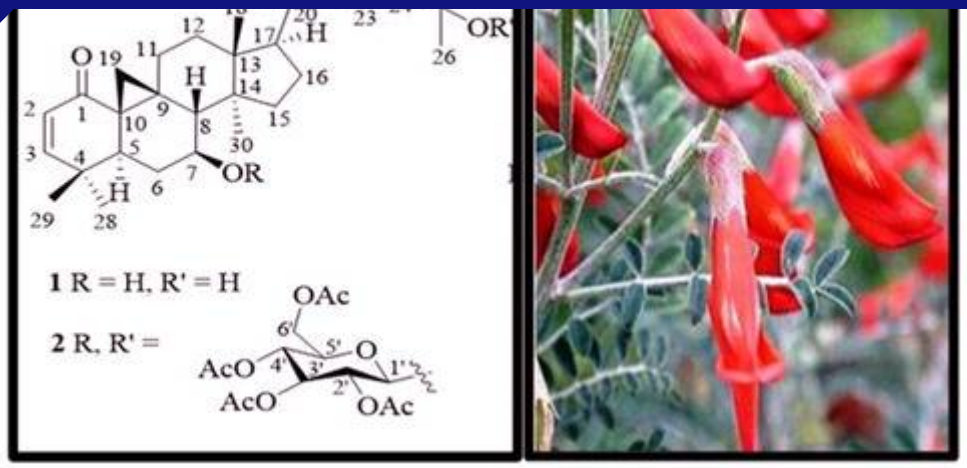


Article

Cycloartanol and Sutherlandioside C peracetate from *Sutherlandia frutescens* and their immune potentiating effects ›

Odwa Gonyela, Xolani Peter, John B. Dewar, Chris van der Westhuyzen, Paul Steenkamp & Gerda Fouche

Published online: 08 Aug 2019



Article

Three novel non-nitrogenous cassane diterpenoids from *Erythrophleum suaveolens* (Guill. et Perr.) Brenan (Fabaceae) ›

Jacques Dibi Konan, Faustin Aka Kabran, Barthelemy Koffi Attioua, Landry Claude Ahmont Kablan, Sandrine Any-Grah Aka, Armand Angely Koffi, Aminata Ouoyogodé Akoubet, Elvis N'nang Otogo, Blandine Seon-Meniel, Karine Le Blanc, Jean-Christophe Jullian, Drissa Sissouma, Mehdi A. Beniddir & Pierre Champy

Published online: 07 Aug 2019

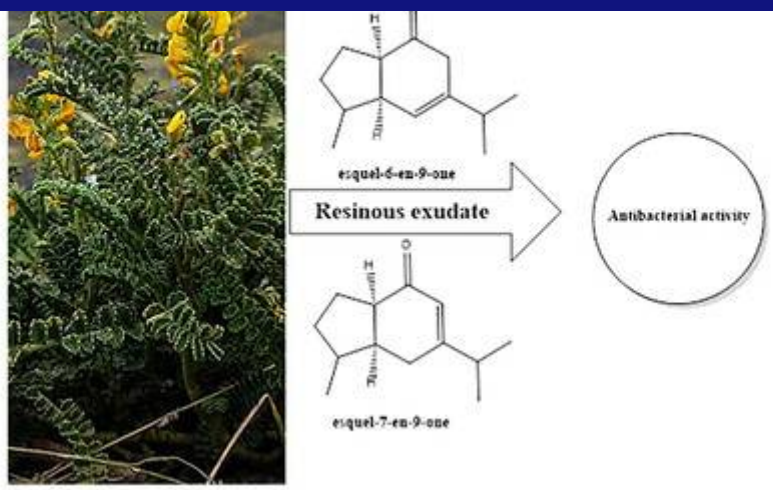
Short Communication

Rapid communication

Activity of *Adesmia boronioides* resinous exudate against phytopathogenic bacteria ›

Iván Montenegro, Miryam Valenzuela, Nicolas Zamorano, Rocio Santander, Carolina Baez & Alejandro Madrid

Published online: 06 Aug 2019



Rapid communication

Phenolic, flavonoid content and radical scavenging activity of *Smilax China* with its inhibitory potential against clinically important enzymes ›

Hafiz Ibtesam Ahmad, Haji Muhammad Shoaib Khan, Naveed Akhtar & Shakeel Ijaz

Published online: 06 Aug 2019

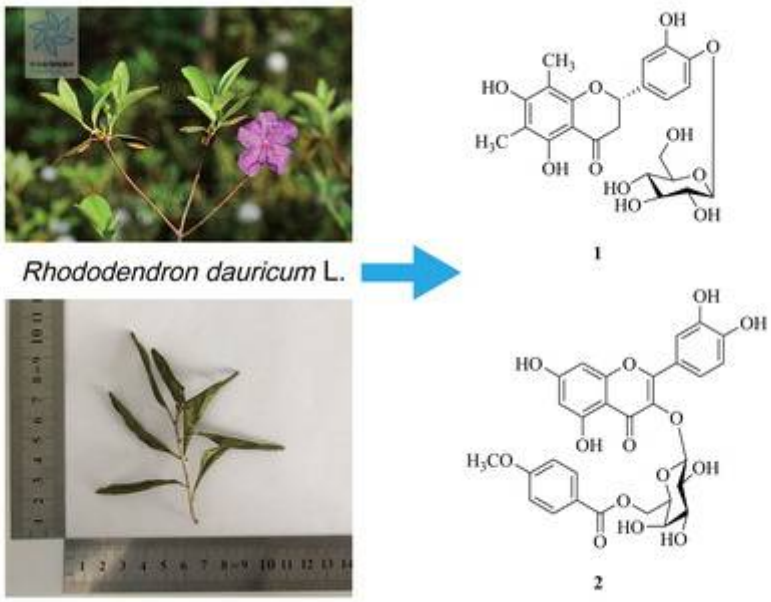
Research Article

Article

Two novel flavonoids from the leaves of *Rhododendron dauricum* L. with their inhibition of TNF-α production in LPS-induced RAW

Wei Zhou & Gao Li

Published online: 06 Aug 2019

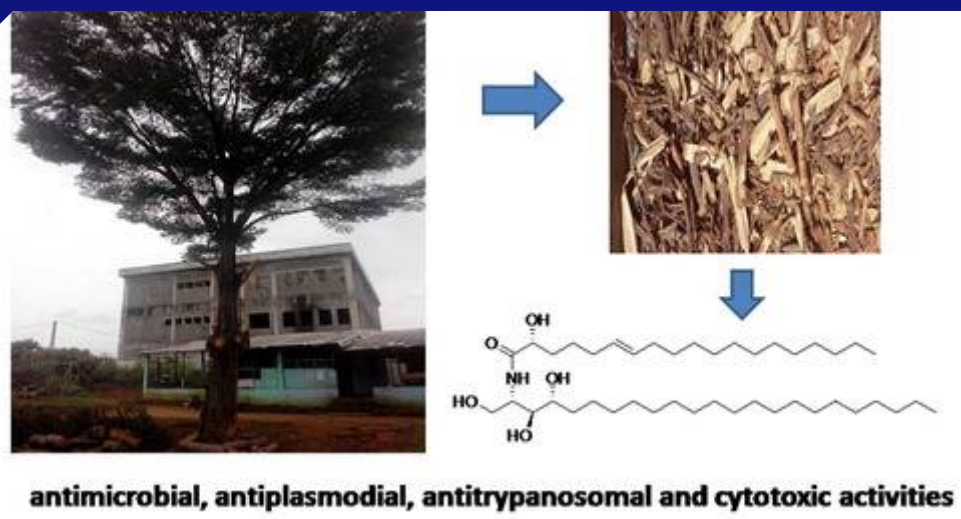


Article

Terminaliamide, a new ceramide and other phytoconstituents from the roots of *Terminalia mantaly* H. Perrier and their biological activities ›

Jean Emmanuel Mbosso Teinkela, Xavier Siwe Noundou, Simone Fannang, Achille Mbem Song, Jules Clément Assob Nguedia, Heinrich C. Hoppe & Rui Werner Maçedo Krause

Published online: 06 Aug 2019



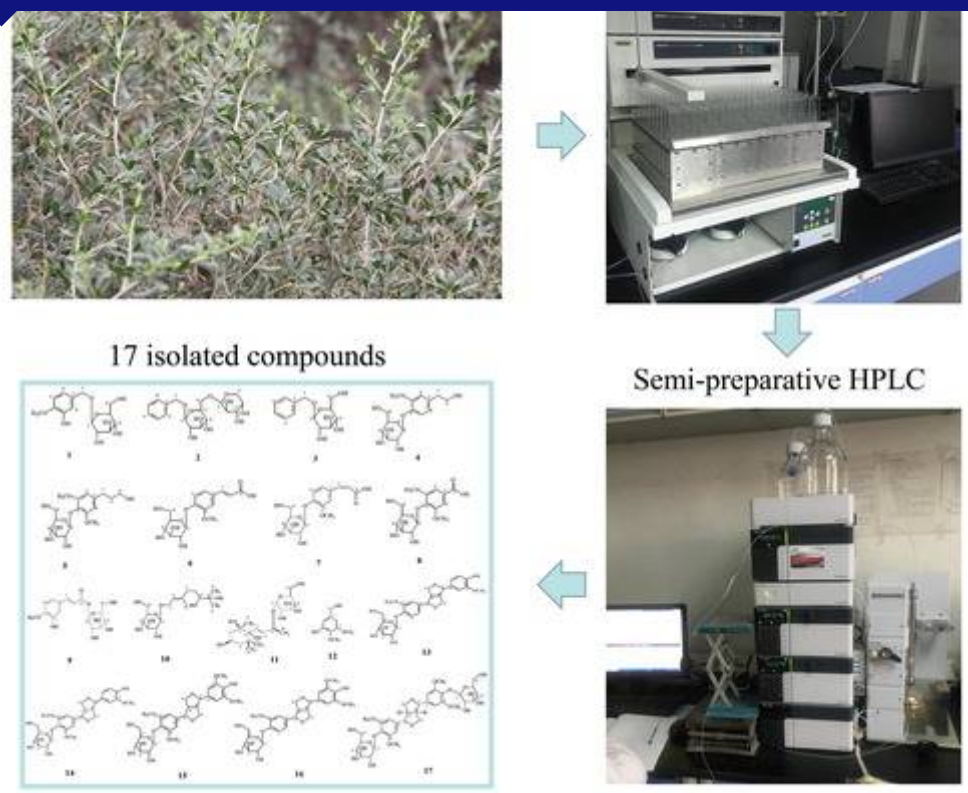
Short Communication

Rapid communication

Phenolic glycosides from *Nitraria sibirica* leaves and their *in vitro* biological activities ›

Chimengul Turghun, Mahinur Bakri, Ge-Yu Liu, Khayrulla Bobakulov & Haji Akber Aisa

Published online: 05 Aug 2019



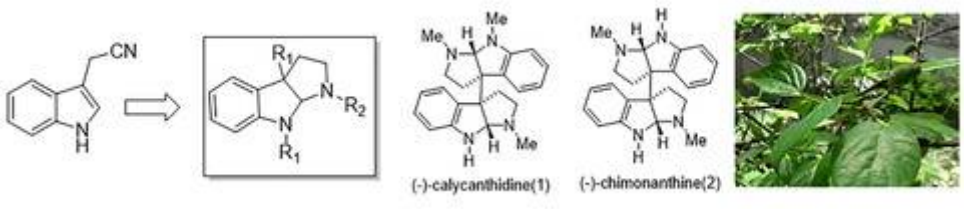
Research Article

Article

Synthesis and biological evaluations of a series of calycanthaceous analogues as antifungal agents ›

Shaojun Zheng, Rui Zhu, Bing Tang, Lizhuang Chen, Hongjin Bai & Jiwen Zhang

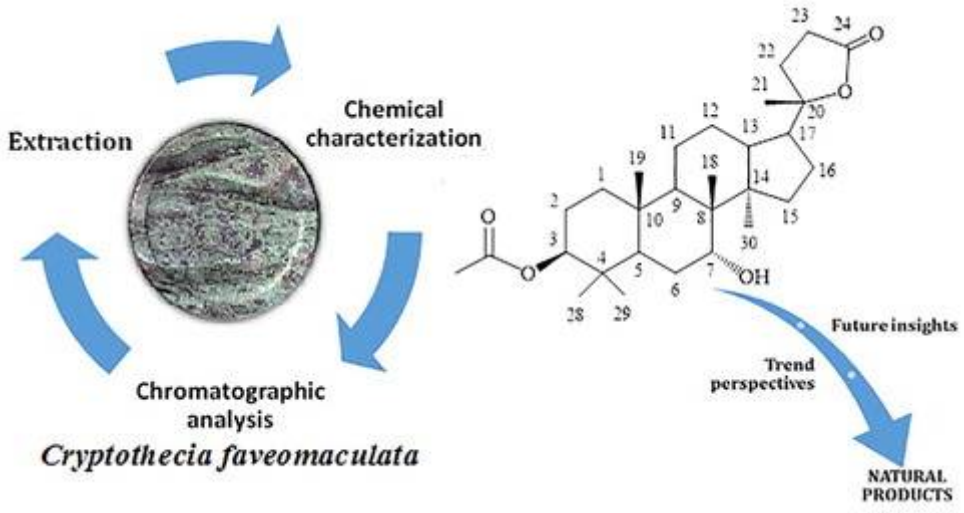
Published online: 05 Aug 2019



Cryptothecia faveomaculata Makhija & Patw ›

Nguyen Ngoc Tuan, Ping-Chung Kuo, Tran Trung Hieu, Le Nguyen Tuong Vi, Quach Tong Hung, Le Tien Dunge, Nguyen Duy Trinh, Nguyen Quang Trung, Nguyen Cuu Khoa, Ha Viet Hai & Tran Dinh Thang

Published online: 02 Aug 2019



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Chemical constituents from the leaves of *Elaeocarpus floribundus* ›

Ayorinde Victor Ogundele & Archana Moni Das

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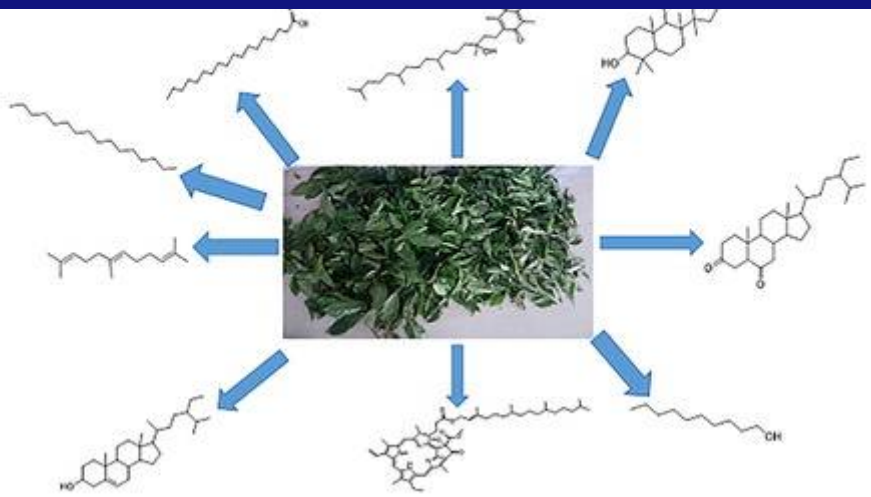
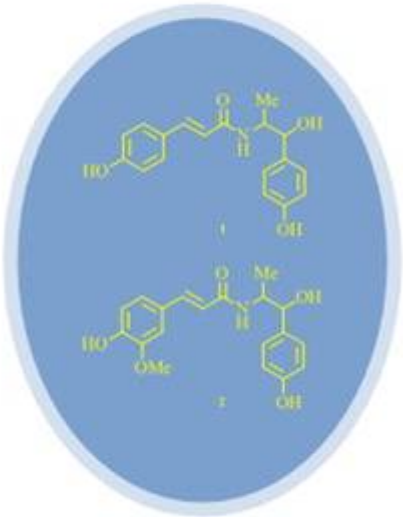


Rapid communication

Stixilamides A and B, two new phenolic amides from the leaves of *Stixis suaveolens* ›

Quoc Anh Ngo, Thi Yen Tran, Thuy Hang Nguyen, Van Tuyen Nguyen, Hong Anh Duong & Hung Viet Pham

Published online: 01 Aug 2019



Rapid communication

Solvent extraction, spectral analysis and antibacterial activity of the bioactive crystals of *Sargassum aquifolium* (Turner) C.Agardh from Red Sea ›

Sivakumar Sivagurunathan Moni, Mohammad Firoz Alam, Hafiz A. Makeen, Hassan A. Alhazmi, Muhammad Sultan, Rahimullah Siddiqui, Aamena Jabeen, Syeda Sanobar, Md Shamsher Alam, Zia Ur Rehman, Mohamed Eltyep Elmobark, Osama Madkhali, Anzarul Haque & Mohammed Albratty

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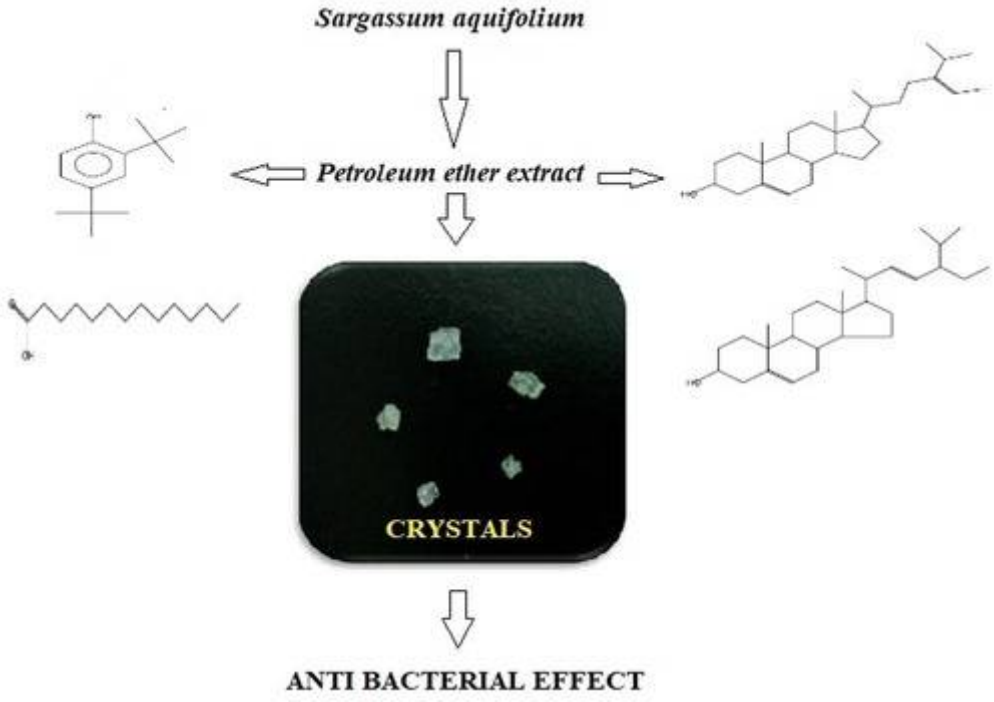
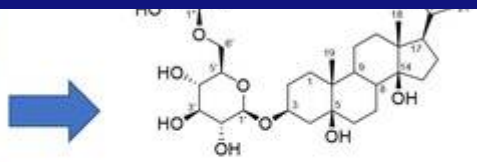


Rapid communication

A new cardenolide glycoside from the roots of *Streptocaulon juventas* (lour.) merr. (Asclepiadaceae) ›

Xuan-Hao Bui, Phu Hoang Dang, Tuan Trong Vo, Nhi Y Thi Nguyen, Minh-Duc Nguyen & Quan Le Tran

Published online: 01 Aug 2019



Periplogenin 3-*O*-β-gentiobioside

Compound	Growth Inhibition (%)		
	NCI-H460	HeLa	MCF-7
1	71.87	60.16	47.72

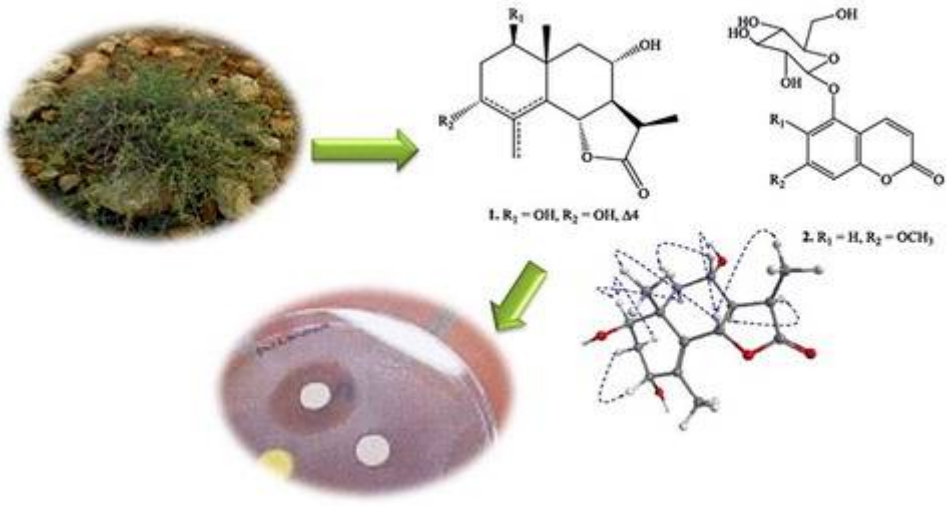
Research Article

Article

New antimicrobial metabolites from the medicinal herb *Artemisia herba-Alba* ›

Tarik A. Mohamed, Abeer A. Abd El Aty, Abdelaaty A. Shahat, Nahla S. Abdel-Azim, Khaled A. Shams, Abdelsamed A. Elshamy, Mehawed M. Ahmed, Sabry H. H. Youns, Taher M. El-Wassimy, Sayed A. El-Toumy & Mohamed-Elamir F. Hegazy

Published online: 31 Jul 2019



Coral *Asterospicularia laurae* in Taiwan ›

Jui-Hsin Su, Chih-I Liu, Mei-Chin Lu, Chi-I Chang, Min-Ying Hsieh, Yu-Chi Lin, Chang-Feng Dai, Ya-Han Zhang, Zheng-Yu Lin & Yun-Sheng Lin

Published online: 31 Jul 2019

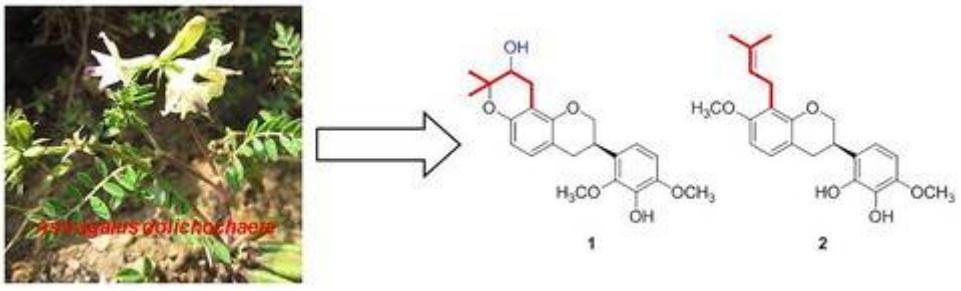
Soft coral *Asterospicularia laurae*

Article

Two new 8-isopentenyl isoflavane derivatives from *Astragalus dolichochaete* diels ›

Ding-Wei Wang, Chao-Jiang Xiao, Lin Qiu, Xin-Yan Tian, Xiang Dong & Bei Jiang

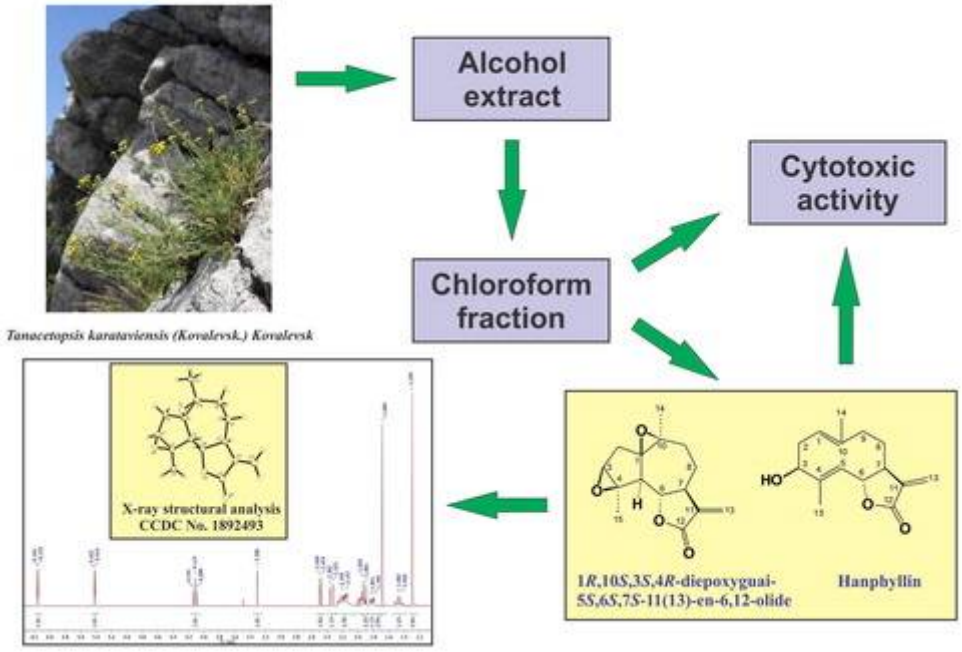
Published online: 30 Jul 2019



karataviensis (Kovalevsk.) Kovalevsk ›

Dilnoza E. Dusmatova, Khayrulla M. Bobakulov, Rimma F. Mukhamatkhanova, Kambarali K. Turgunov, Ekaterina O. Terenteva, Elena A. Tsay, Ildar D. Sham'yanov, Bakhodir Tashkhodzhaev, Shahnoz S. Azimova & Nasrulla D. Abdullaev

Published online: 30 Jul 2019



Article

Three new acenaphthene derivatives from rhizomes of *Musa basjoo* and their cytotoxic activity ›

Li Jiang, Bao Zhang, Yang Wang, Jia Sun, Xue Ma, Guangcheng Wang, Sihong Fu, Changhu Lin & YongJun Li

Published online: 30 Jul 2019

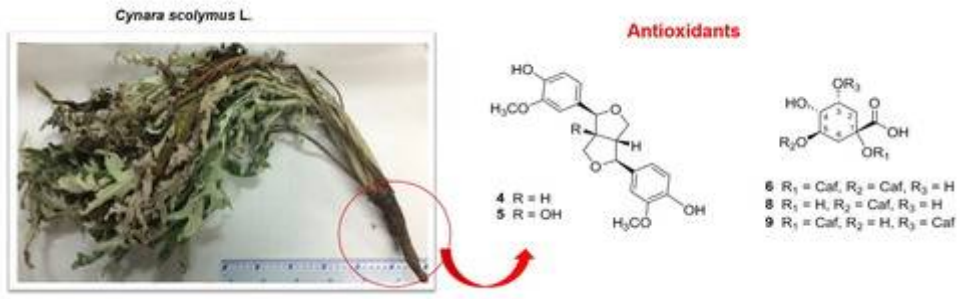
Short Communication

Rapid communication

Characterization Of Secondary Metabolites From The Rhizome Of *Cynara Scolymus* And Their Antioxidant Properties ›

Chia-Lin Lee, Kuo-Chen Liao, Chien-Chih Chen, Yen-An Lin, Tung-Ying Wu, Yun-Lian Jhan, Chao-Jung Chen, Juan-Cheng Yang & Yang-Chang Wu

Published online: 30 Jul 2019



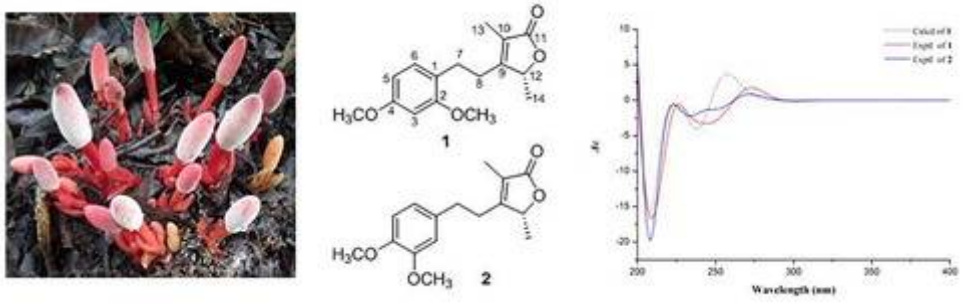
Research Article

Article

New butenolides with anti-inflammatory activity from *Balanophora fungosa* ›

Jie Zhou, Si-Yu Du, Zhong-Ying Fang & Zhi Zeng

Published online: 30 Jul 2019



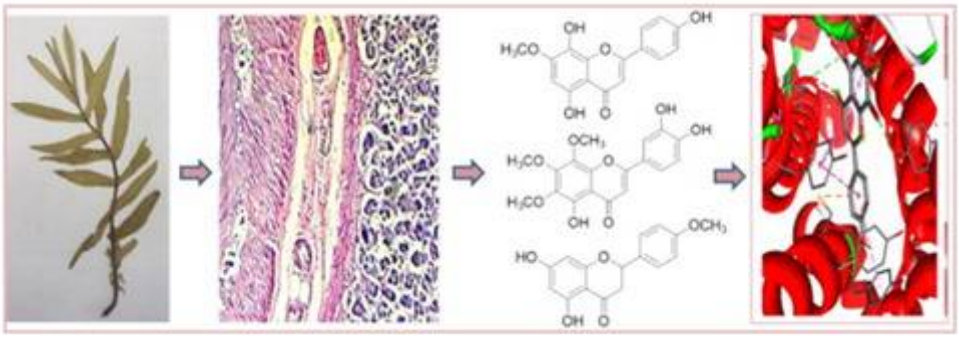
Short Communication

Rapid communication

Antiulcer potential and molecular docking of flavonoids from *Ocimum forskolei* Benth., family *Lamiaceae* ›

Eman Maher Zahran, Usama Ramadan Abdelmohsen, A. Samir Hussein, M. Alaraby Salem, Hany Ezzat Khalil, Samar Yehia Desoukey, Mostafa Ahmed Fouad & Mohamed Salah Kamel

Published online: 30 Jul 2019



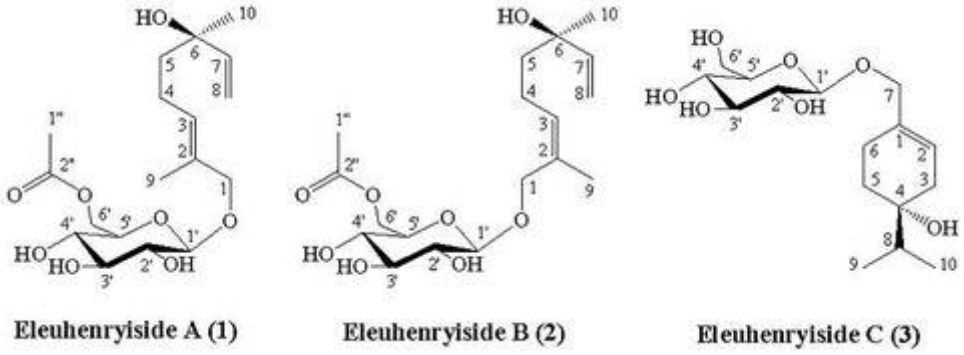
Research Article

Article

Three Novel Monoterpenoid Glycosides From Fruits Of *Eleutherococcus Henryi* ›

Xiao-Jun Li, Kwan-Woo Kim, Dong-Cheol Kim, Hyuncheol Oh, Xiang-Qian Liu & Youn-Chul Kim

Published online: 30 Jul 2019



Eleuhenryiside A (1) Eleuhenryiside B (2) Eleuhenryiside C (3)

Article

Synthesis and antitumor activity of sacroflavonoside ›

Qinghu Wang, Ying Xin, Biligetu Pa, Xiang He & Wenqiang Bao

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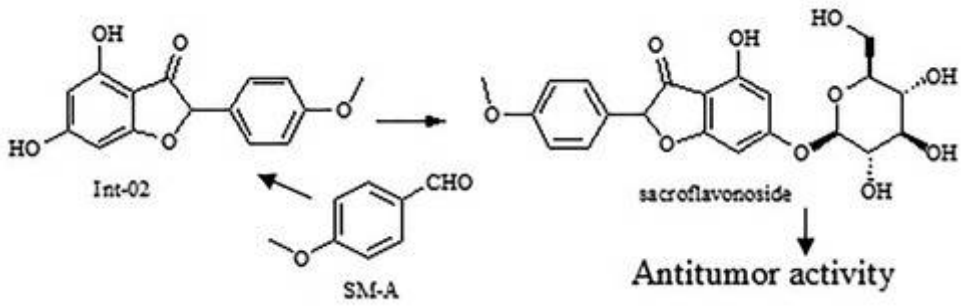

Article

Biosynthesis of ambrein in ambergris: evidence from isotopic data and identification of possible intermediates ›

Steven J. Rowland, Paul A. Sutton & George A. Wolff

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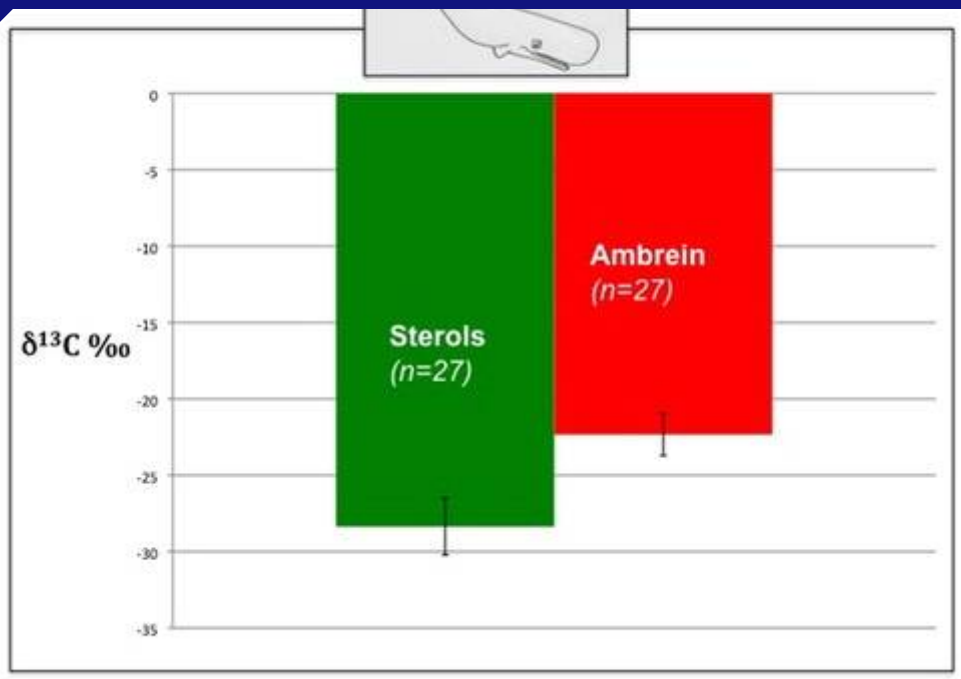

Short Communication

Rapid communication

Carbon nanotube/layered double hydroxide nanocomposite as a fibre coating for determination the essential oils of *Achillea eriophora* DC with the headspace solid-phase microextraction ›

Marzieh Piryaei & Marzieh Babashpour-Asl

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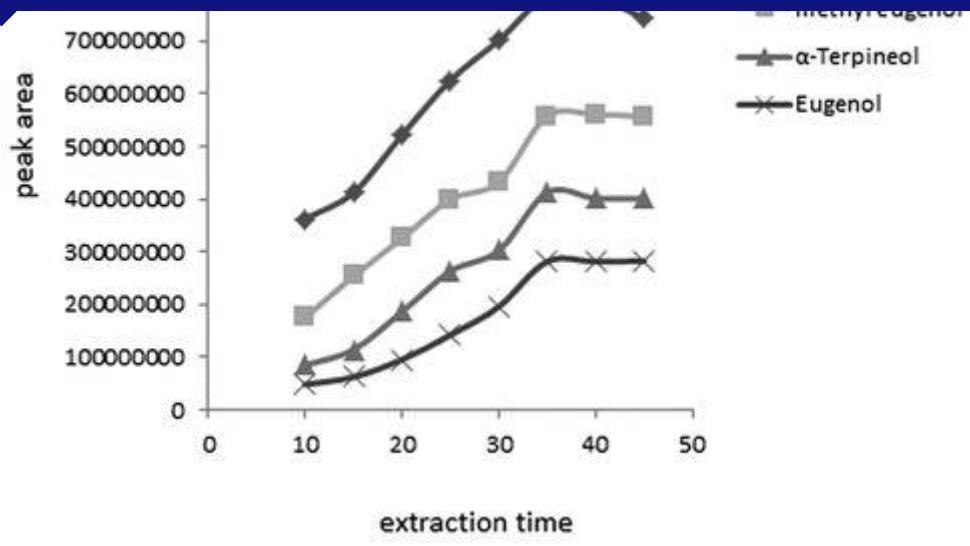

Research Article

Article

Chemical constituents from the fruits of *Cullen corylifolium* (L.) Medik. by the targeted separation mode ›

Xiangyue Liu, Jing Yang, Huijuan Yu, Jing Zhang, Jie Du, Xinhui Wang, Yuefei Wang & Xin Chai

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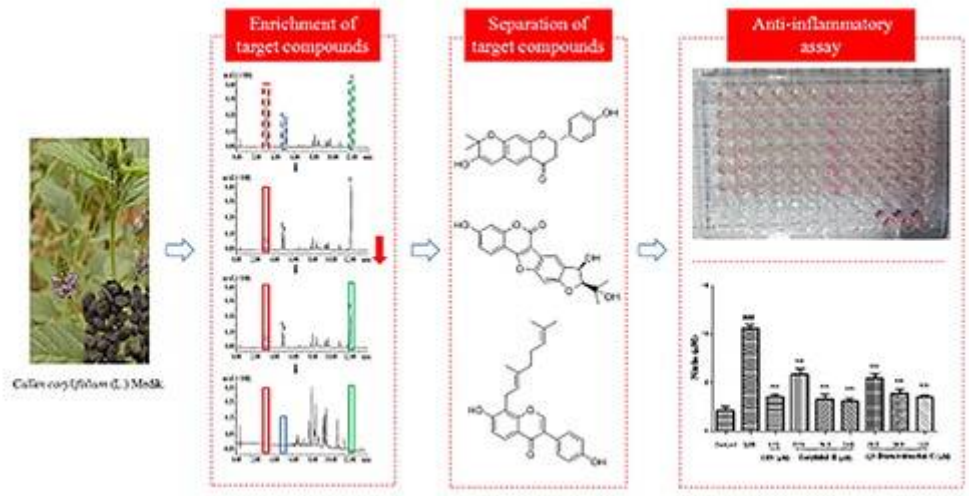
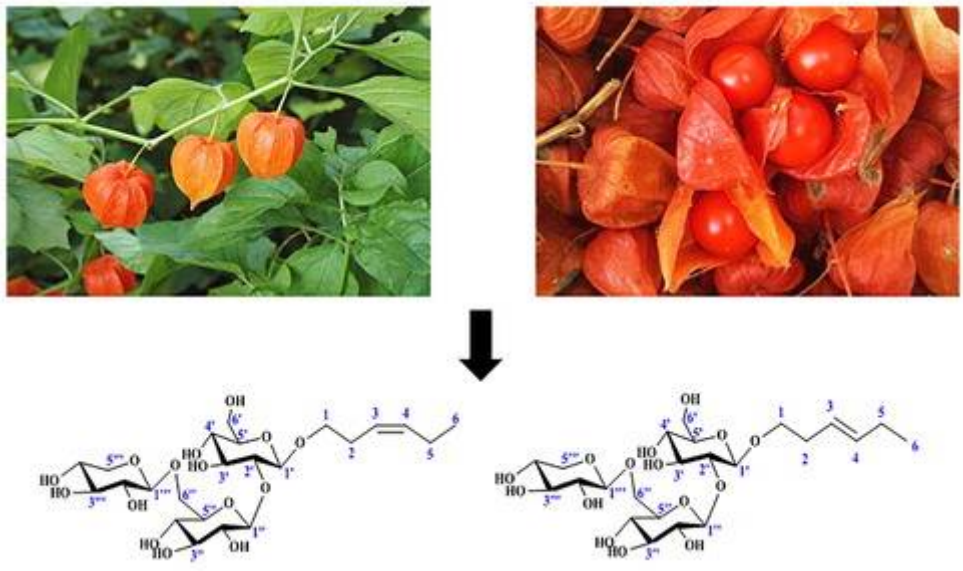


Two new 3-hexenol glycosides from the calyces of *Physalis alkekengi* var. *franchetii* ›

Zunpeng Shu, Yun Tang, Yanni Yang, Zihe Ding, Renxing Zhong, Tianyi Xia, Xinjia Li, Cuiying Zheng, Zhixiong Wen, Wei Li & Yi Wang

Published online: 25 Jul 2019



Short Communication

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Chemical constituents of the volatiles of stem with leaf and flower of *Neanotis lancifolia* (Hook.f.) W.H.Lewis growing plateau region of Western Ghats, India ›

Rajesh K. Joshi

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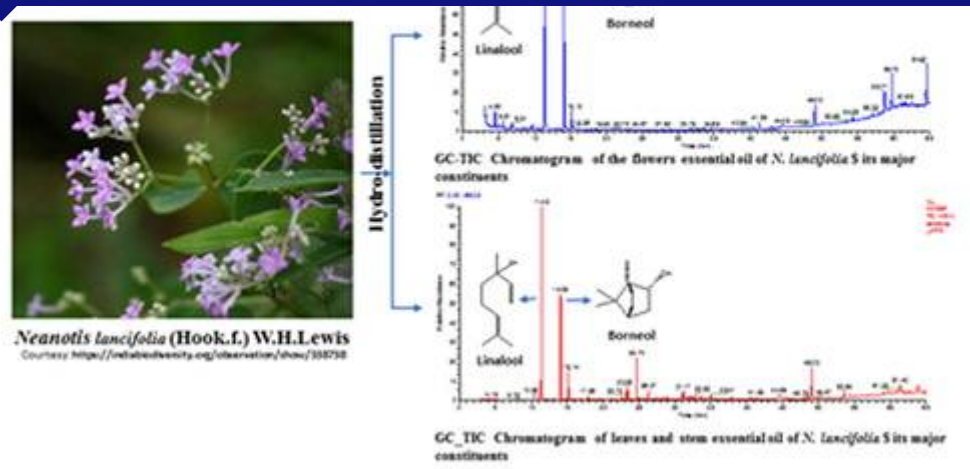

Research Article

Article

Oleanane triterpenoids from *Rubia philippinensis* and their inhibitory effect on 20-HETE synthesis ›

Khong Trong Quan, Byung Gu Min, In Hyun Hwang, Yeon Jung Choi, Sang Kyum Kim & MinKyun Na

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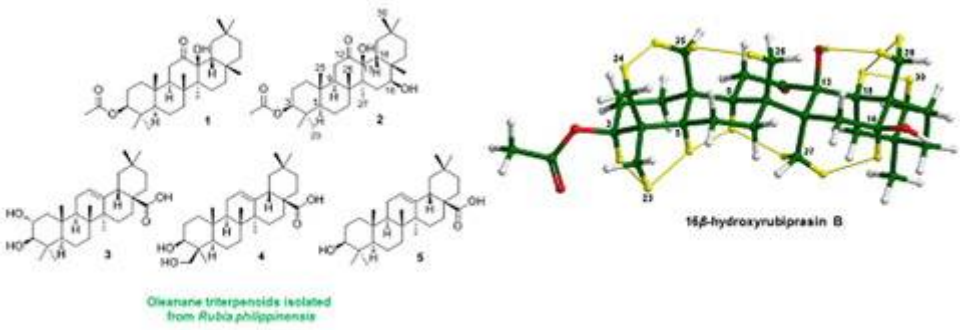

Short Communication

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albino mice ›

Ayman Saber Mohamed, Shimaa Anter Mahmoud, Amel Mahmoud Soliman & Sohair Ramadan Fahmy

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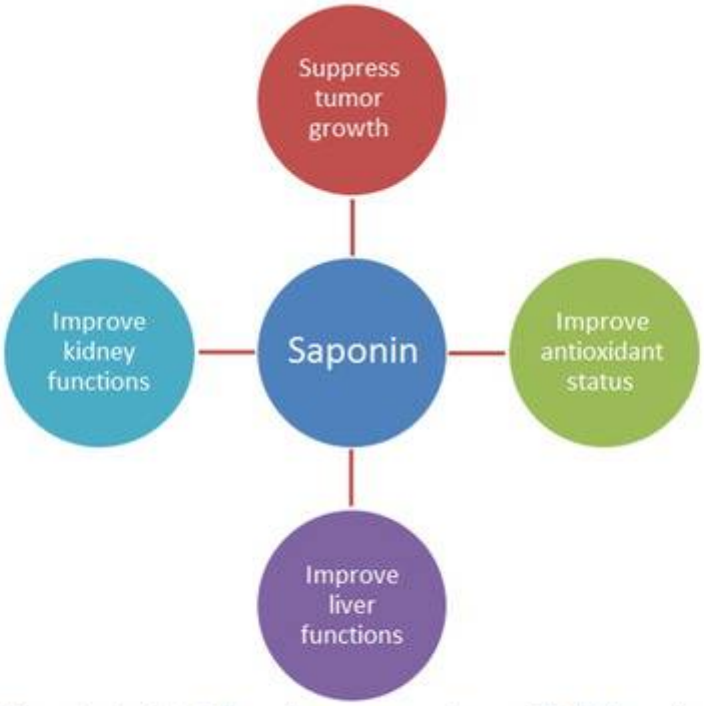


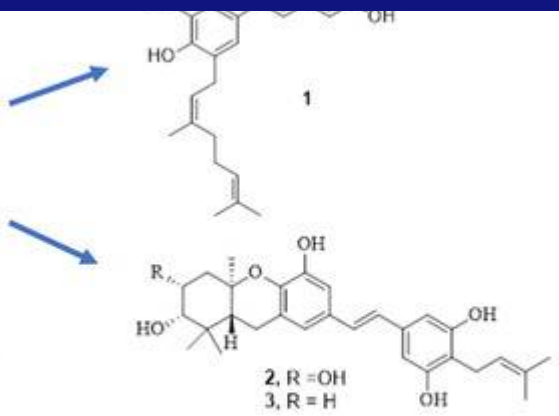
Effect of Saponin isolated from the sea cucumber on Ehrlich ascites carcinoma bearing mice

Rapid communication

In vitro anti-enteroviral activity of stilbenoids isolated from the leaves of *Macaranga barteri* ›

Peter A. Segun, Omonike O. Ogbole, Toluwanimi E. Akinleye, Temitope O. C. Faleye & Adekunle J. Adeniji

Published online: 25 Jul 2019



Compound	MNTC	CC_{50}	IC_{50}			SI	
			E7	E13	E19	E7	E19
Mappain (**1**)	10 μM	3.24 μM	1.23 μM	NA	0.24 μM	2.6	13.5
Vedelianin (**2**)	10 nM	0.78 nM	0.025 nM	NA	0.0036 nM	31.2	216.7
Schweinfurthin G (**3**)	10 nM	0.82 nM	0.043 nM	NA	0.018 nM	19.1	45.6

Rapid communication

Thermal desorption modulation based detection of volatile constituents of *Alpinia galanga* by two dimensional gas chromatography and time of flight mass spectrometry ›

Subhashree Singh, Suprava Sahoo, Asit Ray, Ambika Sahoo, Sanghamitra Nayak & Basudeba Kar

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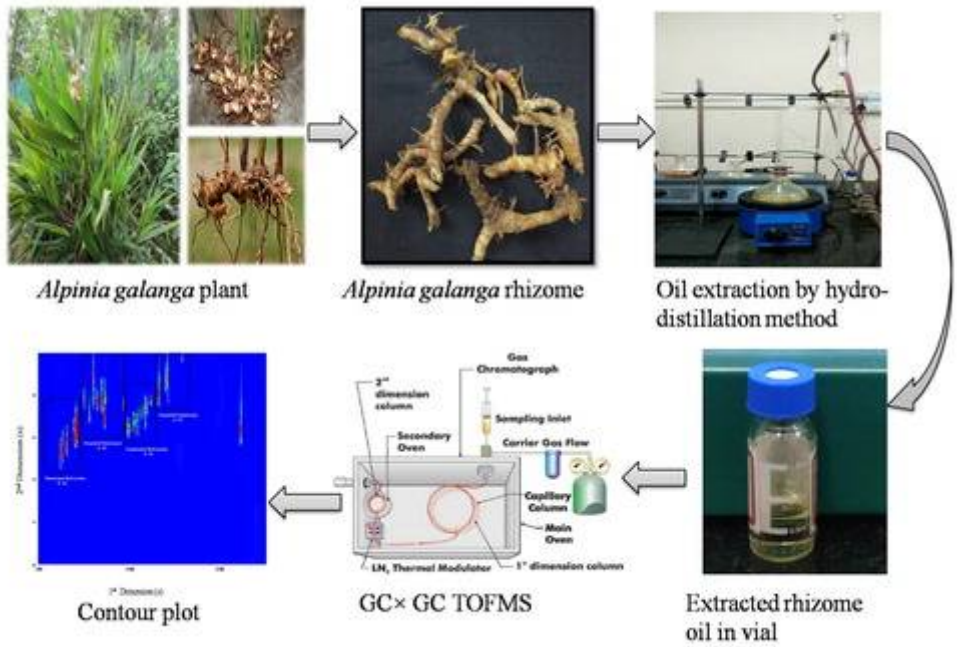

Research Article

Article

Three new flavonoids from *Penthorum chinense* Pursh and their docking studies ›

Wen-Wen Zhao, Wei-Wei Guo, Jun-Fang Guo, Xing Wang, Xiao-Qing Chen & Xia Wu

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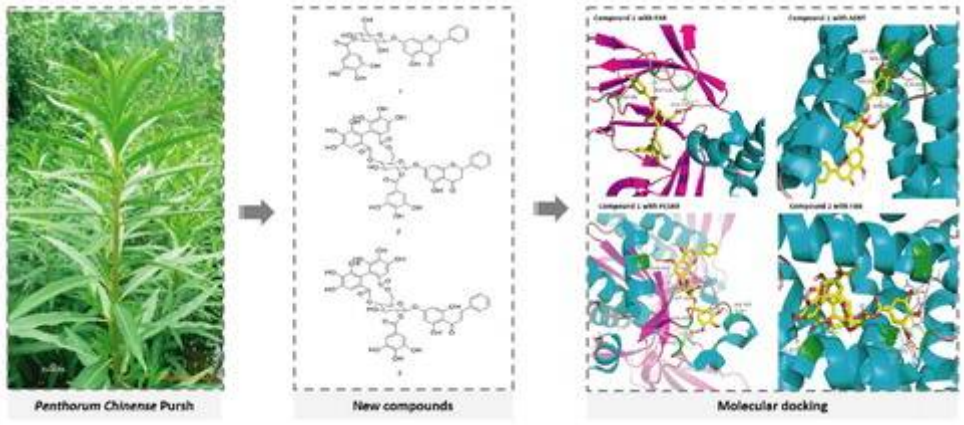
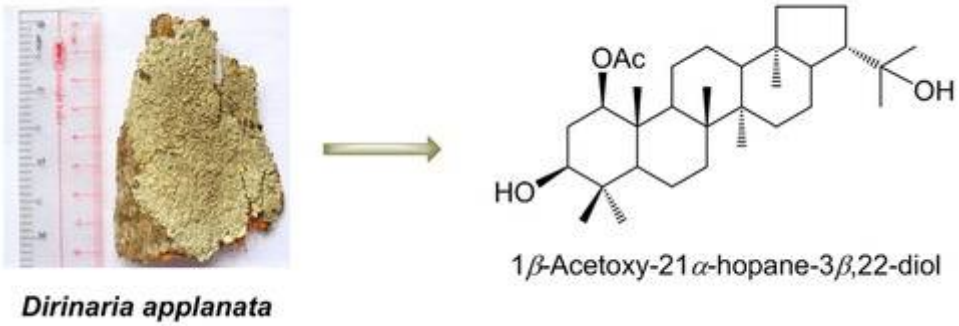


Article

A new hopane derivative from the lichen *Dirinaria applanata* ›

Trong Tuan Nguyen, Thanh Nguyen Quoc Chau, Hieu Mai Van, Toan Phan Quoc, Qui Do Phuoc, The Duy Nguyen, Phuc Dam Nguyen, Tram Nguyen Thi Thu, Tien Dung Le, Trang Dai Thi Xuan, Kamei Kaeko & Kanaori Kenji

Published online: 24 Jul 2019



Short Communication

Rapid communication

Effect of the proportion of curcuminoids on the gastroprotective action of *Curcuma longa* L. in rats ›

Alejandra Orona-Ortiz, Josué A. Velázquez-Moyado, Elizabeth A. Pineda-Peña, José Luis Balderas-López, José Carlos Tavares Carvalho & Andrés Navarrete

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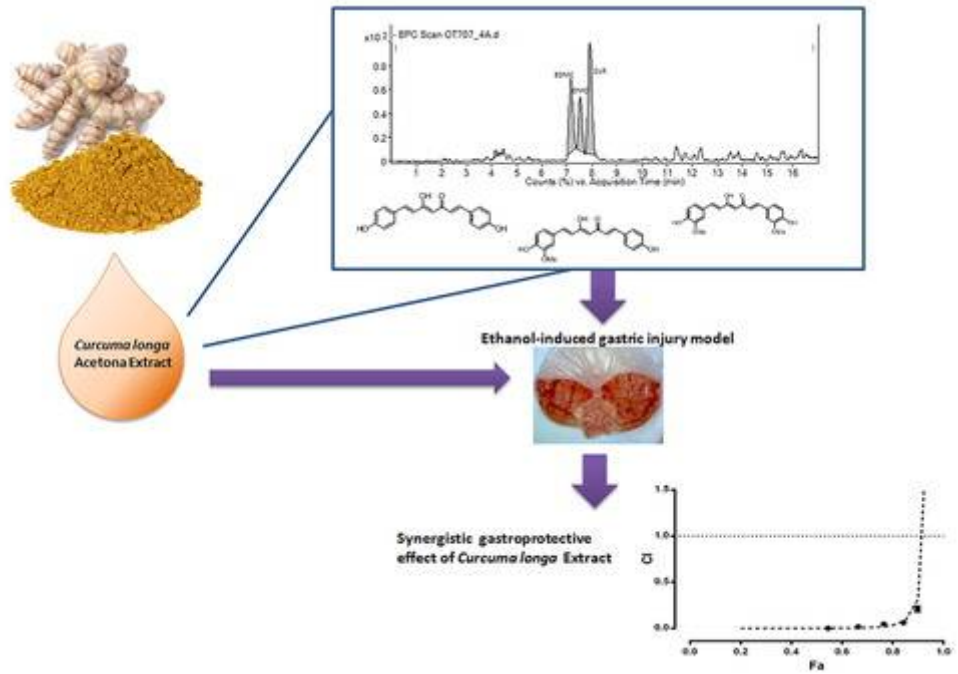

Rapid communication

The cytotoxicity and antioxidant activity analysis of the isolated constituents and extracts from endemic *Centaurea derderiifolia* ›

Fatma Bulut, Ibrahim Demirtas, Serkan Koldas, Fatih Gul, Lutfi Behcet, Tevfik Ozen & Feyza Oke-Altuntas

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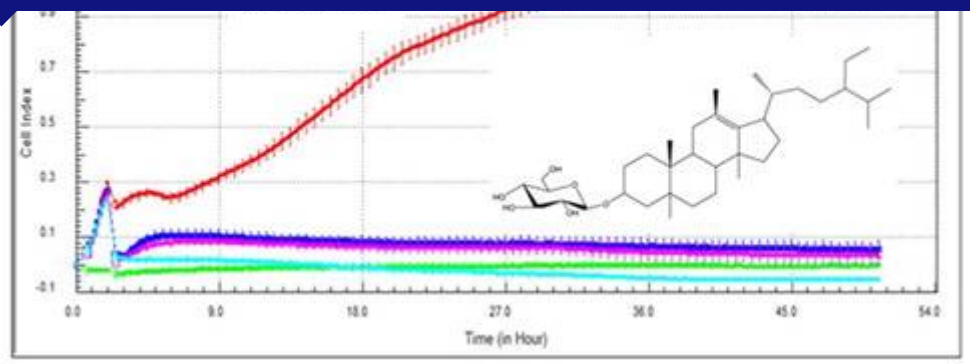


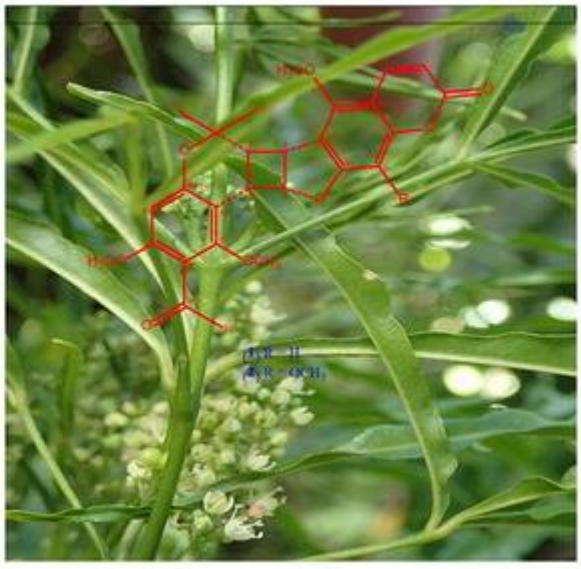
Research Article

Article

Two novel coumarins bearing an acetophenone derivative from the leaves of *Melicope Quercifolia* ›

Ratih Dewi Saputri, Tjitjik Srie Tjahjandarie & Mulyadi Tanjung

Published online: 22 Jul 2019



Short Communication

of *Pterocarya hupehensis* skan ›

Zi Wu, Jianhua Xia, Ziyan Guo, Jiachuan Lei & Jianqing Yu

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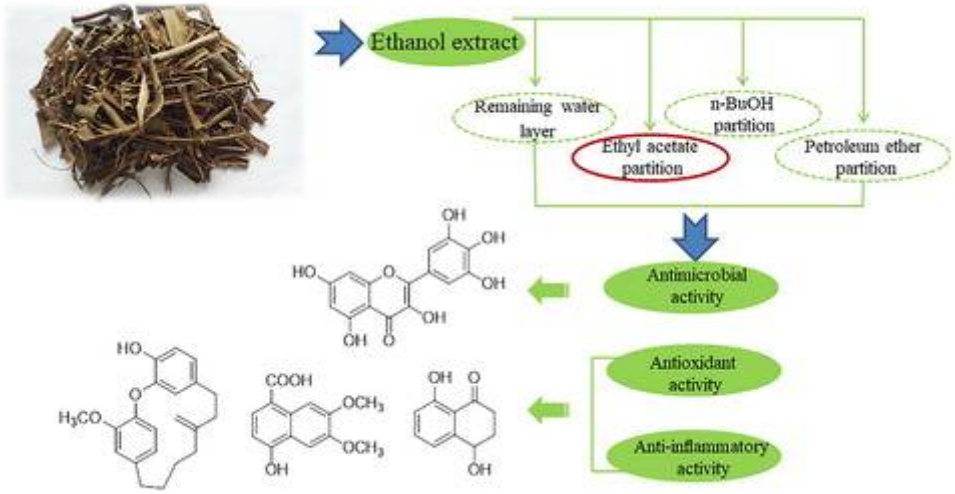

Research Article

Article

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Article

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Review

Review

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Research Article

Article

Phenolic constituents from the fresh pericarps of *Juglans sigillata* ›

Yi Lin, Jingjing Liang, Xiaogang Peng & Hanli Ruan

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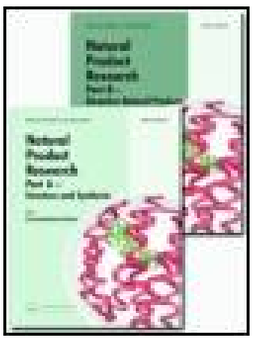

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Two novel coumarins bearing an acetophenone derivative from the leaves of *Melicope Quercifolia*

Ratih Dewi Saputri, Tjitjik Srie Tjahjandarie & Mulyadi Tanjung

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Two novel coumarins bearing an acetophenone derivative from the leaves of *Melicope Quercifolia*

Ratih Dewi Saputri, Tjitjik Srie Tjahjandarie and Mulyadi Tanjung

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

ABSTRACT

Meliquercifolins A (**1**), and B (**2**), two new coumarins are bearing an acetophenone derivative were isolated from the leaves of *Melicope quercifolia* along with three known compounds, melicodenines E (**3**), F (**4**) and I (**5**). Structures of two new compounds were identified based on spectroscopic analyses (UV, HR-ESI-MS, 1 D and 2 D NMR). Cytotoxic activities of compounds (**1–5)** towards three human cancer cells (HeLa, MCF-7, P-388), compounds **1**, **4** and **5** showed very potent activity against Hela cells with IC_{50} values 2.6; 0.8; 1.1 μM, respectively.

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Cytotoxicity; *Melicope quercifolia*; Meliquercifolins A and B

1. Introduction

Melicope quercifolia (Rutaceae) is a small tree and found as an endemic plant in West Java, Indonesia. The leaves of *M. quercifolia* have been used to treat skin diseases (Appelhans et al. 2018). Acetophenones (Nguyen et al. 2016), alkaloids (George et al. 2017), coumarins (Xu et al. 2016), flavonoids (Saputri et al. 2018), and phenylpropanoids (Nakashima et al. 2012) are phenolic compounds from the *Melicope* plants. Some of the phenolic compounds showed various Diels-Alder adduct and [2 + 2]

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cycloaddition (Nakashima et al. 2012). Melicodenines E (**3**), F (**4**) and I (**5**) formed a [2 + 2] cycloaddition type, and a Diels-Alder adduct type. In the ongoing phytochemical investigation of *M. quercifolia*, we report two new compounds, meliquercifolins A (**1**), and B (**2**) from the leaves of *M. quercifolia*. These structures of two new compounds are coumarins bearing an acetophenone moiety. Heterodimer compounds (**1** and **2**) are the first time found skeleton structure from *Melicope*. The cytotoxic properties against three human cancer cells (P-388, MCF-7, and HeLa) of isolated compounds will also report.

2. Result and discussion

Meliquercifolin A (**1**) obtained a colorless oil in which showed an optical rotation was inactive. Based on the HRESIMS measurement of **1** gave a positive ion peak $[M+H]^+$ at *m/z* 479.1729 correspondings for a molecular formula $C_{27}H_{27}O_8$. The IR absorptions of **1** displayed vibrations the presence of conjugated C = O (1636 cm^{-1}), aromatic (1608 and 1579 cm^{-1}) and ether (1119 cm^{-1}) groups. Two maximum absorptions at λ_{max} 280 (3.86) and 332 (3.88) nm very like with benzoyl and cinnamoyl chromophore. Four signals of a 1,2,3,4-tetrasubstituted cyclobutane ring showed at δ_H 3.05 (1H, dd, *J* = 9.8; 5.8 Hz, H-3), δ_H 3.96 (1H, t, *J* = 2.2 Hz, H-4), δ_H 4.71 (1H, t, *J* = 6.9 Hz, H-6) and δ_H 5.42 (1H, ddd, *J* = 8.2; 6.2; 2.2 Hz, H-7). The signal at δ_H 5.42 implied an oxymethine attached in the cyclobutane ring. Compound **1** also demonstrated the presence of two proton signals of two aromatics at δ_H 5.98 (1H, s, H-8), δ_H 6.21 (1H, s, H-9) and a pair of *cis* vinylic of chromen-2-one ring at δ_H 6.01 (1H, d, *J* = 9.8 Hz, H-3), δ_H 7.82 (1H, d, *J* = 9.8 Hz, H-4). Based on the ^{1}H NMR spectrum, compound **1** likewise showed the presence of three methyl signals at δ_H 2.17 (3H, s, H-10), δ_H 1.19 (3H, s, H-11), δ_H 1.61 (3H, s, H-12) as well as three methoxyl signals at δ_H 4.04 (3H, s, 5-OCH_3), δ_H 3.67 (3H, s, 5′-OCH_3), and δ_H 3.59 (3H, s, 7′-OCH_3). The ^{13}C NMR analysis (APT experiment), compound **1** showed 27 carbon signals that are completely separated, consisting of six methyl carbons, eight methine carbons, and 13 quaternary carbons. Three of them (δ_C 161.9; δ_C 139.5 and δ_C 109.7) are characteristic of C-2, C-3, and C-4 of the chromen-2-one ring (coumarin). Furthermore, two signals of the acetyl group (δ_C 32.3; δ_C 202.5) are characteristic of the acetophenone structure (Nakashima et al. 2012). The signal of a *cis* vinylic of chromen-2-one at δ_H 7.82 (H-4) in the HMBC spectrum exhibited correlation with two oxyaryl carbons, C-5 (δ_C 152.7), C-9a (δ_C 156.7) and a lactone carbonyl at C-2 (δ_C 161.9) as well as the methoxyl signal at δ_H 4.04 correlated to C-5 (δ_C 152.7) unambiguously located the methoxyl group at C-5. Another proton signal of a *cis* vinylic at δ_H 6.01 (H-3) correlated to C-2 (δ_C 161.9) and a quaternary carbon at C-4a (δ_C 108.1). Furthermore, a signal of aromatic at δ_H 6.21 correlated to two oxyaryl carbons at C-9a (δ_C 156.7); C-8a (δ_C 168.5) and two quaternary carbons at C-4a (δ_C 108.1); C-5a (δ_C 104.7) showed that the signal of δ_H 6.21 at H-9. A signal of an oxymethine at δ_H 5.42 correlated to C-8a (δ_C 168.5), and C-4′ (δ_C 34.7) revealed that a part of the heterodimer is bergapten (coumarin) (Nakashima et al. 2012). The HMBC spectrum, a signal of methine at δ_H 4.71 (H-6) correlated to C-3′ (δ_C 45.5), C-4′ (δ_C 34.7) and C-8a (δ_C 168.5) reinforced the structure of the bergapten experiencing a [2 + 2] cycloaddition reaction on furano ring (Nakashima et al. 2012). A methine signal (cyclobutane ring) at

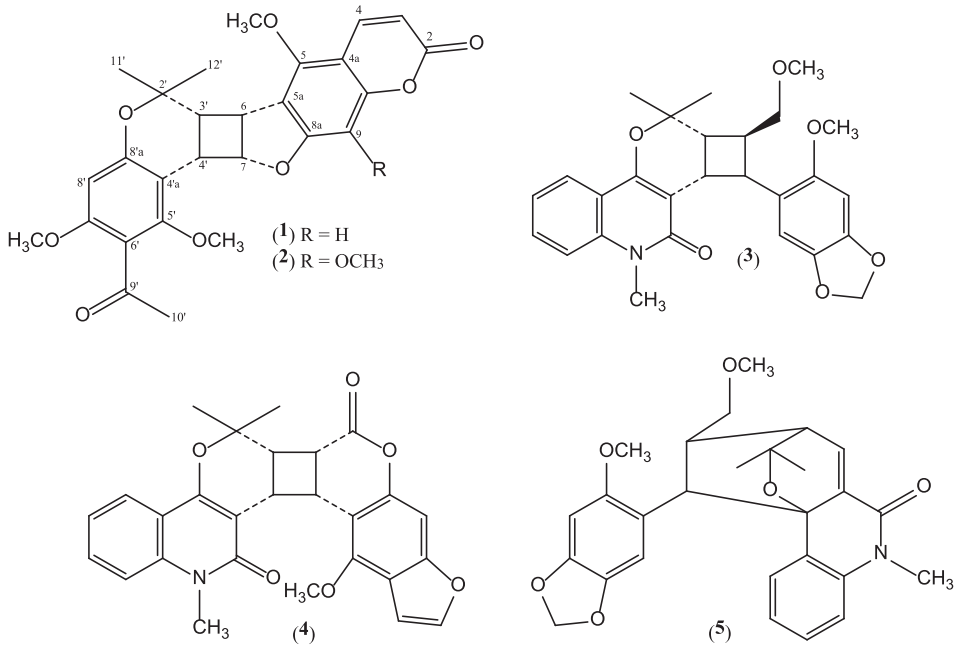

Figure 1. Chemical structures of isolated compounds from *M. quercifolia*.

δ_H 3.96 (H-4) correlated to δ_C 44.1 (C-6), δ_C 84.9 (C-7), δ_C 156.4 (C-8a) and δ_C 106.6 (C-4a). Two methyl signals of pyrano ring at δ_H 1.19 (H-11) and δ_H 1.61 (H-12) correlated to a methine carbon at C-3′ (δ_C 45.5) and an ether cyclic carbon at C-2′ (δ_C 74.0). Besides, a signal of aromatic isolated at δ_H 5.98 (H-8) correlated to an oxyaryl carbon at δ_C 156.8 (C-7), and two quaternary carbons at δ_C 106.6 (C-4a); 117.8 (C-6). A methoxyl signal at δ_H 3.67 (7-OCH_3) correlated to δ_C 156.8 (C-7). Another a methoxyl signal at δ_H 3.59 (5-OCH_3) correlated to δ_C 155.7 (C-5). A methyl signal of acetyl at δ_H 2.17 (H-10) correlated to δ_C 202.5 (C-9). These correlations showed that a part of evodionol (Nakashima et al. 2012). This result implied that compound **1** is a reaction of [2 + 2] cycloaddition between bergapten-evodionol. Therefore, the structure of meliquercifolin A established as **1**.

Meliquercifolin B (**2**) also acquired as a colorless oil. The UV absorption bands (λ_{max} 269, 335), and IR (1620, 1601, 1571 and 1110 cm^{-1}) absorptions very semblable with **1**. The molecular formula of compound **2** was assigned to be $C_{28}H_{29}O_9$ exhibited positive ion peak $[M + H]^+$ at *m/z* 509.1802 (calcd for 509.1812) by HRESIMS measurement. The ^1H and ^{13}C NMR spectrum of **2** had very semblable with **1**. The main difference, the ^1H and ^{13}C NMR of **2** showed a methoxyl group at C-9 (δ_H 3.98; δ_C 58.6). The HMBC and HMQC experiments confirmed the location of a methoxyl group at C-9. With the addition, a methoxyl group attached in the aromatic ring of coumarin skeleton indicated is [2 + 2] cycloaddition between isopimpinellin-evodionol. Based on UV, IR, HRESIMS, 1 D, and 2 D NMR measurements, the structure of meliquercifolin B assigned as **2.** The chemical structures of isolated compounds shown in (Figure 1).

Three known compounds, melicodenine E (**3**), melicodenine F (**4**) and melicodenine I (**5**) from HRESIMS, 1 D and 2 D NMR data showed chemical formula, and the chemical

Table 1. Cytotoxic activities of isolated compounds (**1–5**).

	IC_{50} (μM)		
Compound	HeLa	MCF-7	P-388
1	2.6 ± 0.10	>100	78.9 ± 1.20
2	>100	>100	>100
3	>100	>100	11.9 ± 0.42
4	0.8 ± 0.01	>100	38.3 ± 0.87
5	1.1 ± 0.05	>100	>100
Artonin E	–	–	1.33 ± 0.07
Doxorubicin	0.9 ± 0.04	0.8 ± 0.02	–

shift very resemblant with published previously (Nakashima et al. 2012; George et al. 2017). Compound **3** is a form of a [2 + 2] cycloaddition reaction of *N*-methylflindersin-melicodin A, and compound **4** is *N*-methylflindersin-bergapten. Compound **5** is a [4 + 2] cycloaddition (a Diels-Alder adduct type) two N-methylflindersins (George et al. 2017; Nakashima et al. 2012).

Those cytotoxic activities of isolated compounds, compounds **1**, **4** and **5** showed high activity against HeLa cells while compounds **2** and **3** were inactive. However, all of the isolated compounds were inactive against MCF-7 and P-388 cells (Table 1). For coumarin bearing an acetophenone derivative, compound **1** more active than compound **2** against HeLa cells. The influence of a methoxyl group at C-9 suggested as a critical element to decrease the cytotoxic effect towards HeLa cells. The melicodenine E (**4**) more active than meliquercifolins A (**1**). However, compound **4** slightly active than compound **5**. The *N*-methylflindersin factor is a crucial element to enhance the cytotoxic effect of HeLa cells. In addition to the *N*-methylflindersin factor tend to increase cytotoxic activity against human colon cancer cells (DLD-1) (Nakashima et al. 2012).

3. Experimental

3.1. Plant material

The fresh leaves of *M. quercifolia* obtained from Cianten Farm, Cigudek District, Bogor, West Java, Indonesia on Nov. 2017. The plant identified by Mr. Ismail Rachman, a botanist senior from the Herbarium Bogoriense, Bogor, Indonesia. A specimen (MQ 20171104) deposited as a reference.

3.2. Extraction and isolation

The air-dried leaves of *M. quercifolia* (2.0 kg) were extracted with MeOH three times (6 L, each for two days) at room temperature. Evaporation of the solvent with evaporator gave a MeOH extract (450 g) and then partitioned with *n*-hexane three times. Furthermore, the MeOH extract was added with H_2O (4:1 v/v) and partitioned with EtOAc three times gave the crude extract (5 g). The EtOAc extract (4.8 g), fractionationated by CC on silica gel, eluted with *n*-hexane-EtOAc (from 9:1 to 3:7) providing two fractions, A and B. Fraction A (1.3 g) was fractionationated by CC chromatography on polyamide, eluted with *n*-hexane-$CHCl_3$ (from 9:1 to 1:4) gave two subfractions, A_1 and A_2. Compounds **3** (13 mg) and **4** (15 mg) were isolated from subfraction A_2 (655 mg) using radial planar chromatography with the same eluent. Fraction B (800 g) was

separated by CC chromatography on polyamide, and eluted *n*-hexane-EtOAc (from 4:1 to 1:1) gave subfractions B_1-B_2. Compounds **1** (5 mg) and **2** (7 mg) was obtained from subfraction B_1 (265 mg) by radial planar chromatography, eluted with *n*-hexane-diisopropylether (from 3:9 to 7:3), and diisopropylether as a solvent system. By the same methods, compound **5** (16 mg) isolated from subfraction B_2 (148 mg).

3.3. Spectral data

Meliquercifolin 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_{max} (cm^{-1}): 3411, 2972, 2925, 2852, 1649, 1604, 1579 and 1159. ^{1}H-NMR (400 MHz, $CDCl_3$) δ_H ppm: 6.01 (1H, *d*, *J* = 9.8 Hz, H-3), 7.81 (1H, *d*, *J* = 9.8 Hz, H-4), 4.04 (3H, *s*, 5-OCH_3), 4.71 (1H, *t*, *J* = 6.9 Hz, H-6), 5.42 (1H, *ddd*, *J* = 8.2; 6.2; 2.2 Hz, H-7), 6.21 (1H, *s*, H-9), 3.05 (1H, *dd*, *J* = 9.8; 5.8 Hz, H-3′), 3.96 (1H, *t*, *J* = 2.2 Hz, H-4′), 3.67 (3H, *s*, 5′-OCH_3), 3.59 (3H, *s*, 7′-OCH_3), 5.98 (1H, *s*, H-8′), 2.17 (3H, *s*, H-10′), 1.19 (3H, *s*, H-11′) and 1.61 (3H, *s*, H-12′). ^{13}C-NMR (100 MHz, $CDCl_3$), δ_C ppm: 161.1 (C-2), 109.7 (C-3), 139.5 (C-4), 108.1 (C-4a), 152.7 (C-5), 104.7 (C-5a), 44.1 (C-6), 84.9 (C-7), 168.5 (C-8a), 91.7 (C-9), 156.7 (C-9a), 74.0 (C-2′), 45.5 (C-3′), 34.7 (C-4′), 106.6 (C-4′a), 155.7 (C-5′), 62.6 (5′-OCH_3), 117.8 (C-6′), 156.8 (C-7′), 55.8 (7′-OCH_3), 96.8 (C-8′), 156.4 (C-8′a), 202.5 (C-9′), 32.3 (C-10′), 25.3 (C-11′) and 25.7 (C-12′). HRESIMS: *m/z* $[M+H]^+$ calcd. for $C_{27}H_{27}O_8$ 479.1706, found 479.1729.

Meliquercifolin B (**2**): yellow solid, UV/Vis (MeOH) λ_{max} (nm) (log ε): 217 (3.33), 234 (3.12), 255 (3.02), 268 (2.98) and 299 (2.69) nm. IR (KBr) ν (cm^{-1}): 3448, 2966, 2923, 2854, 1651, 1627, 1460 and 1186. ^{1}H-NMR (400 MHz, $CDCl_3$) δ_H ppm: 6.02 (1H, *d*, *J* = 9.6 Hz, H-3), 7.79 (1H, *d*, *J* = 9.6 Hz, H-4), 3.68 (3H, *s*, 5-OCH_3), 4.75 (1H, *t*, *J* = 6.8 Hz, H-6), 5.50 (1H, *dd*, *J* = 6.8; 3.9 Hz, H-7), 3.98 (3H, *s*, 9-OCH_3), 3.09 (1H, *dd*, *J* = 9.9; 5.8 Hz, H-3′), 3.99 (1H, *dd*, *J* = 5.8; 1.8 Hz, H-4′), 3.68 (3H, *s*, 5′-OCH_3), 3.57 (3H, *s*, 7′-OCH_3), 5.92 (1H, *s*, H-8′), 2.21 (3H, *s*, H-10′), 1.12 (3H, *s*, H-11′), and 1.66 (3H, *s*, H-12′). ^{13}C-NMR (100 MHz, $CDCl_3$), δ_C ppm: 160.9 (C-2), 109.9 (C-3), 139.6 (C-4), 104.4 (C-4a), 126.0 (C-5), 106.9 (C-5a), 44.4 (C-6), 85.3 (C-7), 159.8 (C-8a), 148.1 (C-9), 149.1 (C-9a), 74.1 (C-2′), 45.7 (C-3′), 34.5 (C-4′), 106.2 (C-4′a), 156.9 (C-5′), 62.7 (5′-OCH_3), 117.3 (C-6′), 156.8 (C-7′), 55.8 (7′-OCH_3), 96.8 (C-8′), 163.8 (C-8′a), 209.2 (C-9′), 32.3 (C-10′), 25.4 (C-11′), and 25.7 (C-12′). HRESIMS: *m/z* $[M+H]^+$ calcd. for $C_{28}H_{29}O_9$ 509.1812, found 509.1802.

3.4. Cytotoxic assay

Effect cytotoxic of compounds (**1**-**5**) against HeLa (human cervical cancer cells), MCF-7 (human breast cancer cells), P-388 (human murine leukemia cells) were evaluated using the MTT colorimetric methods (Mah et al. 2015; Tanjung et al. 2017, 2018; Segun et al. 2019). Doxorubicin used as a control positive for HeLa, and MCF-7 as well as artonin for P-388 cells.

4. Conclusions

Meliquercifolins A (**1**) and B (**2**), two new coumarins bearing an acetophenone derivative were isolated from the leaves of *M. quercifolia* together with three known

compounds, melicodenines E (**3**), F (**4**) and I (**5**). Compounds (**1** and **2**) are the first time coumarin bearing an acetophenone derivative found on *Melicope*.

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Disclosure statement

No potential conflict of interest reported by the authors.

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