DOI 10.1007/s10600-016-1853-7
Chemistry of Natural Compounds, Vol. 52, No. 6, November, 2016

A NEW SESQUITERPENE FROM THE RHIZOMES OF *Hedychium yunnanense*

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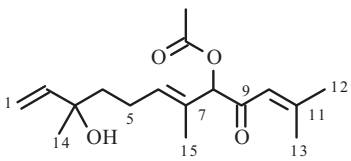
*A new sesquiterpene, hedyunchene A (**1**), was isolated from the rhizomes of* Hedychium yunnanense*, together with two known compounds 6β-hydroxystigmasta-4,22-dien-3-one (**2**) and 6β-hydroxystigmast-4-en-3-one (**3**). Their structures were determined on the basis of NMR (1D and 2D) and mass spectroscopic analysis.*

Keywords: Zingiberaceae, *Hedychium yunnanense*, sesquiterpene, hedyunchene A.

Species of the genus *Hedychium* (Zingiberaceae) are distributed in tropical areas of the world, including south of China [1, 2], some of which have been widely used as traditional Chinese medicine to treat liver diseases and stomach ailments such as pain, indigestion, swelling, diarrhea, hernia, and so on [3, 4]. Phytochemical investigations revealed that a large number of diterpenes were isolated from the plants of this genus [3, 5]. *H. yunnanense* grows in southern China, including the provinces of Yunnan, Sichuan, and Guangxi [3], and contains mainly diterpenes [6–8]. As a part of our ongoing project towards the discovery of new active constituents from the species of Zingiberaceae [9, 10], a new sesquiterpene, hedyunchene A, was isolated from the rhizomes of *Hedychium yunnanense*, together with two known compounds 6*β*-hydroxystigmasta-4,22-dien-3-one (**2**) [11] and 6*β*-hydroxystigmast-4-en-3-one (**3**) [12]. This paper deals mainly with the isolation and structural determination of the new compound **1**.

Hedyunchene A (**1**) was obtained as a colorless oil. The molecular formula $C_{17}H_{26}O_4$ was established by HR-ESI-MS (*m/z* 317.1729 $[M + Na]^+$, calcd 317.1721). The ^1H NMR spectrum (Table 1) showed signals due to five tertiary methyls at δ 1.79 (s, H-12), 2.04 (s, H-13), 1.18 (s, H-14), 1.48 (s, H-15), and 2.04 (s, 8-OCOC$\underline{H}_3$), two trisubstituted olefinic protons at δ 5.72 (t, J = 7.1 Hz, H-6) and 6.00 (s, H-10), a pair of monosubstituted olefinic ones at δ 5.08 (d, J = 17.3 Hz, H-1a), 4.93(d, J = 12.7 Hz, H-1b), and 5.79 (dd, J = 17.3, 12.7 Hz, H-2), an oxygenated proton at δ 5.25 (s, H-8), and two methylenes.



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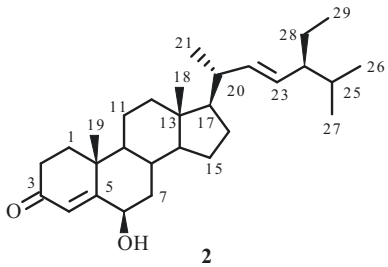

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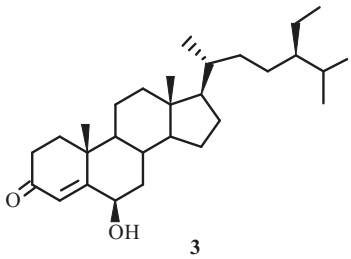

3

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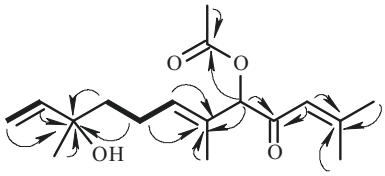
TABLE 1. ^{1}H (600 MHz) and ^{13}C (150 MHz) NMR Data of Compound **1** ($CDCl_3$, δ, ppm, J/Hz)

C atom	δ_H	δ_C	C atom	δ_H	δ_C
1	5.08 (d, J = 17.3, H-1a),	111.8 (t)	9	–	193.6 (s)
	4.93 (d, J = 12.7, H-1b)		10	6.00 (s)	119.4 (d)
2	5.79 (dd, J = 17.3, 12.7)	144.7 (d)	11	–	158.9 (s)
3	–	72.8 (s)	12	1.79 (s)	27.9 (q)
4	1.48 (m)	41.1 (t)	13	2.04 (s)	21.0 (q)
5	2.04 (m)	22.7 (t)	14	1.18 (s)	27.6 (q)
6	5.72 (t, J = 7.1)	134.0 (d)	15	1.48 (s)	12.1 (q)
7	–	128.8 (s)	8-O$\underline{C}$OCH$_3$	–	170.2 (s)
8	5.25 (s)	84.6 (d)	8-OCO$\underline{C}$H$_3$	2.04 (s)	20.7 (s)



1

COSY → HMBC

Fig. 1. The key COSY and HMBC correlations of compound **1**.

Analysis of the ^{13}C NMR, DEPT, and HSQC data revealed signals corresponding to 17 carbons, which were classified into five quaternary carbons including two carbonyl ones of an *α,β*-unsaturated lactone at δ 193.6 (s, C-9) and an acetoxy group at 170.2 (s, 8-O$\underline{C}$OCH$_3$), three methylenes including a terminal olefinic carbon at 111.8 (t, C-1), four methines including two olefinic carbons at δ 134.0 (d, C-6) and 119.4 (d, C-10) and an oxygenated one at δ 84.6 (d, C-8), and five methyls. In the ^{1}H–^{1}H COSY spectrum (Fig. 1), two spin systems corresponding to the units of CH_2=CH and CH_2–CH_2–CH were revealed by the correlations between H-1 and H-2, H-4 and H-5, and H-5 and H-6. The linkage of the former fragments was confirmed by the HMBC correlations from H-1 and H-2 to C-3, H-4 and H-5 to C-3, and H-5 and H-6 to C-7 (Fig. 1). Moreover, the HMBC spectra revealed other key correlations from H-14 to C-3, H-15 to C-7, H-8 and a methyl proton at 2.04 (s) to the carbon signal at 170.2 (s), H-8 and H-10 to C-9, and H-10, H-12, and H-13 to C-11 (Fig. 1). In particular, the location of an acetoxy group was confirmed by the correlation of H-8 to the carbon signal at 170.2. Thus, the planar configuration of **1** was determined as shown in Fig. 1.

EXPERIMENTAL

General Procedures. Column chromatography (CC) was performed on silica gel (100–200 or 200–300 mesh, Qingdao Marine Chemical Ltd. Co., China); MCI gel CHP20P (75–150 μM, Mitsubishi Chemical Co., Japan) was used; semipreparative reverse-phase (RP) HPLC was carried out on an Agilent 1100 liquid chromatograph equipped with a Zorbax SB-C_{18} column; NMR spectra were taken on a Bruker Avance III-600 instrument with chemical shifts given in ppm (δ) using TMS as an internal standard; UV spectra were obtained using a Shimadzu 210A double-beam spectrophotometer with λ_{max} (log ε) in cm^{-1}; IR spectra (KBr pellets) was measured using a Bio-Rad FTS-135 spectrometer; optical rotations were determined with a Jasco DIP-370 digital polarimeter; ESI and HR-ESI-MS were recorded on an API Qstar Pulsar instrument.

Plant Material. The rhizomes of *Hedychium yunnanense* were collected from Mengla County of Xishuangbanna, Yunnan Province, People′s Republic of China in October, 2013 and identified by Yunhong Tan of Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences.

Extraction and Isolation. The dried and powdered rhizomes of *Hedychium yunnanense* (5 kg) were extracted with ethanol under reflux for 8 h (3 × 15 L). The resulting residue was partitioned between EtOAc and H_2O, and then *n*-BuOH and H_2O. The EtOAc extract (170 g) was obtained after evaporation of the solvents under reduced pressure and then fractionated by column chromatography using a gradient solvent system of petroleum ether–Me_2CO (9:1 to 1:1, v/v) to yield six fractions, Fr. 1–6. Fraction 3 (8 g) was subjected to CC (silica gel, $CHCl_3$–Me_2CO, 20:1, v/v) to afford four subfractions, Subfr. 3.1–3.4.

Subfraction 3.1 was subjected to CC (silica gel, $CHCl_3$–EtOAc, 10:1, v/v) and further purified by CC (MCI) to yield **1** (8 mg). Subfraction 3.2 was subjected to CC (silica gel, $CHCl_3$–EtOAc, 9:1, v/v) to yield **2** (3 mg) and **3** (2 mg).

Hedyunchene A (1). $C_{17}H_{26}O_4$, colorless oil. $[\alpha]_D^{19.6}$ –198.6° (*c* 0.1, $CDCl_3$). UV spectrum ($CHCl_3$, λ_{max}, nm) (log ε): 294 (2.71), 244 (4.06), 193 (3.02). IR spectrum (KBr, ν, cm^{-1}): 3495, 2973, 2931, 1740, 1697, 1621, 1445, 1373, 1235, 1024, 922. HR-ESI-MS *m/z* 317.1729 $[M + Na]^+$ (calcd for $C_{17}H_{26}O_4Na$, 317.1721). ^1H and ^{13}C NMR, see Table 1.

6*β*-Hydroxystigmasta-4,22-dien-3-one (2). $C_{29}H_{46}O_2$, colorless powder. ^1H NMR (400 MHz, $CDCl_3$, δ, ppm, J/Hz): 5.82 (1H, br.s, H-4), 5.13 (1H, dd, J = 15.2, 8.8, H-22), 5.02 (1H, dd, J = 15.2, 8.4, H-23), 4.35 (1H, br.s, H-6), 1.38 (3H, s, H-19), 1.02 (3H, d, J = 6.5, H-21), 0.74 (3H, s, H-18), 0.85 (3H, t, J = 7.6, H-29), 0.81 (3H, d, J = 7.6, H-26), 0.79 (3H, d, J = 7.6, H-27). ^{13}C NMR (100 MHz, $CDCl_3$, δ, ppm): 37.1 (t, C-1), 34.3 (t, C-2), 200.4 (s, C-3), 126.3 (d, C-4), 168.4 (s, C-5), 73.3 (d, C-6), 38.5 (t, C-7), 29.7 (d, C-8), 53.6 (d, C-9), 38.0 (s, C-10), 21.0 (t, C-11), 39.6 (t, C-12), 42.4 (s C-13), 55.9 (d, C-14), 25.4 (t, C-15), 28.9 (t, C-16), 56.0 (d, C-17), 12.1 (q, C-18), 19.5 (q, C-19), 40.4 (d, C-20), 30.0 (q, C-21), 138.1 (d, C-22), 129.5 (d, C-23), 51.2 (d, C-24), 31.9 (d, C-25), 21.1 (q, C-26), 18.9 (q, C-27), 24.2 (t, C-28), 12.2 (q, C-29).

6*β*-Hydroxystigmast-4-en-3-one (3). $C_{29}H_{48}O_2$, colorless powder. ^1H NMR (400 MHz, $CDCl_3$, δ, ppm, J/Hz): 5.82 (1H, br.s, H-4), 4.36 (1H, br.s, H-6), 1.37 (3H, s, H-19), 0.92 (3H, d, J = 6.4, H-21), 0.74 (3H, s, H-18), 0.85 (3H, t, J = 7.6, H-29), 0.81 (3H, d, J = 7.2, H-26), 0.83 (3H, d, J = 7.2, H-27). ^{13}C NMR (100 MHz, $CDCl_3$, δ, ppm): 37.1 (t, C-1), 34.3 (t, C-2), 200.4 (s, C-3), 126.3 (d, C-4), 168.4 (s, C-5), 73.3 (d, C-6), 38.5 (t, C-7), 29.7 (d, C-8), 53.6 (d, C-9), 38.0 (s, C-10), 21.0 (t, C-11), 39.6 (t, C-12), 42.5 (s C-13), 55.9 (d, C-14), 24.1 (t, C-15), 28.2 (t, C-16), 56.0 (d, C-17), 12.1 (q, C-18), 19.5 (q, C-19), 36.1 (d, C-20), 18.7 (q, C-21), 33.9 (t, C-22), 26.1 (t, C-23), 45.8 (d, C-24), 29.1 (d, C-25), 19.0 (q, C-26), 19.8 (q, C-27), 23.1 (t, C-28), 12.1 (q, C-29).

Assessment of Cytotoxicity. The cytotoxicities of compound **1** against two cancer cell lines, SGC-7901 (human gastric cancer cell line) and HeLa (human cervical carcinoma), were measured by the SRB method. However, **1** showed no activities against these two cancer cell lines.

ACKNOWLEDGMENT

This work was supported by the National Natural Science Foundation of China (31360080) and the Young Academic and Technical Leader Raising Foundation of Yunnan Province to J-J Xu (2014HB013). The authors are grateful to the staff of the analytical group at the State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences for the spectral data.

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