A new sesquiterpene from the seeds of *Physalis alkekengi L. var. franchi*

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A new sesquiterpene, named as 13-hydroxy-3,11-(7αH, 10βH)-acordien-3-one (**1**), and a known norsesquiterpene 3β-hydroxy-5α, 6α-epoxy-7-megastigmen-9-one (**2**) were isolated from the seeds of *Physalis alkekengi L. var. franchi*. The structure of **1** was established by spectroscopic methods. Compound **1** was found to show modest antibacterial activity.

Keywords: sesquiterpene, *Physalis alkekengi L. var. franchi*, Chinese medicine

The plant *Physalis alkekengi L. var. franchi* (Solanaceae) is used in traditional Chinese medicine to reduce fever.[1] Previous studies on the chemical constituents of *Physalis alkekengi L. var. franchi* resulted in the isolation of a number of physalins-type steroids[2-11]and cycloheptane alkaloids.[12,13] In the current search for biologically active compounds from Chinese medicinal plants, a new sesquiterpene, named as 13-hydroxy-3,11-(7αH,10βH)-acordien-3-one (**1**) and one known norsesquiterpene 3β-hydroxy-5α, 6α-epoxy-7-megastigmen-9-one (**2**) (Fig. 1) were isolated from the seeds of this plant. We report the isolation and structural elucidation of these compounds.

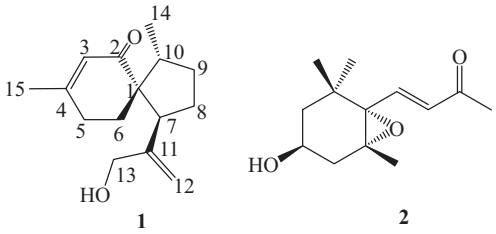

Fig. 1 Structure of compounds **1** and **2**.

Compound **1** was obtained as colourless oil. Its molecular formula $C_{15}H_{22}O_2$ [HR-EIMS *m/z* 234.1632 (Calc. for $C_{15}H_{22}O_2$ 234.1620)], indicated the presence of five degrees of unsaturation. In the IR spectrum, absorption at 3418, 1710, and 1653 cm^{-1} indicated the presence of hydroxyl, carbonyl, and double bond groups, respectively. The ^1H NMR spectrum (Table 1) of **1** displayed the presence of three double bonds protons at δ 4.95, 5.08, 5.75 (each 1H, s), two methyls at δ 0.99 (3H, d, J = 6.8 Hz), 1.95 (3H, s), and a hydroxymethyl at δ 4.14 (2H, s). ^{13}C NMR data (Table 1) revealed the presence of 15 carbon signals, comprising, the following functionalities:- a ketone carbonyl (δ 199.1), two double bonds (δ 108.5, 150.8, 125.6, 166.5), a hydroxymethyl (δ 65.7), and two methyls (δ 15.8, 20.8). The carbonyl group and two double bonds accounted for three degrees of the unsaturation, the remaining two degrees of unsaturation indicated a bicycle system in 1 dicyclic system in **1**.

Analysis of the ^1H NMR, ^{13}C NMR and HMQC spectra of **1** enabled us to assign all the protons to their bonding carbons. The two partial structures **a** (C-5 to C-6), **b** (C-7 to C-10 and C-14) drawn with bold bond were established by ^1H–^1HCOSY spectra (Fig. 2). The planar structure of **1** was deduced from HMBC spectra. In the HMBC spectrum (Fig. 2), the HMBC correlations of H_3-15/C-4, H_3-15/C-3 and H-3/C-2 revealed the presence of α, β–unsaturated ketone, which was confirmed by the UV absorption band at 238 nm (lgε 3.52); the proton signal of H-15 (δ 1.95) correlated with the carbon signal at δ 166.5 (C-4), 41.1 (C-5) revealed the linkage of C-4 and C-5; the proton signal of H-13 (δ 4.14) correlated with the carbon signal at δ 150.8 (C-11), 42.5 (C-7) revealed the linkage of C-7 and C-11; the C-1 linked with C-2 and C-6 verified by the correlation of H_2-6/C-2 and H_2-6/C-1; the HMBC correlations of H_3-14/C-10 and H_3-14/C-1 showed linkage of C-1 and C-10; the linkage of C-1 and C-7 was deduced from the correlation between H-7 and C-1. The planar structure of **1** was thus established.

The relative stereochemistry of **1** was deduced from the NOESY correlation. The signal for H-7 showed an interaction with the signals at δ 0.99 (H-14). The signal at δ 2.02 showed correlation with H-12. The ^1H, ^{13}C NMR spectral data and 2D NMR experiments support the assignment of structure **1** to the new compound named 13-hydroxy-3,11-(7αH, 10βH)-acordien-3-one.

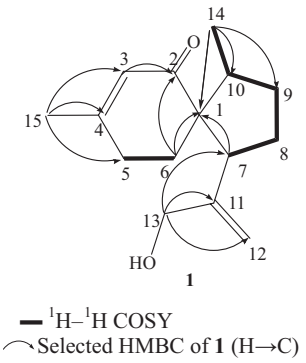

Fig. 2 Selected 2D NMR correlations of **1.**

Compound **2** was identified as 3β-hydroxy-5α, 6α-epoxy-7-megastigmen-9-one by comparison NMR data with literature data.[14]

Experimental

Optical rotations were determined on a Perkin-Elmer 341 polarimeter. IR spectra were recorded on a Perkin-Elmer 577 spectrometer with KBr disks. NMR spectra were measured on a Bruker AM-400 spectrometer with TMS as internal standard. EIMS (70 eV) was carried out on a Finnigan MAT 95 mass spectrometer. All solvents used were of analytical grade (Shanghai Chemical Plant, Shanghai, People's Republic of China). Silica gel (200–300 mesh) was used for column chromatography, and a precoated silica gel GF_{254} plate (Qingdao Haiyang Chemical Plant, Qingdao, People's Republic of China) was used for TLC. C_{18} reverse-phased silica gel (150–200 mesh, Merck) was also used for column chromatography.

Plant material

Physalis alkekengi L. var. franchi seeds were collected from the Bozhou district of Anhui Province and identified by Prof. Yong-Hong Zhang of the Fujian Medical University. A voucher specimen (ZJUT 05623) was deposited at Zhejiang University of Technology, People's Republic of China.

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Table 1 ^{1}H and ^{13}C NMR data of **1** at 400 MHz in ($CDCl_3$)

Carbon	δ_H *J* (Hz)	δ_C	Carbon	δ_H *J* (Hz)	δ_C
1	–	50.0	9	2.62 (1H, m) 2.24 (1H, m)	42.9
2	–	199.1	10	2.12 (1H, m)	39.3
3	5.75 (1H, s)	125.6	11	–	150.8
4	–	166.5	12	5.08 (1H, s) 4.95 (1H, s)	108.5
5	1.66 (1H, m) 2.22 (1H, m)	41.1	13	4.14 (2H, s)	65.7
6	1.70 (1H, m) 2.02 (1H, m)	33.1	14	0.99 (3H, d, 6.8)	15.8
7	2.60 (1H, m)	42.5	15	1.95 (3H, s)	20.8
8	1.97 (1H, m) 1.72 (1H, m)	34.3			

Table 2 Antimicrobial activity of compounds **1** and **2**

Microbes	MIC (mM)[a]		
	1	**2**	Magnolol
Staphylococcus aureus ATCC 25923	0.4	0.20	0.050
Micrococcus luteus ATCC 9341	>1.0	0.40	0.050

[a]MIC was defined as the lowest concentration that inhibited visible growth.

Extraction and purification

The powder of the seeds of *P. alkekengi L. var. franchi* (1.5 kg) was extracted with 95% ethanol at room temperature to give a dark crude extract (124 g), which was then dissolved in water (2 l) to form a suspension, and partitioned with $CHCl_3$ to afford a $CHCl_3$ soluble fraction C (27 g). The fraction C was subjected to silica gel column chromatography eluted with petroleum ether containing increasing amount of acetone to afford fractions 1–2. The fraction 1(5.2 g) was applied to C_{18} reverse-phased silica gel column chromatography eluted with 50% aqueous methanol to yield 2 (15. 0 mg). The fraction 2 (4.1 g) was subjected to silica gel column chromatography and eluted with $CHCl_3$−MeOH (15: 1) to afford 1 (18.0 mg).

13-Hydroxy-3,11-(7αH, 10βH)-acordien-3-one (**1**): Colourless oil, $[\alpha]^{20}{}_D$ −8.2° (*c* 0.36, $CHCl_3$); UV_{max} ($CHCl_3$): 238 (3.52); IR (KBr): 3418, 2957, 2875, 1710, 1653, 1456, 1379 cm^{-1}; EIMS *m/z*: 234 $[M]^+$ (100), 206(18), 191 (22), 137 (38), 108 (36), 79 (26); HR-EIMS *m/z*: 234.1632 [M] (Calc. for $C_{15}H_{22}O_2$ 234.1620). ^{1}H NMR and ^{13}C NMR data: see Table 1

Biological activity evaluation

The microbial cells were suspended in Mueller Hinton broth to form a final density of 5×10^{-5}–10^{-6} CFU/ml and incubated at 37°C for 18 h under aerobic conditions with the respective compounds which have been dissolved in DMSO. The blank controls of microbial culture were incubated with limited DMSO under the same condition. DMSO was determined not to be toxic at a limited amount under these experimental conditions. The antibacterial activity of compound **1** and **2** is shown in Table 2.

The Financial support of the Education Foundation (20051411) of Zhejiang province, P. R. China is gratefully acknowledged.

Received 5 December 2006; accepted 30 December 2006
Paper 06/4330

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