Two Novel Diterpenoids from *Clerodendrum Bungei*

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Two novel royleanones, bungone A (1) and B (2) have been isolated from the stem of *Clerodendrum bungei*. The structures of these two compounds [9,10-dihydro-3,4,9-trimethyl phenanthro[3,2-*b*]pyran (7*H*)-7,12(8*H*)-dione (bungone A) and 9,10-dihydro-8-hydroxymethyl-3,4,9-trimethyl phenanthro[3,2-*b*]pyran (2*H*)-7,12-dione (bungone B)] were determined mainly on the spectral analysis.

Key words diterpenoid; Verbenaceae; bungone A; bungone B; *Clerodendrum bungei*

Chou-mudan is the dried stem and root of a medicinal plant *Clerodendrum bungei* (Verbenaceae), which is widely used as a kind of folk remedy in traditional Chinese medicine for the treatment of uterus prolapsus.[1] The antitumor effect of this material has been reported,[2] but the chemical constituents of the plant have remained unidentified. In the present paper, the structures of two new royleanone diterpenes isolated from the stem of *C. bungei*, bungone A (**1**) and B (**2**), together with three known compounds, sugiol, uncinatone and teuvincenone F are described.

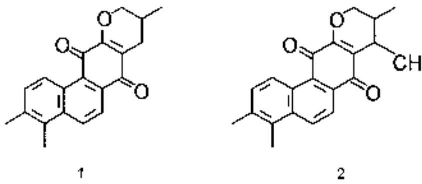
Results and Discussion

Bungone A (**1**) was obtained as orange needles, mp. 182 °C. The molecular formula $C_{20}H_{18}O_3$ (M^+ *m/z*: 306.1791, Calcd 306.1794) was determined by high-resolution MS. The absorption bands in UV spectrum (284, 323, 352 nm) exhibited the presence of para-quinone ketone, and the IR spectrum showed absorption bands (1685, 1580 cm^{-1}) which correspond to ketone and benzene moieties. The ^1H-NMR spectrum of bungone A showed the signals on partially aromatic structure were quite similar to isotanshinone I and danshenxinkun A-C[3,4]: Signals at δ 2.59 (s, 3H) and δ 2.68 (s, 3H) were the methyl groups on the aromatic ring, signals at δ 8.94 (d, 1H) and δ 7.42 (d, 1H) were two aromatic protons on ring A, while signals at δ 7.72 (d, 1H) and δ 7.85 (d, 1H) were the other two aromatic protons on ring B. The ^{13}C-NMR spectrum exhibited the presence of three methyl carbons and some aromatic hydrocarbons, which were identical with those in the ^1H-NMR spectrum.

The difference existed in the remaining fragment C_4H_8O. The ^1H-NMR and ^1H–^1H COSY showed the presence of a CH_2–CH–CH_2 [8-H_2 (δ 2.91, dd, 1H, δ 3.07, dd, 1H), 9-H (δ 3.43, m, 1H), 10-H_2 (δ 4.15, dd, 1H, δ 4.37, dd, 1H)] spin system. One of the methylene groups must be attached to an oxygen atom due to the signals at δ_H 4.15, 4.37 (1H, dd, respectively) and δ_C 78.6. Thus the fragment C_4H_8O could be deduced as a six membered heterocycle containing an oxygen atom.

Analyzing the long-range coupling between the protons and carbons corroborated the structure of bungone A. In the COLOC spectrum, the long-range coulpings between δ_H 8.94 (1H, d) and δ_C 119.5, 136.5, δ_H 7.72 (1H, d) and δ_C 113.0, 136.4, δ_H 7.85 (1H, d) and δ_C 119.5, 194.4, δ_H 2.91, 3.07 (2H, dd) and δ_C 136.4, 170.9 were observed. Bungone A thus had a similar structure as danshenxinkun D.[5] The chiral carbon of C_9 and attachment of one methyl results in the large different chemical shifts of two protons of C_{10}, sometimes up to 0.6 ppm.[6]

Another new diterpenes bungone B (**2**) was obtained as orange rectangles, mp 187 °C. The molecular formula $C_{21}H_{20}O_4$ (M^+ *m/z*: 336.1806, Calcd 336.1813) was determined by high-resolution mass spectrometry. The IR and UV spectrum were quite similar to bungone A (**1**). Both exhibited the presence of *p*-quinone and benzene ring moieties. The obvious difference appeared in the NMR spectrum: The signals at δ_H 2.91, 3.07 (2H, dd), δ_H 4.56 (s, downshield to δ 8.89 after addition of CF_3COOH) and δ_C 56.4 showed existence of a hydroxy-methyl group. The CH–CH–CH_2 [8-H (δ 3.26, m, 1H), 9-H (δ 3.55, m, 1H), 10-H_2 (δ 4.31, 4.80, dd, 2H)] spin system was observed instead of CH_2–CH–CH_2 spin system. So the hydroxymethyl group was deduced to substitute on C-8.



1 2

Fig. 1

Table 1. ^1H-NMR Spectral Data of Compounds **1** and **2** (400 MHz, $CDCl_3$, TMS as int. Standard)

H (ppm)	**1**	**2**
1	8.94, d (*J*=8.2 Hz)	8.96, d (*J*=8.6 Hz)
2	7.42, d (*J*=8.3 Hz)	7.47, d (*J*=8.5 Hz)
5	7.72, d (*J*=9.0 Hz)	7.78, d (*J*=9.2 Hz)
6	7.85, d (*J*=8.9 Hz)	7.89, d (*J*=9.2 Hz)
8-H_2	2.91, 3.07, dd (*J*=11.6, 6.3 Hz)	3.26, m
8-CH_2OH		2.91, 3.07, dd (*J*=10.1 Hz)
9-H	3.43, m	3.55, m
10-H_2	4.15, 4.37, dd (*J*=13.2, 5.5 Hz)	4.31, 4.80, dd (*J*=12.7,5.2 Hz)
3-Me	2.59, s	2.52, s
4-Me	2.68, s	2.65, s
9-Me	1.49, d (*J*=7.0 Hz)	1.54, d (*J*=7.2 Hz)
8-CH_2OH		4.56, s

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Table 2. ^{13}C-NMR Spectral Data of Compounds **1** and **2** (100 MHz, $CDCl_3$, TMS as int. Standard)

Carbon No.	**1**	**2**
1	125.1	125.4
2	124.0	124.5
3	119.2	119.8
4	113.0	113.2
4a	119.5	120.0
5	125.1	125.7
6	128.4	128.6
6a	136.4	135.7
7	194.4	195.1
7a	141.2	141.3
8	40.9	42.1
9	32.8	34.6
10	78.6	80.5
11a	170.9	171.3
12	201.1	202.3
12a	136.5	137.1
12b	131.2	132.5
3-Me	19.3	19.5
4-Me	19.8	20.1
9-Me	17.5	17.6
8-$\underline{C}H_2OH$		56.4

Experimental

The naturally dried and pulverized stems of *Clerodendrum bungei* (10 kg) was collected in Lushan Plant Garden of Jiangxi, China. It was extracted with hot EtOH three times. The solvent was recovered in vacuum to yield crude extract (260 g). A certain volume of water was added to the crude extract and the mixture was agitated thoroughly to form a suspension, which was extracted with $CHCl_3$. After evaporation, the $CHCl_3$ extract (60 g) was subjected to column chromatography on silica gel eluted with an $CHCl_3$–petroleum ether gradient to give bungone A (**1**) (10 mg) and B (**2**) (14 mg), respectively.

Bungone A (**1**): Orange needles, mp. 182 °C; IR ν_{max} cm^{-1}: 3345, 1685, 1580, 1145; UV λ_{max} nm (MeOH) (log ε): 230 (4.58), 284 (4.12), 323 (4.25), 352 (3.84); HR-MS *m/z*: 306.1791 (Calcd for $C_{20}H_{18}O_3$: 306.1794); MS *m/z*: 306 (M^+), 278, 250, 237; ^{1}H-NMR (400 MHz, $CDCl_3$): see Table 1; ^{13}C-NMR (100 MHz, $CDCl_3$): see Table 2.

Bungone B (**2**): Orange rectangles, mp. 187 °C; IR ν_{max} cm^{-1}: 3410 (OH), 1690, 1585, 1140; UV λ_{max} nm (MeOH) (log ε): 232 (4.61), 270 (4.21), 285 (4.10), 326 (4.28), 355 (3.82); HR-MS *m/z*: 324.1806 (Calcd for $C_{20}H_{18}O_3$: 306.1813); MS *m/z*: 324 (M^+), 278, 250, 237; ^{1}H-NMR (400 MHz, $CDCl_3$): see Table 1; ^{13}C-NMR (100 MHz, $CDCl_3$): see Table 2.

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