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ACETOPHENONES FROM *CYNANCHUM TAIWANIANUM**

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Key Word Index—*Cynanchum taiwanianum*; Asclepiadaceae; acetophenones; biacetophenone dimer; cynanchone A; cynandione D.

Abstract—A novel acetophenone derivative, cynanchone A, and a biacetophenone dimer, cynandione D, were isolated from the rhizomes of *Cynanchum taiwanianum*. Their structures were characterized by spectral methods.

INTRODUCTION

In a previous paper [1], we reported the isolation and structural elucidation of three novel biacetophenones, cynandiones A–C from *Cynanchum taiwanianum*. In a continuing study of cytotoxic principles of this species, a novel acetophenone derivative, named cynanchone A, a novel biacetophenone dimer, named cynandione D, and a known pregnane glycoside, wilfoside C1N, have now been isolated. In this paper, we report the characterization of the two new compounds.

RESULTS AND DISCUSSION

Compound **1**, yellow–orange crystals, showed similar UV absorption maxima to those of cynandione A (3) [1], showing absorption bands for hydroxyl groups at 3490 and 3200 cm^{-1}, and a chelated carbonyl at 1638 cm^{-1}. The ^1H NMR spectrum of 1 showed two pairs of *ortho*-coupled aromatic protons at δ 6.74 and 7.77 (*d*, J = 8.8 Hz) and δ 6.92 and 7.03 (*d*, J = 8.8 Hz), similar to those of 3 [1], an acetyl signal at δ 2.68 (*s*), indicating the presence of a similar B ring moiety to that of 3 [1], and

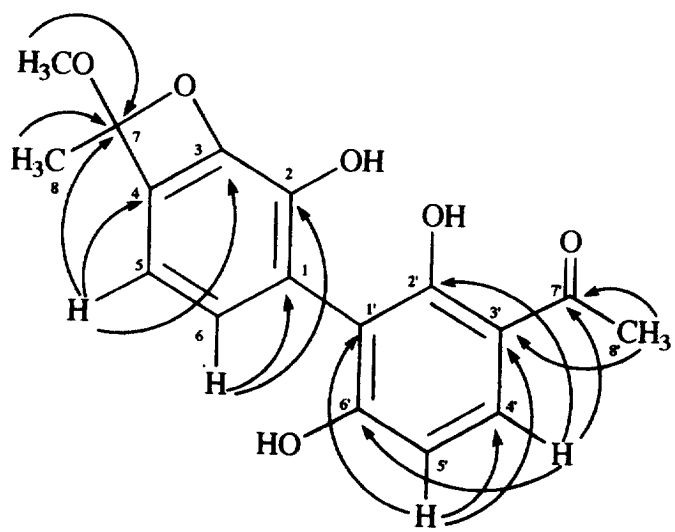

Fig. 1. HMBC spectrum of compound **1**.

a methyl signal at δ 1.60 (3H, *s*) and a methoxyl signal at δ 3.52 (3H, *s*). The absence of an acetyl signal, however, suggested that the substitution of the ring A of **1** was different from that of 3 [1]. In the EI mass spectrum of **1**, except for the $[M]^+$ at m/z 316 and the intense peak at

*Part 2 in the series 'The bioactive constituents of Formosan Asclepiadaceae plants.' For part 1, see ref. [1].

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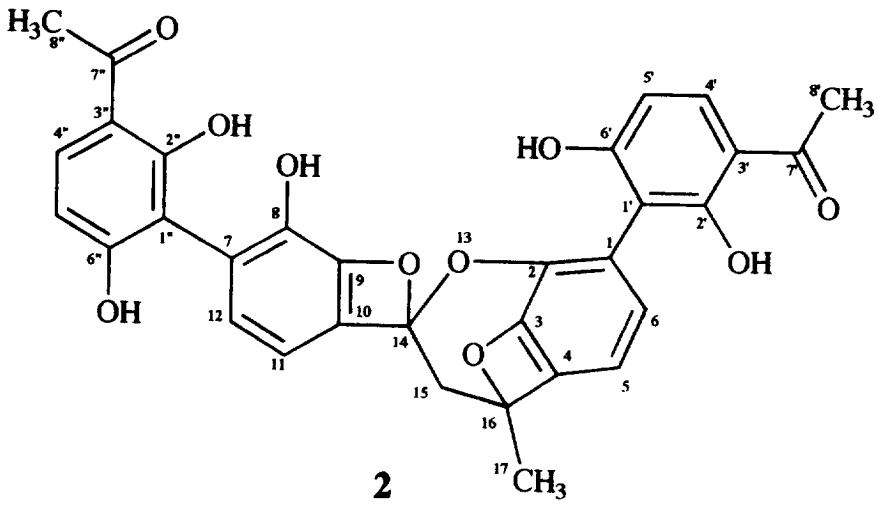
Table 1. ^{13}C and ^{1}H NMR spectral data for compounds **1**,* **2**,* **3** [1], **4** [1] and **5** [1]

	1†‡		2§‡		3§		4‖		5‖	
No.	δC	δH	δC	δH	δC	δH	δC	δH	δC	δH
1	115.3		112.8		113.4		113.3		113.1	
2	146.1		150.7		152.6		143.1		142.3	
3	147.1		147.6		149.3		143.1		142.3	
4	118.9		122.8		128.1		120.9		126.2	
5	118.9	6.92 (*d*)	120.3	7.02 (*d*)	122.0	6.94 (*d*)	118.9	6.97 (*d*)	120.1	6.79 (*d*)
6	122.2	7.03 (*d*)	122.8	7.10 (*d*)	118.5	6.79 (*d*)	121.0	7.17 (*d*)	120.6	7.20 (*d*)
7	104.7		115.0		207.7		117.5		117.8	
8	24.0	1.60 (*d*)	150.7		31.2	2.18 (*d*)	149.1		148.9	
9			146.1				147.8		147.9	
10			120.5				122.1		122.0	
11			120.4	7.08 (*d*)			119.6	7.29 (*d*)	119.5	7.31 (*d*)
12			120.5	7.14 (*d*)			122.1	7.39 (*d*)	122.2	7.41 (*d*)
14			102.6				101.3		100.9	
15			44.4	2.77, 2.93 (*d*)			41.1	3.30, 4.85 (*d*)	46.1	3.43, 5.08 (*d*)
16			72.8				75.6		75.2	
17			25.6	1.40 (*d*)			24.8	2.00 (*s*)	26.2	1.79 (*d*)
1′	110.9		111.5		114.8		112.6		112.4	
2′	159.0		158.2		164.0		159.2		159.0	
3′	115.0		115.0		120.6		115.7		115.5	
4′	131.8	7.77 (*d*)	131.8	7.70 (*d*)	134.3	7.78 (*d*)	133.2	7.78 (*d*)	133.0	7.74 (*d*)
5′	110.9	6.74 (*d*)	111.3	6.58 (*d*)	109.0	6.49 (*d*)	110.8	6.84 (*d*)	111.2	6.85 (*d*)
6′	158.5		158.2		164.0		157.9		157.8	
7′	204.6		205.2		204.9		205.1		205.0	
8′	26.2	2.68 (*s*)	26.2	2.68 (*s*)	26.6	2.56 (*s*)	26.4	2.53 (*s*)	26.3	2.55 (*s*)
1″			114.2				114.1		114.0	
2″			161.0				160.7		161.3	
3″			115.0				116.8		116.6	
4″			132.1	7.74 (*d*)			132.6	7.83 (*d*)	132.4	7.81 (*d*)
5″			115.0	6.45 (*d*)			116.6	6.80 (*d*)	111.6	6.74 (*d*)
6″			158.2				158.7		158.9	
7″			204.2				205.1		205.1	
8″			26.3	2.68 (*s*)			26.7	2.57 (*s*)	26.7	2.58 (*s*)
OCH_3	51.6	3.52 (*s*)								

*Number of directly attached protons to each individual carbons verified by DEPT pulse sequence.
†Measured in $CDCl_3$.
‡Signals obtained by HMQC and HMBC techniques.
§Measured in CD_3OD.
‖Measured in pyridine-d_5.

m/z 285 $[M - OMe]^+$, the significant peaks at *m/z* 284 (base peak), 269, 266, 251 and 237 were all similar to those of 3 [1]. The above evidence clearly indicated that the methoxyl and the methyl groups were substituted at C-7 as shown in formula **1**. In the HMBC spectrum of **1** (Fig. 1), the proton signal of H-5 at δ6.92 showed a cross-peak with the carbon signals of C-7 at δ104.7. Based on the above evidence, cynanchone A was characterized as **1**, which was supported by information from HMBC, HMQC and NOESY experiments. The ^{13}C NMR spectrum of **1** (Table 1) was assigned by ^{1}H-decoupled, DEPT pulse sequence, HMBC, HMQC and NOESY and comparison with **3** (Table 1) [1].

Compound **2** was obtained as a yellow amorphous powder, whose UV spectrum showed similar absorption maxima to those of **3** [1]. The EI mass spectrum showed a $[M]^+$ at *m/z* 568, a base peak at *m/z* 43 and significant peaks at *m/z* 554, 553, 551, 285, 284, 266, 251, 237, 227 and 213, similar to those of **3**, cynandione B (**4**) and cynandione C (**5**) [1]. The HR mass spectrum of **2** displayed a $[M]^+$ at *m/z* 568.1392, corresponding to the formula $C_{32}H_{24}O_{10}$, indicating that **2** was a dimeric compound of **3**. In the ^{1}H NMR spectrum of **2**, those were four pairs of *ortho*-coupled aromatic proton signals which were almost the same as those in **4** (Table 1) [1], except for the signals of H-11, H-12, H-5′ and H-5″, which exhibited significant highfield shifts, respectively, compared to those for the corresponding signals of **4** and **5** (Table 1) [1]. Two acetyl signals were present at δ2.68, a methyl signal at δ1.40, which exhibited a significant highfield shift compared to **4** and **5** (Table 1) [1] and geminal CH_2 signals, again exhibiting significant



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highfield shifts compared to those for **4** and **5** (Table 1) [1].

The ^{13}C NMR spectrum of **2** indicated the presence of 24 aromatic carbons, two acetyl groups, one methyl group, one geminal group and two oxygenated quaternary carbons. The spectrum was almost identical to those of **4** and **5** (Table 1) [1], except for the chemical shifts of C-2, C-3 and C-15 of 4, and C-2 and C-3 of 5, which exhibited significant lowfield shifts, and C-16 which exhibited a significant highfield shift in comparison with **4** and **5** (Table 1) [1]. Based on the above evidence, **2** was characterized as a steric isomer of **4** and **5**. The HMBC spectrum of **2** also showed similar correlations between the geminal CH_2 and methyl signals to those of **4** and **5**. In addition, **2**, **4** and **5** showed different specific rotations (**2**, + 70.4°; **4**, − 18.2°; and **5**, + 30.0°). Therefore, **2** was characterized as the C-14 steric isomer of **4** and **5**. The absolute configurations of **2**, **4** and **5** are still undefined.

EXPERIMENTAL

Extraction and isolation. Fresh rhizomes (5 kg) of *C. taiwanianum*, were collected at Kaohsiung Hsieng, Taiwan, in July 1993. A voucher specimen is deposited in our laboratory. Rhizomes were chopped and extracted with MeOH at room temp. several times. The extract was subjected to CC on silica gel. Elution with CH_2Cl_2–MeOH (19:1) yielded **1**, elution with CH_2Cl_2–MeOH (9:1) yielded **2**, and elution with CH_2Cl_2–MeOH (4:1) yielded wilfoside C1N. Characterization of wilfoside C1N was also achieved by spectral methods.

Compound **1**. Yellow–orange crystals, mp 158–161°. $[\alpha]_D^{25}$ + 20.0° ($CHCl_3$; *c* 0.01). UV λ_{max}^{MeOH} nm (log ε): 216 (4.60), 262 (4.43), 294 (4.29), 307 (4.24) (sh), 365 (4.2). IR ν_{max}^{KBr} cm^{-1} 3490 (chelated OH), 3200 (chelated OH), 1638 (C=O), 1610 (C=O). EIMS (direct inlet) 70 eV, *m/z* (rel. int.):316 $[M]^+$ (4), 285 (20), 284 (100), 269 (15), 266 (35), 251 (3), 237 (6), 213 (2), 195 (2), 181 (2), 139 (3), 115 (4), 102 (3), 91 (5), 77 (6), 63 (4), 55 (5), 43 (40). ^1H NMR ($CDCl_3$): Table 1. ^{13}C NMR($CDCl_3$): Table 1. HRMS calc. for $C_{17}H_{16}O_6$: 316.0947; found $[M]^+$: 316.0954.

Compound **2**. Yellow–orange amorphous powder, mp 224–226°. $[\alpha]_D^{25}$ + 70.4°(MeOH; *c* 0.01). UV λ_{max}^{MeOH} nm (log ε): 221 (4.62), 263 (4.46), 305 (4.26), 357 (4.04) (sh). IR ν_{max}^{KBr} 3520 (chelated OH), 3255 (chelated OH), 1638 (C=O), 1625 (C=O), EIMS (direct inlet) 70 eV, *m/z* (rel. int.): 568 $[M]^+$ (11), 554 $[M - CH_2]^+$ (7), 553 $[M - CH_3]^+$ (30), 551 $[M - 17]^+$ (9), 309 (4), 285 (26), 284 (41), 269 (5), 267 (5), 266 (8), 263 (3), 251 (2), 237 (6), 227 (2), 213 (3), 181 (4), 152 (4), 137 (11), 115 (7), 95 (7), 77 (10), 55 (20), 43 (100). ^1H NMR (CD_3OD): Table 1. ^{13}C NMR (CD_3OD): Table 1. HRMS calc. for $C_{32}H_{24}O_{10}$: 568.1369; found $[M]^+$: 568.1392.

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