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A DITERPENE FROM *EUPHORBIA ANTIQUORUM*

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Key Word Index—*Euphorbia antiquorum*; Euphorbiaceae; diterpene; antiquorin; triterpene; friedelan-3β-ol; β-taraxerol.

Abstract—A new diterpene, named antiquorin, was isolated from *Euphorbia antiquorum*. The structure was elucidated by spectral analysis to be an atisine diterpene *cis*-fused between the A and B rings. Two triterpenes were also isolated and identified as friedelan-3β-ol and β-taraxerol.

INTRODUCTION

In this paper, we report the structure of a new diterpene from *Euphorbia antiquorum* L. growing in Guangxi province in China [1]. The fresh stems are used in Chinese folk medicine for treatment of skin sores and scabies. The mucus of the stems gives rise to blisters on the skin and the loss of sight if the eyes are touched. Anjaneyulu and his coworkers [2, 3] reported the presence of a number of triterpenes and Adolf and his coworkers [4] reported an irritant substance which was a diterpene of 3-*O*-angeloylingenol present in the plant. Now, we describe the isolation and structural elucidation of a new diterpene, antiquorin (**1**) and two triterpenes, friedelan-3β-ol (**2**) and β-taraxerol (**3**).

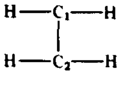
RESULTS AND DISCUSSION

Antiquorin (**1**) was obtained as white crystals ($CHCl_3$–MeOH), mp 163–164°, $C_{20}H_{28}O_3$, $[\alpha]_D^{15} = +70°$ (MeOH; *c* 0.1), CD (MeOH): $\Delta\varepsilon_{190.5} = +3.92$, $\Delta\varepsilon_{215.5} = -2.03$, $\Delta\varepsilon_{303} = +2.24$. It showed UV absorption at 208, 298 nm and IR absorptions at 3433 (OH), 1725 (C=O), (C=O) and 906 (>C=CH$_2$) cm^{-1}, respectively. The ^{13}C NMR spectrum revealed that the structure of **1** consisted of two carbonyl groups (δ 216 and 218), three tertiary methyls, four quaternary carbons, four methines and seven methylenes. Among the 20 carbons the presence of an exocyclic methylene was shown by the quaternary carbon signal at δ 142.3 and the methylene carbon at 111.1. There was also a secondary carbon bearing a hydroxy group at δ 75.15. By means of the ^{13}C–^{1}H and ^{1}H–^{1}H COSY spectra, compound **1** consisted of partial structure (I–IV) due to several spin systems that were partitioned by the quaternary carbons.

In the ^{1}H NMR spectrum, the signals of 2-Hα at δ 2.58 and 2-Hβ at 2.38 revealed that C-2 was connected with a carbonyl group. From the chemical shift at δ 47.5 of a quaternary carbon, the carbonyl group on C-3 was suggested, together with a quaternary carbon at C-4 bearing two methyls. Separate irradiations of 1-Hα at δ 1.88 and also the methyl located at C-4, showed NOE enhancements of the C-20 methyl group at δ 0.84 and 5-Hα at 1.35, respectively. The partial structure (A and B ring) of **1** therefore could be composed of I and II. The chemical shifts and coupling constants of 1-H and 2-H as well as the coupling relationships of 5-H, 6-H and 7-H are shown in Table 1.

A NOE was observed at the signal of 11-H by irradiation of the C-20 methyl at δ 0.84. The irradiation of 17-H at δ 5.01 and 4.85 showed the enhancement of 12-H and 15-H, respectively. NOE effects were also observed between the signals of 13-H at δ 3.88 (*d*, $J_{12\alpha,\,13\beta} = 3$ Hz) and 12-H$_\alpha$ at 2.82 (*ddd*, $J_{12\alpha,\,13\beta} = 3.0$, $J_{11\alpha,\,12\alpha} = 2.6$, $J_{11\beta,\,12\alpha} = 2.6$ Hz), and those of 12-H and 11-H. Therefore, the spin system was expanded to include III and IV. On the basis of the above reasons, the plane structure of **1** could be constructed as V, VI or VII.

Winsein and Labhar [5, 6] reported independently that the characteristic UV spectra of a γ,δ-unsaturated ketone showed three absorption bands at 187 and 300 nm due to $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transition and at 210–239 nm (solvent: heptane) or 214–244 nm (solvent: 95% EtOH), which were produced by coupling between the carbonyl group and a double bond of an unsaturated ketone. The UV spectrum of a β,γ-unsaturated ketone was very similar to that of a γ,δ-unsaturated ketone, but the 300 nm absorption band of the β,γ-unsaturated ketone was characterized by considerable fine structure, which corresponded to the fine structure exhibited by CD [7, 8]. The UV and CD spectra of **1** gave no fine structure. Thus, the plane structure of **1** could be suggested to be V or VI, and not VII. Furthermore, it was found by means of Dreiding



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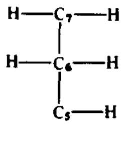

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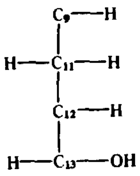

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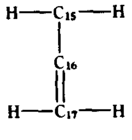


IV

Table 1. The ^{1}H and ^{13}C NMR spectral data of compound **1** (ppm)

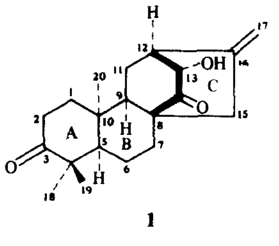
1-Hβ	1.39 *ddd*	$J_{1\beta,1\alpha}=12.2$ Hz	1-C	36.70 *t*
		$J_{1\beta,2\alpha}=11.7$ Hz	2-C	34.07 *t*
		$J_{1\beta,2\beta}=5.4$ Hz	3-C	216.0 *s*
1-Hα	1.88 *ddd*	$J_{1\alpha,1\beta}=12.2$ Hz	4-C	47.50 *s*
		$J_{1\alpha,2\alpha}=5.4$ Hz	5-C	55.15 *d*
		$J_{1\alpha,2\beta}=3.2$ Hz	6-C	19.95 *t*
2-Hα	2.56 *ddd*	$J_{2\alpha,2\beta}=14.3$ Hz	7-C	30.39 *t*
		$J_{2\alpha,1\beta}=11.7$ Hz	8-C	47.31 *t*
		$J_{2\alpha,1\alpha}=5.4$ Hz	9-C	51.50 *d*
2-Hβ	2.38 *ddd*	$J_{2\beta,2\alpha}=14.3$ Hz	10-C	37.56 *s*
		$J_{2\beta,1\alpha}=3.2$ Hz	11-C	25.35 *s*
		$J_{2\beta,1\beta}=5.4$ Hz	12-C	44.80 *t*
5-Hα	1.35 *dd*	$J_{5\alpha,6\beta}=9.7$ Hz	13-C	75.15 *d*
		$J_{5\alpha,6\alpha}=3.4$ Hz	14-C	218.0 *s*
6-Hα	1.56 *m**			
6-Hβ	1.52 *m**			
7-Hα	1.00 *ddd*	$J_{7\alpha,7\beta}=11.0$ Hz	15-C	43.71 *t*
		$J_{7\alpha,6\beta}=10.0$ Hz	16-C	142.3 *s*
		$J_{7\alpha,6\alpha}=3.0$ Hz	17-C	111.1 *d*
7-Hβ	2.44 *ddd*	$J_{7\beta,7\alpha}=11.0$ Hz	18-C	26.17 *q*
		$J_{7\beta,6\alpha}=3.0$ Hz	19-C	21.98 *q*
		$J_{7\beta,6\beta}=3.0$ Hz	20-C	13.71 *q*
9-Hα	1.68 *dd*	$J_{9\alpha,11\alpha}=10.5$ Hz		
		$J_{9\alpha,11\beta}=5.4$ Hz		
11-Hα	2.02 *ddd*	$J_{11\alpha,11\beta}=12.5$ Hz		
		$J_{11\alpha,9\alpha}=10.5$ Hz		
		$J_{11\alpha,12\alpha}=2.6$ Hz		
11-Hβ	1.75 *ddd*	$J_{11\beta,11\alpha}=12.5$ Hz		
		$J_{11\beta,9\alpha}=5.4$ Hz		
		$J_{11\beta,12\alpha}=2.6$ Hz		
12-Hα	2.82 *ddd*	$J_{12\alpha,13\beta}=3.0$ Hz		
		$J_{12\alpha,11\alpha}=2.6$ Hz		
		$J_{12\alpha,11\beta}=2.6$ Hz		
13-Hβ	3.88 *d*	$J_{13\beta,12\alpha}=3.0$ Hz		
15-H	2.30 *m*			
17-H	5.01 *m**			
17-H	4.85 *m**			
18-Me	1.01 *s*			
19-Me	1.10 *s*			
20-Me	0.84 *s*			

Assigned by ^{13}C–^{1}H COSY and DEPT.
*Overlapped.

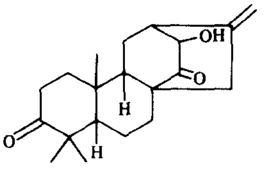
models that four molecular patterns based on the orientations at ring junctions were possible for both V and VI. By observation of the octant rule for the C-3 carbonyl group in each of the four patterns, the symbol and intensity of the Cotton effect (300 nm) could be predicted for the states of the fused A and B rings of V and VI (Table 2). The symbols and intensities of the Cotton effect of **1** were positive and strong at 300 nm in the CD spectrum, and they agreed with the predicted results (Table 2) shown as pattern 4 ($10_{\alpha\text{-Me}}$, 5-Hα). The A and B rings were *cis*-fused and the 20-CH$_3$ and 5-H were all in the α-configuration. The B and C rings formed a boat conformation. Since the C-14 carbonyl group was located nearer to 7-Hβ than to 7-Hα, the lower chemical shift of 7-Hβ at δ 2.44 was observed compared to that of 7-Hα at δ 1.00. If the endocyclic system was like VI, the 7-Hβ and 7-Hα would both be deshielded by the carbonyl group in a similar manner. The chemical shift of 1-Hβ in high field at δ 1.39 indicated that the hydrogen was located in a vertical plane to the carbonyl group. The above result provided the information that the endocyclic carbons, bearing a hydroxy group at C-13 and a carbonyl group at C-14, were linked at C-8 and C-12 in the β-configuration. Finally, the configuration of 9-H and 12-H were suggested to be both in the α-orientation. If 13-H was in the β-configuration, the dihedral angle of 13-H and 12-H was near 30° ($J = 7$ Hz). However, if 13-H was in the β-configuration, the dihedral angle was near 70° ($J = 3$ Hz). The observed result agreed with the latter and, therefore, 13-H was in the α- and the C-13 hydroxyl group was in the β-configurations.

Table 2. The symbols and intensities of Cotton effects predicted by the octant rule based on Dreiding molecular patterns (300 nm)

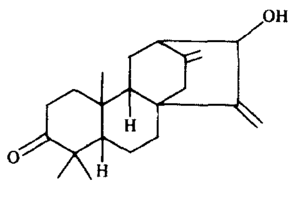
Pattern	10-C	5-C	The symbols and intensities of Cotton effects: V	The symbols and intensities of Cotton effects: VI
1	β-Me	α-H	−(weak)	+(weak)
2	β-Me	β-H	−(strong)	+(weak)
3	α-Me	β-H	−(weak)	+(weak)
4	α-Me	α-H	+(strong)	+(strong)



1



V



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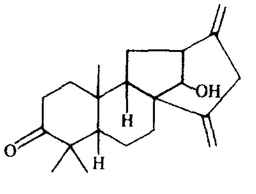

VII

The structures of two triterpenes (**2**: mp 286–289° and **3**: 282–284°) were determined to be friedelan-3β-ol and β-taraxerol, respectively, by comparison with the data described in the literature [3, 9].

EXPERIMENTAL

Plant material. Euphorbia antiquorum was collected in Guangxi province, China. The voucher specimen was deposited in the Herbarium of Guangxi Institute of Chinese Traditional Medicine and Pharmacy, Nanlin, Guangxi province, China.

Extraction and isolation. The fresh stems of *E. antiquorum* were cut into small pieces and percolated with EtOH. The EtOH soln was concd and re-extracted with $CHCl_3$. Activated charcoal was added to the $CHCl_3$ soln. After filtration, the extract was evapd and subjected to chromatography over silica gel H. Elution with petrol–EtOAc (20:1) yielded compound **2**; petrol–EtOAc (40:3) yielded compound **3**, petrol–EtOAc (5:1) yielded compound **1**.

Compound **1** (*antiquorin*). White crystals, mp 163–164° ($CHCl_3$–MeOH), $[\alpha]_D^{15} = +70°$ (MeOH; *c* 0.1), $[M^+]$ at m/z 316.2057 (calcd 316.2040), CD (MeOH): $\Delta\varepsilon_{190.5} = 3.92$, $\Delta\varepsilon_{215.5} = -2.03$, $\Delta\varepsilon_{303} = 2.24$. UV λ_{max}^{MeOH} nm: 208, 292. IR ν_{max}^{KBr} cm^{-1}: 3433, 1725, 1696, 1486, 1435, 1421, 1270, 1035. MS m/z (rel. int.): 316 (85), 273 (8), 259 (18), 206 (2), 192 (2), 176 (3), 173 (12), 171 (12), 161 (25), 150 (27), 137 (21), 133 (26), 131 (22), 113 (34), 109 (34), 107 (38), 95 (30), 93 (38), 91 (60), 41 (100). The ^{13}C NMR and ^1H NMR spectral data were shown in Table 1.

Compound **2** (*friedelan-3β-ol*). White crystals, mp 286–289° ($CHCl_3$–MeOH), $[\alpha]_D^{20} = +20°$ ($CHCl_3$; *c* 0.1), $[M^+]$ at m/z 428, $C_{30}H_{52}O$, Liebermann–Burchard test: positive, IR ν_{max}^{KBr} cm^{-1}: 3480, 2925, 1580, 1460, 1390, 1002, 1001, 1000. ^1H NMR ($CDCl_3$, 270 MHz): δ 0.86 (3H, *s*, Me), 0.93 (3H, *d*, $J = 5.5$ Hz), 0.94 (3H, *s*, Me), 0.96 (3H, *s*, Me), 0.99 (6H, *s*, 2 × Me), 1.00 (3H, *s*, Me). MS m/z (rel. int.): 428 $[M]^+$ (11), 410 (10), 395 (5), 342 (1), 275 (18), 247 (5), 232 (18), 218 (24), 207 (9), 205 (26), 177 (26), 165 (47), 95 (100). The above data were consistent with the literature data [9, 10] on friedelan-3β-ol.

Compound **3** (*β-taraxerol*). White crystals, mp 282–284°, $[\alpha]_D = 0°$ ($CHCl_3$), $[M]^+$ at m/z, $C_{30}H_{50}O$, Liebermann– Burchard test: positive. IR ν_{max}^{KBr} cm^{-1}: 3500, 2949, 1480, 1460, 1380, 1040, 1000. ^1H NMR ($CDCl_3$, 270 MHz): δ 0.80 (3H, *s*, Me), 0.82 (3H, *s*, Me), 0.91 (3H, *s*, Me), 0.95 (6H, *s*, 2 × Me), 0.96 (3H, *s*, Me), 0.97 (3H, *s*, Me), 1.09 (3H, *s*, Me), 3.50 (1H, *m*, 3-H), 5.52 (1H, *m*, 15-H). MS m/z (rel. int.): 426 $[M]^+$ (22), 401 (11), 302 (43), 267 (27), 273 (3), 232 (8), 218 (27), 207 (9), 205 (32), 204 (10), 135 (3), 124 (3). The above data were consistent to the literature data [3] on β-taraxerol.

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