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D:A-FRIEDO-OLEANANE TRITERPENES FROM THE STEM OF *HOMALIUM LONGIFOLIUM*

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Key Word Index—*Homalium ceylanicum*; Flacourtiaceae; stem; D:A-friedo-oleanane triterpenes; 3β-benzoyl-D:A-friedo-oleanan-27,16α-lactone; 3β-acetoxy-D:A-friedo-oleanan-27,16α-lactone; NMR.

Abstract—Two D:A-friedo-oleanane triterpenes have ben isolated from the stems of *Homalium longifolium*. They were characterized by extensive use of heteronuclear multiple bond coherence NMR spectroscopy as the novel compounds 3β-benzoyl-D:A-friedo-oleanan-27,16α-lactone and 3β-acetoxy-D:A-friedo-oleanan-27,16α-lactone.

INTRODUCTION

Homalium longifolium Benth is a tree common in the rain forests of the southern part of the Malay Peninsular [1]. Previous work on the genus yielded spermine-type alkaloids [2] and phenolic glucosides [3–4]. In a continuing investigation of the chemistry of the Flacourtiaceae, we examined the stem bark of this species and isolated two novel D:A-friedo-oleanane triterpenes. Compounds of this type have been reported previously from several sources in the family (see for example, [5–7]). Elucidation of the structure of the two triterpenes was largely achieved through the use of HMBC NMR spectroscopy [8].

RESULTS AND DISCUSSION

The two triterpenes were isolated from the petrol extract of the stems by VLC and then preparative TLC. The more polar of the two, compound **1**, analysed for $C_{37}H_{52}O_4$ by HREIMS. The ^{13}C NMR spectrum (Table 1) revealed resonances attributable to two carbinols at δ_C75.8 and 83.7 and two carbonyls; an ester carbonyl at δ_C166.6, and a lactone carbonyl at δ_C177.2. The ^1H NMR spectrum (Table 1) was typical for the aromatic ester of a triterpene. Signals for seven methyls were revealed in the spectrum, of which six were singlets and one a doublet, suggesting a friedelane skeleton, which is common in the family [5–7]. The secondary methyl (δ0.81) had a carbon resonance at δ_C10.3, which is the typically shielded position for methyl-23 of a C-3 oxygenated friedelane [7]. The aromatic region of the spectrum exhibited resonances for five protons; their multiplicity was suggestive of an unsubstituted benzoate ring.

From the HMBC spectrum of **1** ^2J and ^3J ^{1}H–C-couplings associated with the methyl and some of the methine proton resonances could be inferred (Table 2), allowing the identification of most of the friedelane skeleton. Thus, from methyl-23 a ^2J coupling to C- 4 (*d*) and ^3J couplings to C-3 (*d*, δ_C75.8) and C-5 (*s*) were visible. The methyl-24 resonances, which also revealed interactions with C-5 (^2J) and C-4 (^3J), showed further ^3J correlations with C-10 (*d*) and C-6 (*t*). C-10 was in turn linked to methyl-25 by a ^3J correlation; this methyl showed further couplings to C-8 (*d*, ^3J), C-9 (*s*, ^2J) and C-11 (*t*, ^3J). Similarly, a ^3J coupling linked C-8 to the next methyl group, Me-26, which also showed couplings to C-15 (*t*, ^3J), C-13 (*s*, ^3J) and C-14 (*s*, ^2J). None of the three remaining methyls could be associated with this partial skeleton, thereby indicating that methyl did not contribute. Hence, C-27 must be the site for one of the carbonyl carbons.

The oxymethine proton at H-3, identified by means of the HC-COBI experiment, was found to be coupled to the ester carbonyl at δ_C166.6. This required that the benzoyl ester be at C-3 leaving the lactone carbonyl to occupy the C-27 position. Methyl-29 and methyl-30 resonances could be identified by virtue of the ^3J couplings they exhibited with each other and by their couplings with a quaternary carbon, which could be assigned to C-20, and to two methylenes at C-19 and C-21. The final methyl group, which must be methyl-28, showed ^2J coupling to a quaternary carbon (C-17) and ^3J couplings to a methylene (C-22) and the carbinol at δ_C83.7. The carbinol proton (δ3.98), in turn, showed ^3J correlation to the lactone carbonyl (C-27) and further correlations to both C-15 (^2J) and C-14 (^3J). This carbinol must therefore be placed at C-16, thereby establishing **1** as a friedelan-27-16α lactone. Further confirmation for this structure was obtained from the remaining methine

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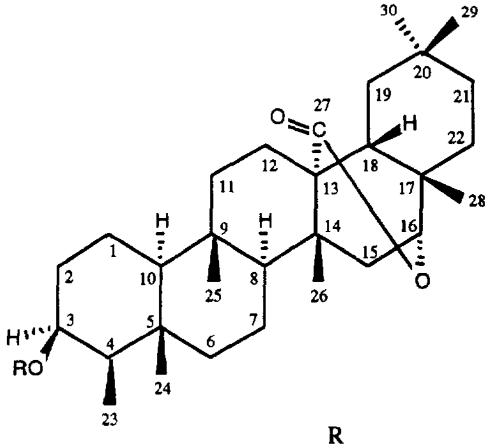
Table 1. ^{13}C and ^{1}H NMR spectral data for compounds 1 and 2

	^{13}C		^{1}H	
C/H	1	2	1	2
1	21.8	21.8		
2	32.6	32.1	2.19 *m*	
3	75.8	74.7	4.87 *m*	4.90 *ddd*
4	50.0	47.9	1.40–1.46 *m*	(5.7, 2.8, 2.8)
5	38.7	38.3		
6	40.7	41.0		
7	18.7	16.5		
8	57.7	57.8	0.85 *m*	
9	37.4	37.5		
10	59.0	60.0	1.0–1.1 *m*	
11	36.3	36.3		
12	19.6	18.5		
13	51.6	51.6		
14	38.2	38.1		
15	39.7	39.6		
16	83.7	83.6	3.98 *br s*	3.97 *t* (3.2)
17	36.2	36.2		
18	39.3	39.3	1.94–1.99 *m*	
19	31.7	31.7		
20	28.1	28.2		
21	36.4	36.7		
22	30.2	30.3		
23	10.3	11.5	0.81 *d* (6.7)	0.80 *d* (7.1)
24	14.6	15.8	0.89 *s*	0.91 *s*
25	18.2	18.3	0.87 *s*	0.89 *s*
26	20.6	20.5	1.19 *s*	1.19 *s*
27	177.2	177.2		
28	23.5	23.5	1.21 *s*	1.20 *s*
29	30.7	30.8	0.99 *s*	0.99 *s*
30	34.8	34.8	0.93 *s*	0.90 *s*
C=O	166.6	171.0		
Me	—	21.6		2.04 *s*
1′	131.1	—		
2′,6′	129.7	—	8.03 *dd* (8.2, 1.2)	
3′,5′	128.5	—	7.53 *t* (7.7)	
4′	132.9	—	7.54 *dt* (7.4, 1.2)	



R
1 C_6H_5CO
2 MeCO

proton (H-18), which showed heteronuclear correlations to methyl-28, C-27, C-19, C-16 and C-13.

Thus, the structure for **1** was established as 3*β*-benzoyl-D:A-friedo-oleanan-27,16*α*-lactone, which is a new natural product. The stereochemistry of the C-3 substituent was established as axial (*β*) by virtue of the small coupling constants between H-3 and the H-4 and H-2 protons. Similar lactonized friedo-oleananes derived from oxidation of the C-27 methyl have been isolated from other flacourtiaceaous species [5, 7] but in such cases the lactone was from C-27 to C-15*α*. This appears to be the first record of a 27,16*α*-lactone.

The ^{1}H and ^{13}C NMR spectra of compound **2** closely resembled those of **1** except for the absence of the aromatic ring signals, which were replaced by those for an acetoxyl group, seen as a deshielded methyl singlet at $\delta 2.04$ ($\delta_C 21.6$, 171.0). Loss of the benzoate and replacement with an acetate were confirmed by the high-resolution EIMS which exhibited a molecular ion at *m/z* 498,

Table 2. HMBC H-C-C-C-: long-range coupling interactions for compound 1

^{1}H signal	^{1}H–^{13}C cross-peaks ^{2}J	^{3}J
2	75.8 (C-3)	59.0 (C-10), 50.0 (C-4)
3	50.0 (C-4), 32.6 (C-2)	166.6 (O–C=O), 10.3 (C-23)
4	75.8 (C-3), 10.3 (C-23)	14.6 (C-24)
16	39.7 (C-15)	177.2 (C-27), 38.2 (C-14)
18	51.6 (C-13), 31.7 (C-19)	177.2 (C-27), 83.7 (C-16), 23.5 (C-28)
23	50.0 (C-4)	75.8 (C-3), 38.7 (C-5)
24	38.7 (C-5)	59.0 (C-10), 50.0 (C-4), 40.7 (C-6)
25	37.4 (C-9)	59.0 (C-10), 57.7 (C-8), 36.3 (C-11)
26	38.2 (C-14)	57.7 (C-8), 51.6 (C-13), 39.7 (C-15)
28	36.2 (C-17)	83.7 (C-16), 30.2 (C-22)
29	28.1 (C-20)	36.4 (C-21), 34.8 (C-30), 31.7 (C-19)
30	28.1 (C-20)	36.4 (C-21), 30.7 (C-29)
4′	-	129.7 (C-2′,6′)
2′,6′		166.6 (O–C=O), 132.9 (C-4′), 129.7 (C-6′,2′)
3′,5′		131.1 (C-1′), 128.5 (C-5′,3′)

solving for the empirical formula $C_{32}H_{50}O_4$. Confirmation of the lactone ring was again obtained through the HMBC experiment, via the tracking of resonances coupling to the methyl groups and H-16. Thus, compound **2** was established as 3β-acetoxy-D:A-friedo-oleanan-27,16α-lactone. The full ^1H and ^{13}C NMR data for **3** are given in Table 1.

EXPERIMENTAL

Mps: (uncorr.); IR: KBr; NMR: pyridine-d_5, using standard pulse sequences (HMBC, $d_6 = 1/2\ J = 70$ msec). High-resolution EIMS: direct probe insert (120°, 70 eV).

Plant material. Stems of *H. longifolium* were collected at Pasoh Forest Reserve, Negeri Sembilan, Malaysia, in February, 1992. Species identification was by comparison with material in the Herbarium, Forest Research Institute Malaysia (FRIM).

Extraction and isolation of compounds. The ground stems (4.5 kg) were extracted in a Soxhlet with petrol (bp 60–80°). On concentration a residue of solid (9.0 g) was obtained and this was fractionated by VLC over silica gel. The fraction eluted with 25–35% EtOAc in hexane was concd and then subjected to CC over silica gel eluting with $CHCl_3$ followed by a gradient of $CHCl_3$–EtOAc. Subsequent prep TLC (hexane–$CHCl_3$, 1:1) of the fraction eluted with $CHCl_3$ yielded **1** (27 mg). The fraction eluted with 5% EtOAc yielded **2** (8 mg) upon concn and cooling.

3β-*Benzoyl-D:A-friedo-oleanan*-27,16α-*lactone* (**1**). White plates from MeOH, mp 318–320° (dec); $[\alpha]_D - 26$ ($CHCl_3$, *c* 0.3). Found: [M] = *m/z* 560.3867; $C_{37}H_{52}O_4$ requires 560.3865. IR ν_{max} cm^{-1}: 2945, 1726, 1449, 1275, 1115, 709, ^1H and ^{13}C NMR: Table 1; EIMS *m/z* (rel. int.): 560 (2.4), 439 (35), 438 (100), 423 (59), 370 (64), 314 (82).

3β-*Acetyoxy-D:A-friedo-oleanan*-27,16α-*lactone* (**2**). White plates from MeOH, mp 322–324° (dec.); $[\alpha]_D - 11$ ($CHCl_3$; *c* 0.8); Found: $[M]^+$ = *m/z* 498.3698; $C_{32}H_{50}O_4$ requires 498.3709. IR ν_{max} cm^{-1}: 2865, 1726, 1465, 1243, 1116; ^1H and ^{13}C NMR: Table 1; EIMS *m/z* (rel. int.): 498 (0.7), 439 (30), 438 (85), 423 (43), 371 (52), 370 (100), 369 (38), 355 (32).

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