Euphane-Type Triterpene Tridesmosides from the Leaves of *Rhoiptelea chiliantha*

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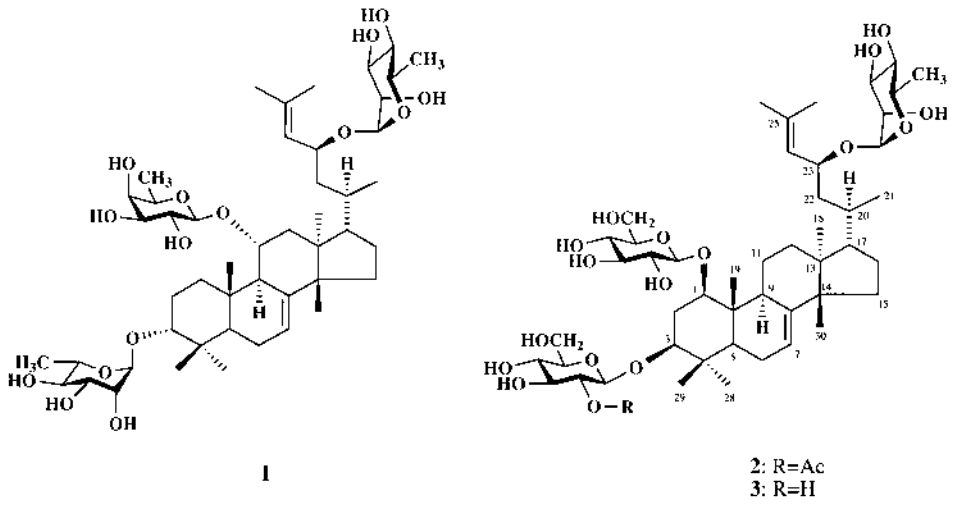
Investigation of the MeOH extract of the leaves of *Rhoiptelea chiliantha* DIELS *et* HAND.-MAZZ. (Rhoipteleaceae) led to the isolation of two new euphane-type triterpene tridesmosides termed rhoiptelesides C and D. Their structures were elucidated on the basis of spectral and chemical evidence.

Key words *Rhoiptelea chiliantha*; Rhoipteleaceae; euphane; triterpene tridesmoside; rhoipteleside

We carried out intensive investigation on the chemical constituents of *Rhoiptelea chiliantha* DIELS *et* HAND.-MAZZ., the only species of Rhoipteleaceae from the viewpoint of chemotaxonomy.[1] We recently isolated two triterpene tridesmosides, rhoiptelesides A (**1**) and B, and a bisdesmoside rhoipteleside E from the fruits and leaves of this plant.[2] These compounds represent the first glycosides of euphane-type triterpene, and rhoiptelesides A (**1**) and B are triterpene tridesmosides which are extremely rare in nature. Further examination of the extracts of the leaves resulted in the isolation of two new triterpene tridesmosides, rhoiptelesides C (**2**) and D (**3**). This paper deals with the structural determination of these constituents.

Rhoipteleside C (**2**) was isolated as a white amorphous powder whose ^{1}H- and ^{13}C-NMR spectra (Table 1) resembled those of rhoipteleside A (**1**).[2] Observation of three anomeric proton signals [δ 4.49 (d, J=8 Hz), 4.51 (d, J=8 Hz), 4.67 (d, J=1 Hz)] in the ^{1}H-NMR spectrum suggested that **2** is also a triterpene tridesmoside. Detailed analyses of the ^{1}H-NMR, ^{1}H–^{1}H correlation spectroscopy (COSY) and ^{1}H-detected heteronuclear single quantum coherence (HSQC) spectral data established that three sugar moieties in the molecule of **2** are glucopyranose, 2-*O*-acylated glucopyranose and rhamnopyranose. The acyl group was determined to be an acetyl on the basis of the ^{1}H-detected heteronuclear multiple bond correlation (HMBC) between ester carbonyl (δ 171.7) and both methyl group (δ 2.06, s) and H-2 (δ 4.73 dd, J=8, 9 Hz) of the acylated glucose (Fig. 1). Taking into account the above-mentioned NMR spectral evidence and the result of the positive FAB-MS (m/z 993 $[M+Na]^+$), the molecular formula of the aglycone moiety of **2** was determined to be identical to that of **1**. The ^{1}H- and ^{13}C-NMR signals arising from the D-ring and side chain portion of **2** are almost identical to those of **1**, suggesting that **2** differs from **1** only in the structure of rings A—C. The ^{1}H-NMR spectrum of **2** showed signals due to three oxygen-bearing methine protons of aglycone moiety, one of which (δ 4.45, dt, J=4, 10 Hz) was attributable to H-23 on the side chain portion. Both remaining methine protons [δ 3.82, dd, J=4, 12 Hz, H-3; δ 3.21 (dd, J=5, 12 Hz, H-1)] were correlated with the methylene signals [δ 2.45 (m), 1.67 (t, J=12 Hz), H_2-2] in the ^{1}H–^{1}H COSY spectrum. In addition, the HMBC spectrum revealed long-range correlations between the C-3 methine signal at δ 87.9 and both Me-28 (δ 0.92) and Me-29 (δ 0.82) proton signals (Fig. 1). The spectral evidence described above indicated that C-1, 3 and 23 of **2** are oxygenated. Furthermore, the gross structure of the aglycone and the positions of the sugars were unequivocally determined with the aid of an HMBC experiment (Fig. 1). Both H-1 and H-3 were established as axially orientated because $J_{H1,H2ax}$ and $J_{H3,H2ax}$ are 12 Hz. The ^{13}C-NMR chemical shifts of the rhamnose moiety in **2** established its α anomeric configuration.[3] The β anomeric configurations of glucopyranose and 2-*O*-acetyl glucopyranose were determined from their $^3J_{H1,H2}$ coupling



1

2: R=Ac
3: R=H

Chart 1

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Table 1. ^{13}C-NMR Spectral Data for the Aglycones of **1**, **2**, and **3**

No.	**1**[a)]	**2**[a)]	**3**[b)]	No.	**1**[a)]	**2**[a)]	**3**[b)]
C-1	32.9	81.0	81.2	C-16	29.3	29.3	29.3
C-2	21.3	31.7	31.9	C-17	55.0	55.2	55.2
C-3	80.8	87.9	87.7	C-18	22.3	23.0	23.0
C-4	38.6	40.1	40.4	C-19	14.1	8.9	8.9
C-5	46.1	50.4	50.6	C-20	34.1	34.2	34.2
C-6	25.0	24.6	24.6	C-21	19.9	20.0	20.0
C-7	121.9	119.1	119.1	C-22	42.4	42.3	42.3
C-8	144.5	147.9	147.9	C-23	71.4	71.3	71.3
C-9	54.9	50.7	50.7	C-24	126.1	126.0	126.0
C-10	38.0	41.5	41.5	C-25	139.3	139.3	139.3
C-11	72.3	21.8	21.8	C-26	26.1	26.1	26.1
C-12	44.6	36.2	36.2	C-27	18.7	18.7	18.6
C-13	45.1	44.1	44.1	C-28	29.7	27.9	28.0
C-14	52.6	52.5	52.5	C-29	22.8	15.9	15.9
C-15	35.5	35.5	35.5	C-30	28.4	28.4	28.4

a) 125 MHz, CD_3OD. *b*) 75 MHz, CD_3OD.

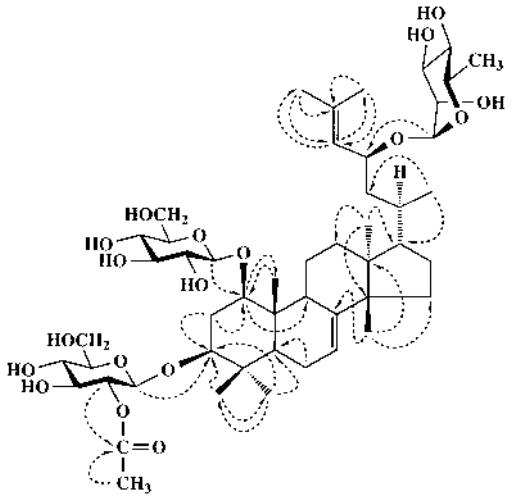

Fig. 1. HMBC (H to C) of **2**

constant. Comparison of the ^{13}C-NMR data related to aglycone of **2** with those of **1** suggested that the former is also a euphane-type triterpene, and this was confirmed by the observation of the nuclear Overhauser effect (NOE) correlations between Me-28 and H-5, between H-5 and H-9, between H-9 and Me-18, and between Me-18 and H-20. The absolute configuration of the rhamnose in **2** was suggested to be the same as that of its biogenetically-related triterpene tridesmoside rhoipteleside A (**1**) in which the absolute configuration of the rhamnose was determined to be L-form.[2)] On the basis of the above spectroscopic evidence, the structure of rhoipteleside C was determined to be represented by formula **2**.

Rhoipteleside D (**3**) displayed very similar ^{1}H- and ^{13}C-NMR spectra (Table 1) to those of **2**, suggesting that **3** is also a triterpene tridesmoside. Comparison of the ^{13}C-NMR chemical shifts of **3** with those of **2** (Table 1) indicated that they have the same euphane-type triterpene aglycone. The lack of acetyl signals in the ^{1}H- and ^{13}C-NMR spectra of **3**, and the upfield shift (−1.2 ppm) of H-2 of the glucose attached to C-3 of the aglycone indicated that **3** is a deacetyl product of **2**. This was supported by observation of the $[M+Na]^+$ ion peak at *m*/*z* 951 in the positive FAB-MS spectrum of **3**. Finally, the hydrolysis of **2** with 5% NaOH afforded **3** confirming the structure of **3**.

This paper describes the isolation and structural elucidation of two additional triterpene tridesmosides, rhoiptelesides C (**2**) and D (**3**), from the leaves of *Rhoiptelea chiliantha*. These euphane-type triterpene tridesmosides are considered to be characteristic constituents of Rhoipteleaceae from the standpoint of chemotaxonomy.[2)]

Experimental

General The instruments used to measure the physical data, the experimental conditions for chromatography and plant material were described in our previous paper.[3)]

Extraction and Separation The MeOH extract of the air-dried leaves (510 g) was suspended in H_2O, and sequentially extracted with Et_2O and EtOAc. The remaining H_2O layer (51.3 g) was subjected to column chromatography over Sephadex LH-20 with water containing an increasing amount of methanol. The fraction (15.9 g) eluted with H_2O was separated by MCI-gel CHP 20P (60—100% MeOH) to afford fraction 1 (8.4 g), fraction 2 (2.5 g) and fraction 3 (710 mg). Fraction 3 was subjected to silica gel chromatography [$CHCl_3$–MeOH–H_2O (9 : 1 : 0.1—7 : 3 : 0.5)] and Chromatorex ODS (60—100% MeOH) column chromatographies to afford rhoipteleside B[2)] (234 mg), **2** (68 mg) and **3** (12 mg).

Rhoipteleside C (**2**): A white amorphous powder, $[\alpha]_D^{15}$ −54.4° (*c*=0.3, MeOH). *Anal*. Calcd for $C_{50}H_{82}O_{18}\cdot 2.5H_2O$: C, 59.10; H, 8.63. Found: C, 58.97; H, 8.20. Positive FAB-MS *m*/*z*: 993 $(M+Na)^+$. ^{1}H-NMR (500 MHz, CD_3OD): aglycone-δ 5.27 (1H, br s, H-7), 4.92 (1H, d, *J*=10 Hz, H-24), 4.45 (1H, dt, *J*=4, 10 Hz, H-23), 3.82 (1H, dd, *J*=4, 12 Hz, H-1), 3.21 (1H, dd, *J*=5, 12 Hz, H-3), 2.52 (1H, m, H-11), 2.45 (1H, m, H-2), 2.42 (1H, m, H-9), 2.14, 2.02 (each 1H, m, H_2-6), 1.93 (1H, m, H-16), 1.86 (1H, t, *J*=11 Hz, H-22), 1.78 (3H, d, *J*=1 Hz, H_3-26), 1.76 (1H, m, H-12), 1.74 (3H, d, *J*=1 Hz, H_3-27), 1.67 (1H, t, *J*=12 Hz, H-2), 1.63 (1H, m, H-12), 1.52 (1H, m, H-11), 1.50, 1.45 (each 1H, m, H_2-15), 1.35 (1H, m, H-20), 1.28 (3H, m, H-5, 16, 22), 1.02 (3H, s, H_3-30), 0.92 (3H, s, H_3-28), 0.87 (3H, d, *J*=6 Hz, H_3-21), 0.84 (3H, s, H_3-19), 0.82 (3H, s, H_3-29), 0.80 (3H, s, H_3-18). 1-glucose-δ 4.49 (1H, d, *J*=8 Hz, H-1), 3.17 (1H, dd, *J*=8, 9 Hz, H-2), 3.36 (1H, t, *J*=9 Hz, H-3), 3.24 (1H, t, *J*=9 Hz, H-4), 3.28 (1H, m, H-5), 3.66 (1H, m, H-6a), 3.93 (1H, dd, *J*=2, 12 Hz, H-6b); 2-*O*-acetyl-glucose-δ 4.51 (1H, d, *J*=8 Hz, H-1), 4.73 (1H, dd, *J*=8, 9 Hz, H-2), 3.51 (1H, t, *J*=9 Hz, H-3), 3.36 (1H, t, *J*=9 Hz, H-4), 3.32 (1H, m, H-5), 3.66 (1H, m, H-6a), 3.89 (1H, dd, *J*=2, 12 Hz, H-6b), 2.06 (3H, s, acetyl); 23-rhamnose-δ 4.67 (1H, d, *J*=1 Hz, H-1), 3.68 (2H, m, H-2, 3), 3.36 (1H, t, *J*=9 Hz, H-4), 3.65 (1H, dq, *J*=9, 6 Hz, H-5), 1.27 (3H, d, *J*=6 Hz, H-6). ^{13}C-NMR (125 MHz, CD_3OD): aglycone see Table 1. Rhamnose-δ 97.6 (C-1), 72.6 (C-2), 72.5 (C-3), 74.1 (C-4), 69.8 (C-5), 18.1 (C-6); glucose-δ 99.6 (C-1), 75.4 (C-2), 77.8 (C-3), 72.6 (C-4), 78.2 (C-5), 63.6 (C-6); 2-*O*-acetyl-glucose-δ 104.2 (C-1), 75.7 (C-2), 76.1 (C-3), 71.7 (C-4), 77.9 (C-5), 62.8 (C-6), 21.2, 171.7 (acetyl).

Rhoipteleside D (**3**): A white amorphous powder, $[\alpha]_D^{15}$ −56.2° (*c*=0.3, MeOH). *Anal*. Calcd for $C_{48}H_{80}O_{17}\cdot 2H_2O$: C, 59.73; H, 8.77. Found: C, 59.36; H, 8.32. Positive FAB-MS *m*/*z*: 951 $(M+Na)^+$. ^{1}H-NMR (500 MHz, CD_3OD): δ 5.28 (1H, d, *J*=1 Hz, H-7), 4.92 (1H, d, *J*=10 Hz, H-24), 4.67 (1H, d, *J*=1 Hz, rha-1), 4.50, 4.33 (each 1H, d, *J*=8 Hz, glc-1, 1′), 4.44 (1H, m, H-23), 3.93, 3.89 (each 1H, dd, *J*=2, 12 Hz, glc-6a), 3.83 (1H, dd, *J*=4, 12 Hz, H-1), 2.50 (3H, m, H-2, 9, 11), 1.78 (3H, d, *J*=1 Hz, H_3-26), 1.74 (3H, d, *J*=1 Hz, H_3-27), 1.27 (3H, d, *J*=7 Hz, rha-6), 1.03 (3H, s, H_3-30), 1.02 (3H, s, H_3-29), 0.93 (3H, s, H_3-28), 0.87 (3H, d, *J*=6 Hz, H_3-21), 0.86 (3H, s, H_3-19), 0.81 (3H, s, H_3-18). ^{13}C-NMR (75 MHz, CD_3OD): aglycone see Table 1. Rhamnose-δ 97.7 (C-1), 72.6 (C-2), 72.5 (C-3), 74.2 (C-4), 69.9 (C-5), 18.2 (C-6); 1-glucose-δ 99.7 (C-1), 75.5 (C-2), 77.9 (C-3), 72.3 (C-4), 78.3 (C-5), 63.6 (C-6); 3-glucose-δ 106.7 (C-1), 75.6 (C-2), 78.2 (C-3), 71.8 (C-4), 77.7 (C-5), 63.0 (C-6).

Alkaline Hydrolysis of 2 A solution of **2** (15 mg) in 5% NaOH [H_2O–MeOH (3 : 1), 10 ml)] was heated at 80 °C for 4 h. The reaction solution was then extracted with Et_2O. The resulting organic layer was dried over Na_2SO_4 and concentrated under reduced pressure to yield a residue, which was purified by silica gel column chromatography [$CHCl_3$–MeOH–H_2O (8 : 2 : 0.2)] to give **3** (8 mg).

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