New Triterpene Constituents, Foliasalacins A_1—A_4, B_1—B_3, and C, from the Leaves of *Salacia chinensis*

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Four dammarane-type, three lupane-type, and an oleanane-type triterpenes named foliasalacins A_1 (1), A_2 (2), A_3 (3), A_4 (4), B_1 (5), B_2 (6), B_3 (7), and C (8) were isolated from the leaves of *Salacia chinensis* LINN. collected in Thailand. The structures of new triterpene constituents (1—8) were characterized on the basis of chemical and physiochemical evidence.

Key words *Salacia chinensis*; Hippocrateaceae; foliasalacin; dammarane type triterpene; lupane type triterpene; oleanane type triterpene

During the course of our characterization studies on bioactive constituents from *Salacia* species,[1—13] we have reported the isolation and absolute stereostructure elucidation of thirteen megastigmane glycosides, foliasalaciosides A_1, A_2, B_1, B_2, C, D, E_1, E_2, E_3, F, G, H, and I, and seven new phenolic glycosides, foliachinenosides A_1, A_2, A_3, B_1, B_2, C, and D, from the leaves of *Salacia chinensis* LINN. (Hippocrateaceae) together with twenty known constituents.[14—16] As a continuing study on the leaves of *S. chinensis*, we have isolated four dammarane-type, three lupane-type, and an oleanane-type triterpenes named foliasalacins A_1 (**1**), A_2 (**2**), A_3 (**3**), A_4 (**4**), B_1 (**5**), B_2 (**6**), B_3 (**7**), and C (**8**) from the less polar fraction of the leaves. This paper deals with the isolation and structure elucidation of these eight new triterpenes.

The dried leaves of *S. chinensis*, which were collected at Nakhon Si Thammarat province, Thailand, were finely cut and extracted with methanol (MeOH) to furnish a methanolic extract (13.0%). The MeOH extract was partitioned into an EtOAc–H_2O (1 : 1, v/v) mixture to furnish an EtOAc-soluble fraction (4.1%) and an aqueous phase as previously reported.[14—16] From the EtOAc-soluble fraction, foliasalacins A_1 (**1**, 0.00038%), A_2 (**2**, 0.00018%), A_3 (**3**, 0.00038%), A_4 (**4**, 0.00011%), B_1 (**5**, 0.00073%), B_2 (**6**, 0.00076%), B_3 (**7**, 0.00070%), and C (**8**, 0.00005%), were isolated using normal-, and reverse-phase silica gel column chromatography, and finally HPLC (Chart 1).

Structures of Dammarane-Type Triterpenes, Foliasalacins A_1, A_2, A_3, and A_4 Foliasalacin A_1 (**1**), $[\alpha]_D^{26}$ +33.1° ($CHCl_3$), was isolated as a white powder. The IR spectrum of **1** showed absorption bands at 3424 and 1646 cm^{-1} ascribable to hydroxyl and olefin functions. The electron ionization (EI) MS of **1** exhibited a molecular ion peak at *m/z* 458, and the high resolution (HR) EI-MS analysis revealed the molecular formula of **1** to be $C_{31}H_{54}O_2$. The ^{1}H- ($CDCl_3$) and ^{13}C-NMR (Table 1) spectra[17] of **1** showed signals assignable to eight methyls [δ 0.77, 0.85, 0.87, 0.96, 0.97, 1.12, 1.65 (1.647) (3H each, all s, H_3-29, 19, 18, 30, 28, 21, 27), 1.02 (1.019, 3H, d, J=6.7 Hz, H_3-31)], a methine bearing an oxygen function [δ 3.20 (1H, dd, J=4.8, 11.7 Hz, H-3)], a terminal double bond [δ 4.68 (4.678, 2H, m, H_2-26)], together with ten methylenes, five methines, and six quaternary carbons. The spectral data of **1** were similar to those of a dammarane triterpene with an unusual and extra methyl group at the 24-position, carnaubadiol (**9**),[18] except for the signals due to the side chain part (C-23—27, 31). As shown in Fig. 1, the ^{1}H–^{1}H correlation spectroscopy (^{1}H–^{1}H COSY) experiment on **1** indicated the presence of partial structures written in bold lines, and in a heteronuclear multiple-bond correlation (HMBC) experiment, long-range correlations were observed between the following protons and carbons: H-5 and C-1, 7; H_3-18 and C-8, 13—15; H_3-19 and C-1, 5, 9, 10; H_3-21 and C-17, 20, 22; H_2-26 and C-24, 25, 27; H_3-27 and C-24—26; H_3-28 and C-3—5, 29; H_3-29 and C-3—5, 28; H_3-31 and C-23—25. Next, the stereochemistry of the tetracyclic carbon skeleton structure (C-1—19, 28—30) in **1** was clarified using nuclear Overhauser enhancement spectroscopy (NOESY) experiment, which showed NOE correlations between the following proton pairs: Hα-1 and H-3, H-9; Hβ-1 and H_3-19; H-3 and H-5, H_3-28; H-5 and H-9; H-

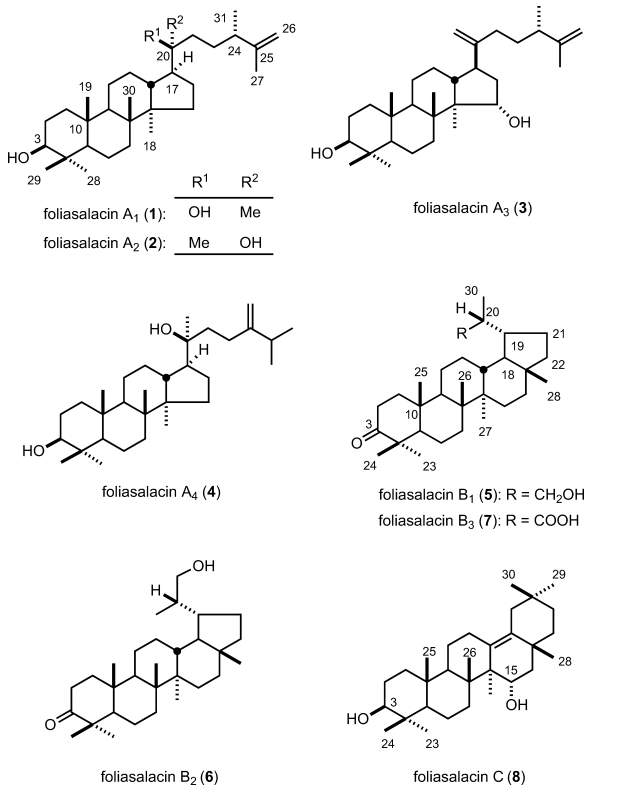

Chart 1. Structures of New Foliasalacines from the Leaves of *Salacia chinensis*

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9 and H_3-18; H-13 and H_3-21, H_3-30; H-17 and H_3-18. On the basis of above mentioned evidence, **1** was presumed to be the 24-isomer of **9**. By comparing the chemical shifts of the 20—22 carbons of **1** [δ_C 25.5 (C-21), 39.1 (C-22), 75.3 (C-20)] with those of the 20-epimers of dammarane type compounds, dammarenediol I (**10**, 20*R*) [δ_C 23.5 (C-21), 41.8 (C-22), 75.8 (C-20)][19] and dammarenediol II (**11**, 20*S*) [δ_C 24.9 (C-21), 40.5 (C-22), 75.4 (C-20)],[19] which measured in the same solvent ($CDCl_3$) as **1**, the stereostructure of the 20-position in **1** was certificated to be *S** orientation. Finally, the stereostructure of the 24-position in **1** was determined to be *S** by the application of the reported NMR method.[20,21] Namely, the configuration at the 24-position in **1** was characterized by comparison of the $\Delta\delta$ values of the side chain protons (H-26—27, H-26—31, and H-27—31) in the ^{1}H-NMR ($CDCl_3$) spectrum of **1** with those of known compounds, codisterol (**12**) [(24*S*)-methylcholesta-5,25-dien-3β-ol], epicodisterol (**13**) [(24*R*)-methylcholesta-5,25-dien-3β-ol], and leucastrin (**14**) [(3*S*,17*S*,20*S*,24*S*)-3,20-dihydroxy-24-methylprotost-25-ene]. As shown in Table 2, the $\Delta\delta$ values of the 26- and 27-protons, the 26- and 31-protons, and the 27- and 31-protons in **1** were approximated to those of codisterol (**12**) and leucastrin (**14**), thus the configuration at the 24-position in **1** was elucidated to be *S** orientation. On the basis of this evidence and comparison of the ^{1}H- and ^{13}C-NMR data of **1** with those of **9**, foliasalacin A_1 (**1**) was characterized to be the 24-isomer of carnaubadiol (**9**).

Table 1. ^{13}C-NMR Data for **1**—**4**

Position	1	2	3	4
1	39.1	39.1	39.2	39.1
2	27.4	27.4	27.4	27.4
3	79.0	79.0	78.9	79.0
4	39.0	39.0	39.0	39.0
5	55.9	55.9	55.7	55.9
6	18.3	18.3	18.2	18.3
7	35.2	35.3	36.3	35.2
8	40.4	40.4	40.9	40.4
9	50.7	50.6	51.4	50.7
10	37.1	37.1	37.3	37.1
11	21.6	21.5	21.3	21.6
12	24.7	25.4	24.9	24.8
13	42.3	42.2	43.5	42.4
14	50.4	50.0	50.5	50.4
15	31.2	31.1	74.0	31.2
16	27.6	27.6	38.7	27.5
17	49.5	49.3	45.3	49.8
18	16.5	16.4	9.1	16.5
19	16.2	16.2	16.4	16.2
20	75.3	75.7	152.2	75.4
21	25.5	23.8	107.8	25.4
22	39.1	40.2	32.3	39.4
23	28.9	28.4	33.6	28.4
24	41.7	41.7	41.0	156.5
25	149.9	149.9	149.8	34.0
26	109.6	109.6	109.6	21.94
27	18.8	18.8	18.9	21.96
28	28.0	28.0	28.0	28.0
29	15.4	15.4	15.4	15.4
30	15.5	15.5	15.7	15.5
31	20.0	20.0	19.8	106.2

Measured in $CDCl_3$ at 125 MHz.

Foliasalacin A_2 (**2**), $[\alpha]_D^{25}$ +22.0° ($CHCl_3$), was isolated as a white powder. The IR spectrum of **2** showed absorption bands at 3423 and 1647 cm^{-1} assignable to hydroxyl and olefin functions, respectively. Its molecular formula

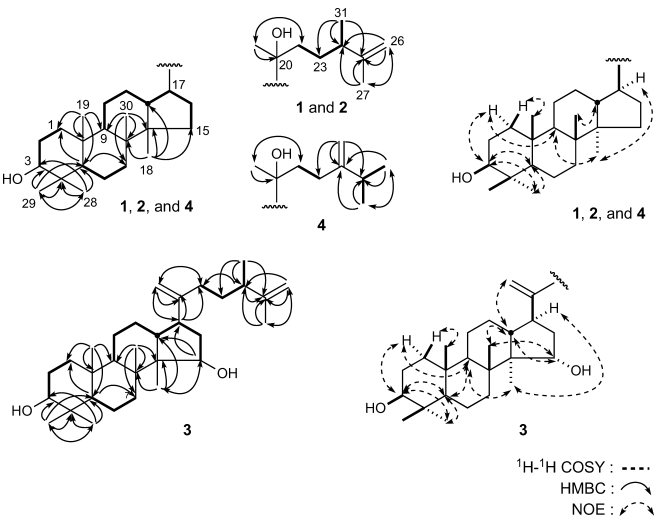

Fig. 1. Selected ^{1}H–^{1}H COSY, HMBC, and NOE Correlations of **1**—**4**

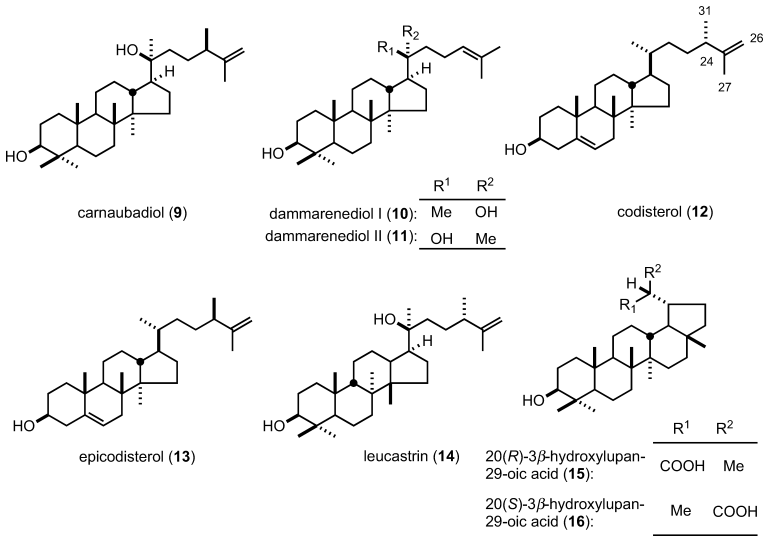

Chart 2

Table 2. Comparison of ^{1}H Chemical Shifts of Compounds of **1**—**3**, **12**—**14**

H	**1**	**2**	**3**	**12**	**13**	**14**
26	4.678	4.680	4.688	4.658	4.654	4.674
27	1.647	1.647	1.647	1.635	1.649	1.646
31	1.019	1.016	1.020	0.990	0.984	1.014
$\Delta\delta$						
26–27	3.031	3.033	3.131	3.023	3.005	3.028
26–31	3.659	3.664	3.668	3.668	3.670	3.660
27–31	0.628	0.631	0.627	0.645	0.665	0.632

Measured in $CDCl_3$ at 500 MHz.

$C_{31}H_{54}O_2$, the same as that of **1**, was determined from the molecular ion peak at *m/z* 458 and by HR-EI-MS measurement. The ^{1}H- ($CDCl_3$) and ^{13}C-NMR (Table 1) spectra[17] of **2** showed signals assignable to eight methyls [δ 0.78, 0.85, 0.88, 0.97, 0.98, 1.10, 1.65 (1.647) (3H each, all s, H_3-29, 19, 18, 30, 28, 21, 27), 1.02 (1.016, 3H, d, J=6.7 Hz, H_3-31)], a methine bearing an oxygen function [δ 3.20 (1H, dd, J=5.2, 11.6 Hz, H-3)], a terminal double bond [δ 4.68 (4.680, 2H, m, H_2-26)], together with ten methylenes, five methines, and six quaternary carbons. The proton and carbon signals in the ^{1}H- and ^{13}C-NMR spectra of **2** were superimposable on those of **1**, except for the signals due to the 20—22-positions. The ^{1}H–^{1}H COSY, HMBC, and NOESY experiments on **2** (shown in Fig. 1) indicated that **2** was the 20-isomer of **1**. By comparing the chemical shifts of the 20—22 carbons of **2** with those of the 20-epimers of dammarane type triterpenes, dammarenediol I (**10**, 20*R*) and dammarenediol II (**11**, 20*S*),[19] the stereostructure of the 20-position in **2** was elucidated as *R** form. On the other hand, the 24-position in **2** was confirmed to be *S** orientation by the same method[21] as that for **1** (the $\Delta\delta$ values of H-26—27, H-26—31, and H-27—31 of **2** were shown in Table 2). Consequently, the structure of **2** was elucidated as shown.

Foliasalacin A_3 (**3**), $[\alpha]_D^{27}$ +31.4° ($CHCl_3$), was isolated as a white powder. The molecular formula, $C_{31}H_{52}O_2$, was determined by EI and HR-EI-MS measurement. The ^{1}H-($CDCl_3$) and ^{13}C-NMR (Table 1) spectra[17] of **3** showed signals ascribable to seven methyls [δ 0.78, 0.86, 0.95, 0.98, 1.06, 1.65 (1.647) (3H each, all s, H_3-29, 19, 18, 28, 30, 27), 1.02 (1.020, 3H, d, J=6.7 Hz, H_3-31)], two methines bearing an oxygen function [δ 3.21 (1H, dd, J=4.9, 11.6 Hz, H-3], 4.26 (1H, dd, J=8.6, 8.6 Hz, H-15), two terminal double bonds {δ 4.69 (4.688, 2H, m, H_2-26), [4.70 (1H, m), 4.71 (1H, br s), H_2-21]}, together with nine methylenes, five methines, and five quaternary carbons. As shown in Fig. 1, the ^{1}H–^{1}H COSY experiment on **3** indicated the presence of partial structure written in bold lines, and in the HMBC experiment, long-range correlations were observed between the following proton and carbon pairs: H-5 and C-1, 7; H-15 and C-13, 17, 18, H_3-18 and C-8, 13—15; H_3-19 and C-1, 5, 9, 10; H_2-21 and C-17, 20, 22; H_2-26 and C-24, 25, 27; H_3-27 and C-24—26; H_3-28 and C-3—5, 29; H_3-29 and C-3—5, 28; H_3-31 and C-23—25. The above-mentioned evidence indicated that **3** was a dammarane-type triterpene with the 24-methyl and the 20- and 25-*exo*-methylenes at the side chain. In the NOESY experiment, NOE correlations were observed between Hα-1 and H-3, H-9; Hβ-1 and H_3-19; H-3 and H-5, H_3-28; H-5 and H-9; H-9 and H_3-18; H-13 and H-15, H_3-30; H-15 and H_3-30; H_3-18 and Hα-17, so that the stereostructure of **3** including the 3β and 15α-hydroxyl groups was clarified. On the other hand, the stereostructure of the 24-position was presumed to be *S** by the same NMR method as that for **1** and **2** (Table 2). Those findings led us to formulate the structure of **3** as shown.

Foliasalacin A_4 (**4**), $[\alpha]_D^{27}$ +25.9° ($CHCl_3$), was also obtained as a white powder. The IR spectrum of **4** showed absorption bands at 3422 and 1647 cm^{-1} ascribable to hydroxyl and olefin functions, respectively. Its molecular formula, $C_{31}H_{54}O_2$, was determined from the molecular ion peak at *m/z* 458 and by HR-EI-MS measurement. The ^{1}H- ($CDCl_3$) and ^{13}C-NMR (Table 1) spectra[17] of **4** showed signals assignable to eight methyls [δ 0.78, 0.85, 0.89, 0.96, 0.98, 1.16 (3H each, all s, H_3-29, 19, 18, 30, 28, 21), 1.04, 1.04 (3H each, both d, J=6.9 Hz, H_3-26, 27)], a methine bearing an oxygen function [δ 3.20 (1H, dd, J=4.2, 11.0 Hz, H-3)], a terminal double bond [δ 4.69, 4.75 (1H each, both br s, H_2-31)], together with ten methylenes, five methines, and five quaternary carbons. The proton and carbon signals in the ^{1}H- and ^{13}C-NMR spectra of **4** were superimposable on those of foliasalacin A_1 (**1**), except for the signals due to the 24—27- and 31-positions in the side chain. By comparison of the chemical shift values of the 20—23 carbons in the ^{13}C-NMR of **4** with those of **1**, the stereostructure at the 20-position in **4** was clarified to be the same as that of **1**. Furthermore, as shown in Fig. 1, long-range correlations were observed between the following protons and carbons: H_2-26 and C-24, 25, 27; H_3-27 and C-24—26; H_2-31 and C-23—25, the structure of the side chain part was determined as shown. On the basis of above-mentioned evidence and detail examination of various NMR data as shown in Fig. 1, the structure of foliasalacin A_4 (**4**) was characterized.

Structures of Lupane-Type Triterpenes, Foliasalacins B_1 and B_2 Foliasalacin B_1 (**5**) was obtained as a white powder with positive optical rotation ($[\alpha]_D^{29}$ +9.4° in $CHCl_3$), and showed absorption bands at 3422 and 1717 cm^{-1} due to hydroxyl and carbonyl functions in the IR spectrum. The molecular formula, $C_{30}H_{50}O_2$, of **5** was determined from the EI-MS [*m/z* 442 $(M)^+$], and by HR-EI-MS analysis. The ^{1}H-($CDCl_3$) and ^{13}C-NMR (Table 3) spectra[17] of **5** showed seven methyls [δ 0.75, 0.94, 0.94, 1.03, 1.08, 1.08 (3H each, all s, H_3-28, 25, 27, 24, 23, 26), 0.97 (3H, d, J=6.8 Hz, H_3-30)], a methene bearing an oxygen function [δ 3.41 (1H, dd, J=8.1, 11.1 Hz), 3.82 (1H, dd, J=4.5, 11.1 Hz), H_2-29], a carbonyl function [δ_C 218.3 (C-3)], together with ten methylenes, five methines, and four quaternary carbons. The ^{1}H–^{1}H COSY experiment on **5** indicated the presence of partial structures written in bold lines (Fig. 2), and in HMBC experiment, the long-range correlations were observed between H-1 and C-3, 5; H-2 and C-3, 10; H_3-23 and C-3—5, 24; H_3-24 and C-3—5, 23; H_3-25 and C-1, 5, 9, 10; H_3-26 and C-7—9, 14; H_3-27 and C-8, 13—15; H_3-28 and C-16—18, 22; H_2-29 and C-19, 20, 30; H_3-30 and C-19, 20, 29. The relative stereostructure of **5** was determined on the NOESY experiment, which showed NOE correlations between H-1α and H-2α; H-1β and H-2β, H_3-25; H-2β and H_3-24, H_3-25; H-5 and H-9, H_3-23; H-9 and H_3-27; H-12α and H_2-29, H_3-30; H-13 and H_3-26, H_3-28; H-18 and H_3-27, H_2-29, H_3-30; H-19 and H_3-28. Finally, reduction of **5** with $NaBH_4$ in anhydrous MeOH gave

Table 3. ^{13}C-NMR Data of **5**—**8** and Related Compounds (**5a** and **6a**)

Position	5	5a	6	6a	7	8
1	39.5	38.7	39.6	38.7	39.5	38.8
2	34.2	27.4	34.2	27.4	34.1	27.3
3	218.3	79.0	218.3	79.0	218.3	79.0
4	47.3	38.9	47.4	38.9	47.3	38.8
5	54.8	55.2	54.9	55.2	54.8	55.0
6	19.7	18.3	19.7	18.3	19.7	18.6
7	33.6	34.3	33.6	34.3	33.7	37.9
8	40.8	40.9	40.8	40.9	40.8	42.4
9	49.4	50.0	49.4	50.0	49.3	50.5
10	36.8	37.1	36.8	37.1	36.8	37.4
11	21.5	20.9	21.4	20.8	21.5	21.7
12	27.2	27.2	26.9	26.9	27.0	25.1
13	38.0	37.9	37.9	38.0	37.8	133.6
14	43.1	43.0	43.1	42.9	43.1	50.7
15	27.3	27.3	27.3	27.3	27.3	67.0
16	35.4	35.5	35.4	35.5	35.3	46.2
17	43.1	43.1	42.9	43.0	43.0	36.2
18	47.4	47.5	47.2	47.2	48.6	133.4
19	43.6	43.6	39.2	39.2	43.5	39.0
20	38.0	38.0	37.9	37.8	42.0	33.3
21	23.1	23.1	21.9	21.9	23.8	35.1
22	40.1	40.1	40.5	40.6	39.7	39.0
23	26.7	28.0	26.7	28.0	26.7	28.0
24	21.0	15.4	21.1	15.4	21.0	15.5
25	15.9	16.1	15.8	16.0	16.0	16.3
26	15.8	16.0	15.9	16.1	15.8	18.1
27	14.4	14.4	14.3	14.4	14.4	13.8
28	17.6	17.6	18.1	18.1	17.8	24.2
29	64.5	64.5	68.2	68.4	181.8	32.3
30	18.0	18.0	10.3	10.3	17.1	24.1

Measured in $CDCl_3$ at 125 MHz.

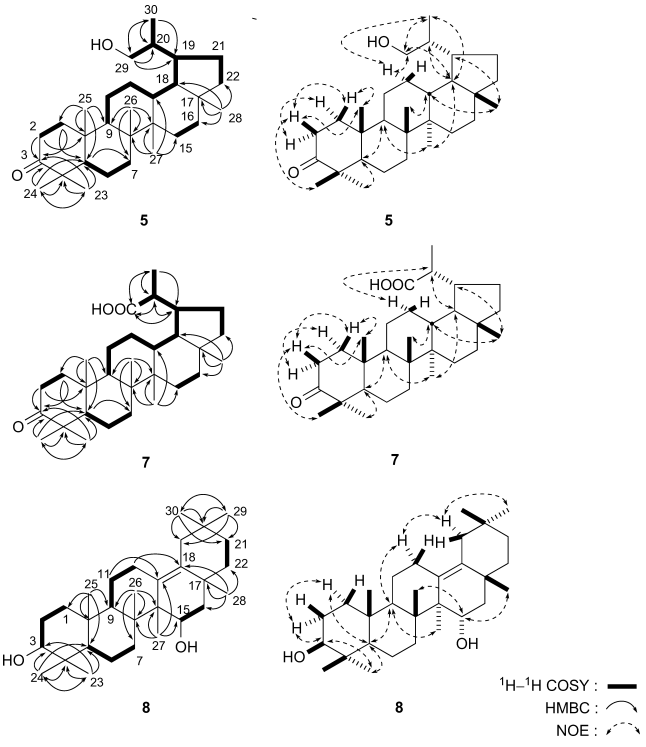

Fig. 2. Selected ^{1}H–^{1}H COSY, HMBC, and NOE Correlations of **5**, **7** and **8**

a known compound, (20*R*)-lupane-3β,29-diol (**5a**)[22] (Fig. 3). Thus, the stereostructure of **5** was characterized as shown.

Foliasalacin B_2 (**6**) was isolated as a white powder with

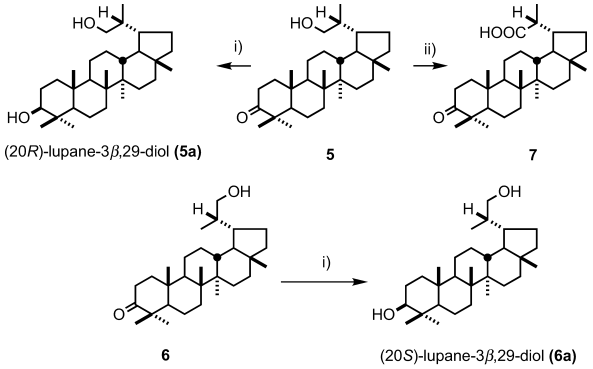

Fig. 3

positive optical rotation ($[\alpha]_D^{26}$ +17.2° in $CHCl_3$). The molecular formula, $C_{30}H_{50}O_2$, was determined from the EI-MS [*m*/*z* 442 $(M)^+$] and by HR-EI-MS measurement. The ^{1}H-($CDCl_3$) and ^{13}C-NMR (Table 3) spectra[17] of **6** [δ 0.78 (3H, s, H_3-28), 0.80 (3H, d, J=6.8 Hz, H_3-30), 1.22, 1.59 (1H each, both m, H_2-21), 1.95 (1H, m, H-19), 3.42 (2H, m, H_2-29); δ_C 10.3 (C-30), 18.1 (C-28), 21.9 (C-21), 39.2 (C-19), 68.2 (C-29)] were very similar to those of **5**, except for the protons of 19-, 21-, and 28—30-positions. Finally, the reduction of **6** with $NaBH_4$ afforded a known compound (20*S*)-lupane-3β,29-diol (**6a**)[22] (Fig. 3). On the basis of this evidence and detail NMR analysis (Fig. 2), the stereostructure of foliasalacin B_2 (**6**) was determined as shown.

Foliasalacin B_3 (**7**) was isolated as a white powder with negative optical rotation ($[\alpha]_D^{27}$ −26.4° in $CHCl_3$). The EI-MS of **7** exhibited a molecular ion peak at *m*/*z* 456, and the HR-EI-MS analysis revealed the molecular formula of **7** to be $C_{30}H_{48}O_3$. The ^{1}H- ($CDCl_3$) and ^{13}C-NMR (Table 3) spectra of **7** showed seven methyls [δ 0.76, 0.93, 0.94, 1.03, 1.08, 1.08 (3H each, all s, H_3-28, 27, 25, 24, 23, 26), 1.15 (3H, d, J=6.9 Hz, H_3-30)], two carbonyl functions [δ_C 181.8 (C-29), 218.3 (C-3)], together with ten methylenes, five methines, and four quaternary carbons. The planar and relative stereostructures of **7** were determined by various NMR experiment as shown in Fig. 2.[17] By comparison of the chemical shift values of the 28- and 30-protons in **7** with known compounds, 20(*R*)- and 20(*S*)-3β-hydroxylupan-29-oic acid (**15**, **16**) [(20*R*): 0.74 (3H, s, H_3-28), 1.15 (3H, d, J=6.5 Hz, H_3-30); (20*S*): 0.77 (3H, s, H_3-28), 1.05 (d, J=6.5 Hz, H_3-30)],[22] the stereostructure of the 20-position in **7** was clarified to be *R** orientation. Finally, **7** was derived by oxidation of **5** with chromium trioxide (CrO_3) in pyridine, so that the stereostructure of foliasalacin B_3 (**7**) was clarified as shown.

Structure of Oleanane-Type Triterpene, Foliasalacin C

Foliasalacin C (**8**) was obtained as a white powder with negative optical rotation ($[\alpha]_D^{28}$ −25.1° in $CHCl_3$) and the IR spectrum of **8** showed absorption bands at 3422 and 1636 cm^{-1} due to hydroxyl and olefin functions. The molecular formula, $C_{30}H_{50}O_2$, was determined from the EI-MS [*m*/*z* 442 $(M)^+$] and by HR-EI-MS analysis. The ^{1}H- ($CDCl_3$) and ^{13}C-NMR (Table 3) spectra[17] of **5** showed eight methyls [δ 0.70, 0.77, 0.86, 0.90, 0.94, 0.98, 1.07, 1.17 (3H each, all s, H_3-30, 24, 25, 26, 29, 24, 28, 27)], two methines bearing an oxygen function [δ 3.23 (1H, dd, J=4.1, 11.0 Hz, H-3), 4.13 (1H, dd, J=8.3, 8.3 Hz, H-15)], a tetra-substituted double

bond [δ_C 133.4 (C-18), 133.6 (C-13)], together with ten methylenes, two methines, and five quaternary carbons. The ^1H–^1H COSY experiment on **8** indicated the presence of partial structures written in bold lines, and in the HMBC experiment, long-range correlations were observed between the following proton and carbon pairs: H_2-11 and C-13; H_2-12 and C-18; H_2-22 and C-18; H_3-23 and C-3—5, 24; H_3-24 and C-3—5, 23; H_3-25 and C-1, 5, 9, 10; H_3-26 and C-7—9, 14; H_3-27 and C-8, 13—15; H_3-28 and C-16—18, 22; H_2-29 and C-19—21, 30; H_3-30 and C-19—21, 29. On the basis of above mentioned evidence, **8** was elucidated to be an olean-13-ene-type triterpene with the 3- and 15-hydroxyl groups. The stereostructures of the 3- and 15-positions in **8** were determined on the NOESY experiment, which showed NOE correlations between the following proton pairs: Hα-1 and Hα-2, H-3, H-9; Hα-2 and H-3; H-3 and H-5, H_3-23; H-9 and Hα-12, H_3-27; Hα-11 and Hα-12; Hα-12 and Hα-19; H-15 and H_3-26, H_3-28; Hα-19 and H_3-29. Consequently, the 3- and 15-hydroxyl functions were elucidated to be β and α-configurations, respectively, and the stereostructure of foliasalacin C (**8**) was characterized as shown in Fig. 2.

Experimental

General Experimental Procedures The following instruments were used to obtain physical data: specific rotations, Horiba SEPA-300 digital polarimeter (l=5 cm); CD spectra, JASCO J-720WI spectrometer; UV spectra, Shimadzu UV-1600 spectrometer; IR spectra, Shimadzu FTIR-8100 spectrometer; EI-MS and high-resolution MS, JEOL JMS-GCMATE mass spectrometer; ^1H-NMR spectra, JEOL EX-270 (270 MHz) and JNM-LA500 (500 MHz) spectrometers; ^{13}C-NMR spectra, JEOL EX-270 (68 MHz) and JNM-LA500 (125 MHz) spectrometers with tetramethylsilane as an internal standard; and HPLC detector, Shimadzu RID-6A refractive index and SPD-10A*vp* UV–VIS detectors. HPLC column, Cosmosil $5C_{18}$-MS-II (Nacalai Tesque Inc., 250×4.6 mm i.d.) and (250×20 mm i.d.) columns were used for analytical and preparative purposes, respectively.

The following experimental conditions were used for chromatography: ordinary-phase silica gel column chromatography, Silica gel BW-200 (Fuji Silysia Chemical, Ltd., Aichi, Japan, 150—350 mesh); reversed-phase silica gel column chromatography, Chromatorex ODS DM1020T (Fuji Silysia Chemical, Ltd., Aichi, Japan, 100—200 mesh); TLC plates and precoated TLC plates with Silica gel $60F_{254}$ (Merck, 0.25 mm) (ordinary phase) and Silica gel RP-18 F_{254S} (Merck, 0.25 mm) (reversed phase); reversed-phase HPTLC, with Silica gel RP-18 WF_{254S} (Merck, 0.25 mm); and detection was achieved by spraying with 1% $Ce(SO_4)_2$–10% aqueous H_2SO_4 followed by heating.

Plant Material The dried leaves of *S. chinensis* were collected at Nakhon Si Thammarat province, Thailand in 2006 and identified by one of authors (Rajamangala University of Technology Srivijaya, Pongpiriyadacha Y.). A voucher of the plant is on file in our laboratory (2006. Thai-06).

Extraction and Isolation The dried leaves of *S. chinensis* Linn. (5.8 kg) were finely cut and extracted 3 times with methanol (MeOH) under reflux for 3 h. Evaporation of the solvent under reduced pressure provided a methanolic extract (756 g, 13.0%). The MeOH extract (712 g) was partitioned into an EtOAc–H_2O (1 : 1, v/v) mixture to furnish an EtOAc-soluble fraction (222 g, 4.1%) and an aqueous phase. The EtOAc fraction (200 g) was subjected to ordinary-phase silica gel column chromatography [3.8 kg, hexane–EtOAc (40 : 1→10 : 1→5 : 1→1 : 1, v/v)→$CHCl_3$–MeOH–H_2O (10 : 3 : 1, v/v/v, lower layer)→MeOH] to give sixteen fractions [Fr. 1 (0.7 g), Fr. 2 (1.3 g), Fr. 3 (28.3 g), Fr. 4 (0.9 g), Fr. 5 (9.0 g), Fr. 6 (14.9 g), Fr. 7 (3.2 g), Fr. 8 (10.7 g), Fr. 9 (9.1 g), Fr. 10 (6.2 g), Fr. 11 (4.2 g), Fr. 12 (13.8 g), Fr. 13 (4.1 g), Fr. 14 (43.2 g), Fr. 15 (16.9 g), Fr. 16 (26.3 g)]. Fraction 10 (6.2 g) was subjected to Sephadex LH-20 column chromatography [200 g, MeOH–$CHCl_3$ (1 : 1, v/v)] to give two fractions [Fr. 10-1 (2400 mg), Fr. 10-2 (3600 mg)]. Fraction 10-2 (3600 mg) was subjected to reversed-phase silica gel column chromatography [120 g, CH_3CN–H_2O (75 : 25→85 : 15→90 : 10→100 : 5, v/v)→CH_3CN→$CHCl_3$] to give nine fractions [Fr. 10-2-1 (150 mg), Fr. 10-2-2 (164 mg), Fr. 10-2-3 (192 mg), Fr. 10-2-4 (817 mg), Fr. 10-2-5 (204 mg), Fr. 10-2-6 (70 mg), Fr. 10-2-7 (49 mg), Fr. 10-2-8 (159 mg), Fr. 10-2-9 (583 mg)]. Fraction 10-2-3 (192 mg) was purified by HPLC [MeOH–H_2O (92 : 8, v/v)] and finally HPLC [MeOH–H_2O (88 : 12, v/v)] to furnish foliasalacins A_3 (**3**, 9.1 mg, 0.00020%) and B_3 (**7**, 31.8 mg, 0.00070%). Fraction 10-2-4 (817 mg) was subjected to HPLC [MeOH–H_2O (92 : 8, v/v)] and HPLC [MeOH–H_2O (88 : 12, v/v)] to furnish foliasalacins A_3 (**3**, 2.1 mg, 0.00005%) and C (**8**, 2.1 mg, 0.00005%). Fraction 10-2-5 (204 mg) was purified by HPLC [MeOH–H_2O (92 : 8, v/v)] and finally HPLC [MeOH–H_2O (88 : 12, v/v)] to afford foliasalacins A_1 (**1**, 17.0 mg, 0.00038%), A_2 (**2**, 8.2 mg, 0.00018%), A_4 (**4**, 4.9 mg, 0.00011%), and B_1 (**5**, 16.8 mg, 0.00037%). Fraction 11 (4.2 g) was subjected to reversed-phase silica gel column chromatography [150 g, MeOH–H_2O (70 : 30→80 : 20→90 : 10, v/v)→MeOH→$CHCl_3$] to afford five fractions [Fr. 11-1 (45 mg), Fr. 11-2 (54 mg), Fr. 11-3 (40 mg), Fr. 11-4 (799 mg), Fr. 11-5 (1960 mg)]. Fraction 11-4 (799 mg) was separated by HPLC [MeOH–H_2O (92 : 8, v/v)] to give sixteen fractions [Fr. 11-4-1 (5.0 mg), Fr. 11-4-2 (9.1 mg), Fr. 11-4-3 (7.1 mg), Fr. 11-4-4 (55.9 mg), Fr. 11-4-5 (18.5 mg), Fr. 11-4-6 (107.7 mg), Fr. 11-4-7 (17.7 mg), Fr. 11-4-8 (29.2 mg), Fr. 11-4-9 (34.5 mg), Fr. 11-4-10 (54.7 mg), Fr. 11-4-11 (64.5 mg), Fr. 11-4-12 (78.6 mg), Fr. 11-4-13 (32.2 mg), Fr. 11-4-14 (15.7 mg), Fr. 11-4-15 (18.1 mg), Fr. 11-4-16 (16.2 mg)]. Fractions 11-4-13 and 11-4-16 were identified as foliasalacins B_1 (**5**, 16.2 mg, 0.00036%) and B_2 (**6**, 32.2 mg, 0.00072%), respectively. Fraction 11-4-7 (17.7 mg) was purified by HPLC [MeOH–H_2O (88 : 12, v/v)] to furnish foliasalacin A_3 (**3**, 5.8 mg, 0.00013%). Fraction 11-4-14 (15.7 mg) was purified by HPLC [MeOH–H_2O (88 : 12, v/v)] to furnish foliasalacin B_2 (**6**, 1.9 mg, 0.00004%).

Foliasalacin A_1 (**1**): A white powder; $[\alpha]_D^{26}$ +33.1° (c=0.85, $CHCl_3$); IR (KBr) ν_{max} 3424, 2941, 2872, 1705, 1646, 1456, 1377, 756 cm^{-1}; ^1H-NMR (500 MHz, $CDCl_3$) δ 0.73 (1H, dd, J=2.0, 11.7 Hz, H-5), 0.77, 0.85, 0.87, 0.96, 0.97, 1.12 (3H each, all s, H_3-29, 19, 18, 30, 28, 21), 0.95 (1H, m, H-1α), 1.02 (3H, J=6.7 Hz, H_3-31), 1.32 (1H, m, H-9), 1.63 (1H, m, H-1β), 1.64 (1H, m, H-13), 1.65 (3H, br s, H_3-27), 1.70 (1H, m, H-17), 3.20 (1H, dd, J=4.8, 11.7 Hz, H-3), 4.68 (2H, m, H_2-26); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 1; EI-MS m/z 458 $(M)^+$ (0.4), 440 (5), 422 (4), 379 (4), 141 (43), 123 (100); HR-EI-MS m/z 458.4132 [Calcd for $C_{31}H_{54}O_2$ $(M)^+$, 458.4124].

Foliasalacin A_2 (**2**): A white powder; $[\alpha]_D^{25}$ +22.0° (c=0.21, $CHCl_3$); IR (KBr) ν_{max} 3423, 2933, 2870, 1647, 1338, 887 cm^{-1}; ^1H-NMR (500 MHz, $CDCl_3$) δ 0.73 (1H, dd, J=2.2, 11.9 Hz, H-5), 0.78, 0.85, 0.88, 0.97, 0.98, 1.10 (3H each, all s, H_3-29, 19, 18, 30, 28, 21), 0.97 (1H, m, H-1α), 1.02 (3H, J=6.7 Hz, H_3-31), 1.31 (1H, m, H-9), 1.69 (1H, m, H-1β), 1.69 (1H, m, H-17), 1.65 (3H, br s, H_3-27), 1.71 (1H, m, H-13), 3.20 (1H, dd, J=5.2, 11.6 Hz, H-3), 4.68 (2H, m, H_2-26); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 1; EI-MS m/z 458 $(M)^+$ (2), 440 (35), 422 (50), 379 (69), 141 (88), 123 (100); HR-EI-MS m/z 458.4120 [Calcd for $C_{31}H_{54}O_2$ $(M)^+$, 458.4124].

Foliasalacin A_3 (**3**): A white powder; $[\alpha]_D^{27}$ +31.4° (c=0.58, $CHCl_3$); IR (KBr) ν_{max} 3422, 2933, 2870, 1705, 1636, 1215, 887, 754 cm^{-1}; ^1H-NMR (500 MHz, $CDCl_3$) δ 0.74 (1H, dd, J=2.2, 11.6 Hz, H-5), 0.78, 0.86, 0.95, 0.98, 1.06 (3H each, all s, H_3-29, 19, 18, 28, 30), 0.94 (1H, m, H-1α), 1.02 (3H, J=6.7 Hz, H_3-31), 1.28 (1H, dd, J=2.8, 11.9 Hz, H-9), 1.65 (3H, br s, H_3-27), 1.68 (1H, m, H-1β), 2.21 (1H, m, H-17), 3.21 (1H, dd, J=4.9, 11.6 Hz, H-3), 4.26 (1H, dd, J=8.6, 8.6 Hz, H-15), 4.69 (2H, m, H_2-26), 4.70 (1H, m, Ha-21), 4.71 (1H, br s, Hb-21); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 1; EI-MS m/z 456 $(M)^+$ (6), 438 (14), 420 (13), 395 (20), 306 (40), 205 (100); HR-EI-MS m/z 456.3973 [Calcd for $C_{31}H_{52}O_2$ $(M)^+$, 456.3967].

Foliasalacin A_4 (**4**): A white powder; $[\alpha]_D^{27}$ +25.9° (c=0.20, $CHCl_3$); IR (KBr) ν_{max} 3422, 2933, 2872, 1647, 889, 803, 754 cm^{-1}; ^1H-NMR (500 MHz, $CDCl_3$) δ 0.73 (1H, dd, J=2.2, 11.9 Hz, H-5), 0.78, 0.85, 0.89, 0.96, 0.98, 1.16 (3H each, all s, H_3-29, 19, 18, 30, 28, 21), 0.99 (1H, m, H-1α), 1.04, 1.04 (3H each, both d, J=6.9 Hz, H_3-26, 27), 1.31 (1H, m, H-9), 1.70 (1H, m, H-1β), 1.71 (1H, m, H-17), 3.20 (1H, dd, J=4.2, 11.0 Hz, H-3), 4.69, 4.75 (1H each, both br s, H_2-31); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 1; EI-MS: m/z 458 $(M)^+$ (4), 440 (44), 422 (43), 379 (43), 190 (34), 141 (100); HR-EI-MS m/z 458.4117 [Calcd for $C_{31}H_{54}O_2$ $(M)^+$, 458.4124].

Foliasalacin B_1 (**5**): A white powder; $[\alpha]_D^{29}$ +9.4° (c=0.79, $CHCl_3$); IR (KBr) ν_{max} 3422, 2936, 2870, 1717, 756 cm^{-1}; ^1H-NMR (500 MHz, $CDCl_3$) δ 0.75, 0.94, 0.94, 1.03, 1.08, 1.08 (3H each, all s, H_3-28, 25, 27, 24, 23, 26), 0.97 (3H, d, J=6.8 Hz, H_3-30), 1.29 (1H, m, H-18), 1.33 (1H, m, H-5), [1.37 (1H, m), 1.68 (1H, m), H_2-21], 1.37 (1H, m, H-9), 1.37 (1H, m, H-12α), 1.40 (1H, m, H-1α), 1.68 (1H, m, H-12β), 1.70 (1H, m, H-13), 1.77 (1H, m, H-19), 1.92 (1H, m, H-1β), 2.43 (1H, ddd, J=4.3, 7.3, 15.6 Hz, H-2α), 2.49 (1H, ddd, J=7.7, 9.5, 15.6 Hz, H-2β), [3.41 (1H, dd, J=8.1, 11.1 Hz), 3.82 (1H, dd, J=4.5, 11.1 Hz), H_2-29]; ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS m/z 442 $(M)^+$ (63), 427 (23), 424 (24), 411

(11), 409 (16), 383 (41), 205 (100); HR-EI-MS *m/z* 442.3815 [Calcd for $C_{30}H_{50}O_2$ $(M)^+$, 442.3811].

Foliasalacin B_2 (**6**): A white powder; $[\alpha]_D^{26}$ +17.2° (*c*=1.70, $CHCl_3$); IR (KBr) ν_{max} 3415, 2935, 2870, 1717, 754 cm^{-1}; ^{1}H-NMR (500 MHz, $CDCl_3$) δ 0.78, 0.95, 0.95, 1.03, 1.08, 1.08 (3H each, all s, H_3-28, 25, 27, 24, 23, 26), 0.80 (3H, d, *J*=6.8 Hz, H_3-30), [1.22 (1H, m), 1.59 (1H, m), H_2-21], 1.24 (1H, m, H-18), 1.32 (1H, m, H-5), 1.36 (1H, m, H-12α), 1.37 (1H, m, H-9), 1.42 (1H, m, H-1α), 1.68 (1H, m, H-12β), 1.72 (1H, m, H-13), 1.92 (1H, m, H-1β), 1.95 (1H, m, H-19), 2.40 (1H, ddd, *J*=4.3, 7.3, 15.6 Hz, H-2α), 2.49 (1H, ddd, *J*=7.7, 9.5, 15.6 Hz, H-2β), 3.42 (2H, m, H_2-29); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS *m/z* 442 $(M)^+$ (64), 427 (19), 424 (27), 411 (7), 409 (12), 383 (31), 205 (100); HR-EI-MS *m/z* 442.3818 [Calcd for $C_{30}H_{50}O_2$ $(M)^+$, 442.3811].

Foliasalacin B_3 (**7**): A white powder; $[\alpha]_D^{27}$ −26.4° (*c*=0.97, $CHCl_3$); IR (KBr) ν_{max} 2936, 2869, 1707, 1460, 1381, 1229, 1115 cm^{-1}; ^{1}H-NMR (500 MHz, $CDCl_3$) δ 0.76, 0.93, 0.94, 1.03, 1.08, 1.08 (3H each, all s, H_3-28, 27, 25, 24, 23, 26), 1.15 (3H, d, *J*=6.8 Hz, H_3-30), 1.44 (1H, m, H-18), 1.32 (1H, m, H-5), 1.41 (1H, m, H-9), 1.52 (1H, m, H-12α), 1.43 (1H, m, H-1α), 1.56 (1H, m, H-12β), 1.73 (1H, m, H-13), 1.78 (1H, m, H-19), 1.92 (1H, m, H-1β), 2.42 (1H, ddd, *J*=4.8, 7.6, 15.8 Hz, H-2α), 2.48 (1H, m, H-2β); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS: *m/z* 456 $(M)^+$ (21), 441 (11), 438 (19), 423 (10), 383 (100), 358 (3), 221 (23), 205 (55), 163 (61); HR-EI-MS *m/z* 456.3601 [Calcd for $C_{30}H_{50}O_2$ $(M)^+$, 456.3603].

Foliasalacin C (**8**): A white powder; $[\alpha]_D^{28}$ −25.1° (*c*=0.11, $CHCl_3$); IR (KBr) ν_{max} 3422, 2941, 2870, 1636, 756 cm^{-1}; ^{1}H-NMR (500 MHz, $CDCl_3$) δ 0.76 (1H, m, H-5), 0.70, 0.77, 0.86, 0.90, 0.94, 0.98, 1.07, 1.17 (3H each, all s, H_3-30, 24, 25, 26, 29, 23, 28, 27), 0.96 (1H, m, H-1α), 1.25 (1H, m, H-11α), 1.44 (1H, m, H-9), 1.47 (1H, m, H-11β), 1.58 (1H, m, H-2β), 1.60 (1H, m, H-19β), 1.66 (1H, m, H-2α), 1.70 (1H, m, H-1β), 1.94 (1H, m, H-12β), 2.25 (1H, dd, *J*=2.7, 14.5 Hz, H-19α), 2.67 (1H, m, H-12α), 3.23 (1H, dd, *J*=4.1, 11.0 Hz, H-3), 4.13 (1H, dd, *J*=8.3, 8.3 Hz, H-15); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS: *m/z* 442 $(M)^+$ (18), 424 (18), 409 (16), 406 (6), 391 (6), 255 (7), 234 (29), 203 (100), 189 (34); HR-EI-MS *m/z* 442.3807 [Calcd for $C_{30}H_{50}O_2$ $(M)^+$, 442.3811].

$NaBH_4$ Reduction of Foliasalacin B_1 (5) A solution of foliasalacin B_1 (**5**) (5.5 mg) in dehydrated MeOH (1.0 ml) was treated with sodium borohydride ($NaBH_4$, 1.0 mg) and the mixture was stirred at room temperature for 1 h. The reaction mixture was quenched in acetone, and then removal of the solvent under reduced pressure yielded a reaction mixture, which was purified by normal-phase silica gel CC [500 mg, hexane–EtOAc (3 : 1, v/v)] to furnish (20*R*)-lupane-3β,29-diol (**5a**, 5.1 mg, 92.6%). The obtained compound **5a** was identified by comparison of their physical data ($[\alpha]_D$, ^{1}H-NMR, MS) with reported values.

(20*R*)-Lupane-3β,29-diol (**5a**): A white powder; $[\alpha]_D^{30}$ −4.0° (*c*=0.48, $CHCl_3$; lit: $[\alpha]_D^{20}$ −14.1°); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS: *m/z* 444 $(M)^+$ (20), 426 (18), 207 (100), 189 (84).

CrO_3–Pyridine Oxidation of Foliasalacin B_1 (5) A solution of foliasalacin B_1 (**5**) (3.9 mg) in pyridine (0.5 ml) was treated with chromium trioxide (CrO_3, 2.0 mg)–pyridine (0.5 ml) mixture, and the mixture was stirred at room temperature for 2.0 h. Removal of the solvent under reduced pressure to a residue, which was purified by HPLC [MeOH–H_2O (92 : 8, v/v)] to give foliasalacin B_3 (**7**) (1.0 mg, 24.8%). The obtained **7** was identified by comparison of their physical data ($[\alpha]_D$, ^{1}H-NMR, ^{13}C-NMR, MS) with the values of isolated foliasalacin B_3 (**7**).

$NaBH_4$ Reduction of Foliasalacin B_2 (6) A solution of foliasalacin B_2 (**6**) (5.6 mg) in dehydrated MeOH (1.0 ml) was treated with $NaBH_4$ (1.0 mg) and the mixture was stirred at room temperature for 1 h. Workup of the reaction mixture as described above to give (20*S*)-lupane-3β,29-diol (**6a**, 5.3 mg, 94.6%). The obtained compound **6a** was identified by comparison of their physical data ($[\alpha]_D$, ^{1}H-NMR, MS) with reported values.

(20*S*)-Lupane-3β,29-diol (**6a**): A white powder; $[\alpha]_D^{30}$ −2.0° (*c*=0.05, $CHCl_3$; lit: $[\alpha]_D^{20}$ −5.8°); ^{13}C-NMR data (125 MHz, $CDCl_3$) δ_C: see Table 3; EI-MS: *m/z* 444 $(M)^+$ (13), 426 (21), 207 (100), 189 (93).

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