New Biologically Active Triterpenoid Saponins from *Scabiosa tschiliensis*

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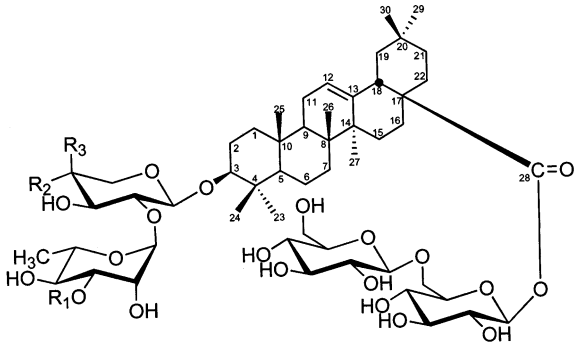
Received October 22, 2003

Eleven new triterpenoid saponins, scabiosaponins A−K (**1**−**11**), and hookerosides A (**12**) and B (**13**) were isolated from the whole plants of *Scabiosa tschiliensis*. The structures of the new compounds were established on the basis of extensive NMR (DEPT, DQF-COSY, HETCOR, TOCSY, HMQC, HMQC-TOCSY, HMBC, and NOESY) and MS studies coupled with chemical degradations. The biological activity of compounds **1**−**10**, **12**, and **13** and prosapogenin **1b** were examined against pancreatic lipase. Scabiosaponins E, F, G, I (**5**, **6**, **7**, **9**), hookerosides A, B (**12**, **13**), and prosapogenin **1b** all exhibited strong inhibition of pancreatic lipase in vitro.

Scabiosa tschiliensis Grun. (Dipsacaceae) is a perennial herb widely distributed in the northeast region of the Inner Mongolia autonomy district and the west of Hebei Province of the People's Republic of China. *S. tschiliensis* is called "Meng Gu Shan Luo Bo", and the flowers have long been used as an herbal medicine for the treatment of headache, fever, cough, and jaundice in Inner Mongolia.[1] *Scabiosa* species have also been used as a remedy for the skin disease mange in Europe.[2] However, there has been no chemical or biological study reported on this plant. In this paper, we report the isolation and structure elucidation of 11 new triterpenoid saponins (**1**−**11**) from the whole plant of *S. tschiliensis* along with the pancreatic lipase inhibitory activity of these compounds (**1**−**10**, **12**, and **13**).



	R_1	R_2	R_3
1	Glc(1→4)Xyl	H	OH
2	Xyl(1→4)Glc(1→4)Xyl	H	OH
3	Glc(1→4)Xyl	H	O-Glc
4	H	H	O-Glc
5	Xyl	OH	H
6	Glc	OH	H
7	Glc(1→4)Glc	OH	H
12	Glc(1→4)Xyl	OH	H
13	Xyl(1→4)Glc(1→4)Xyl	OH	H

Results and Discussion

A methanolic extract of the whole plant of *S. tschiliensis* was suspended in H_2O and then partitioned successively with *n*-hexane, EtOAc, and *n*-BuOH. The *n*-BuOH-soluble fraction, on chromatographic purification over Diaion HP-20, followed by repeated medium-pressure liquid chromatography (MPLC) and HPLC purification, afforded 11 new compounds (**1**−**11**), along with two known saponins, hookeroside A (**12**) and B (**13**). All these compounds were found to possess gentiobiose, that is, a β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside unit directly linked to C-28 of the aglycons.

Scabiosaponin A (**1**) had a molecular formula of $C_{64}H_{104}O_{30}$ determined from its matrix-assisted laser desorption ionization time-of-flight (MALDI-TOF) mass spectra (*m*/*z* 1375 $[M + Na]^+$, 1391 $[M + K]^+$) and from positive HRFABMS data for the $[M + Na]^+$ ion at *m*/*z* 1375 (measured *m*/*z* 1375.6511, calculated *m*/*z* 1375.6510) as well as ^{13}C DEPT NMR spectra. The spectral features and physicochemical properties suggested **1** to be a triterpenoid saponin. The IR spectrum exhibited absorptions at 3419 cm^{-1} (−OH), 1742 cm^{-1} (ester carbonyl), and 1644 cm^{-1} (double bond). The seven tertiary methyl groups (δ 0.90 × 3, 1.10, 1.14, and 1.27 × 2) and one trisubstituted olefinic proton (δ 5.42, br s) observed in the ^1H NMR spectrum coupled with the information from the ^{13}C NMR spectrum (seven sp^3 carbons at δ 15.7, 33.1, 23.7, 17.5, 17.2, 28.2, and 26.1 and two sp^2 olefinic carbons at δ 122.9 and 144.2) indicated that the aglycon possessed an olean-12-ene skeleton. After an extensive 2D NMR study, the aglycon was identified as oleanolic acid. The chemical shifts of C-3 (δ 88.7) and C-28 (δ 176.5) revealed that **1** was a bisdesmosidic glycoside. Of the 64 carbon signals observed in the ^{13}C NMR spectrum of **1** (Tables 1 and 2), 30 were assigned to the aglycon and 34 to the oligosaccharide moieties. The ^1H and ^{13}C NMR spectra of compound **1** exhibited six sugar anomeric protons at δ 4.86 (d, J = 6.0 Hz), 5.04 (d, J = 7.6 Hz), 5.05 (d, J = 7.8 Hz), 5.28 (d, J = 7.8 Hz), 6.24 (br s), and 6.27 (d, J = 8.0 Hz) and carbons at δ 95.7, 101.5, 103.7, 105.1, 105.3, and 107.2 (Tables 2 and 3). The methyl carbon signal at δ 18.5 and the doublet methyl proton signal at δ 1.55 (3H, d, J = 6.0 Hz) indicated the presence of a 6-deoxy sugar. The identities of the monosaccharides and the oligosaccharide sequence were determined by a combination of DQF-COSY, TOCSY, DEPT, HMQC, HMQC-TOCSY, HMBC, and phase-sensitive NOESY NMR experiments. Acid hydrolysis afforded oleanolic acid, and the monosaccharides L-arabinose, L-rhamnose, D-xylose, and D-glucose (1:1:1:3) by HPLC analysis following conversion to the

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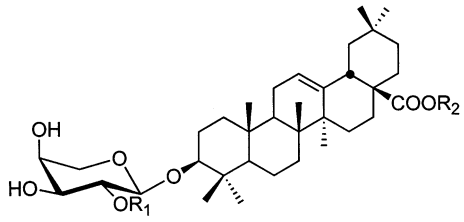
10.1021/np0304722 CCC: $27.50
Published on Web 03/12/2004

Table 1. ^{13}C NMR Spectroscopic Data (δ) for the Aglycon Moieties of **1**−**13**, **1a**, **1b**, and **1c** (125 MHz in pyridine-d_5)[a]

position	1	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
1	39.0	38.8	38.9	38.6	39.0	39.0	39.0	39.0	39.1	39.0	39.0	39.0	38.8	38.8
2	26.7	26.5	26.6	26.6	26.6	26.7	26.6	26.9	26.9	26.9	26.7	26.6	26.6	26.7
3	88.7	88.5	88.7	88.5	88.8	88.7	88.8	88.6	88.7	88.5	88.8	88.9	88.8	88.8
4	39.6	39.5	39.6	39.4	39.6	39.6	39.5	39.7	39.7	39.7	39.6	39.5	39.6	39.6
5	56.0	55.9	56.0	55.7	56.0	56.1	56.1	56.1	56.2	56.1	56.1	56.0	56.1	56.2
6	18.6	18.4	18.5	18.4	18.6	18.6	18.6	18.5	18.6	18.5	18.7	18.7	18.7	18.8
7	33.1	33.0	33.2	33.1	33.1	33.1	33.2	33.1	33.2	33.0	33.5	33.4	33.2	33.2
8	39.9	39.8	39.7	39.6	39.9	40.0	40.0	39.9	40.0	39.9	40.5	40.5	40.2	40.2
9	48.1	48.0	48.0	47.9	48.1	48.1	48.1	48.1	48.1	48.1	47.8	47.7	48.3	48.4
10	37.1	36.9	37.0	36.9	37.1	37.1	37.1	37.1	37.1	37.1	37.0	37.0	37.2	37.2
11	23.8	23.3	23.7	23.6	23.8	23.8	23.9	23.8	23.8	23.8	24.0	24.0	24.1	24.2
12	122.9	122.7	122.5	122.4	122.9	122.9	122.9	123.1	122.9	122.9	128.3	128.4	123.0	123.7
13	144.2	144.0	144.8	144.7	144.2	144.2	144.2	144.2	144.2	144.2	139.3	139.2	144.3	144.4
14	42.1	42.0	42.2	42.0	42.2	42.2	42.2	42.2	42.2	42.2	42.1	42.1	42.1	42.1
15	28.3	28.1	28.3	28.2	28.3	28.3	28.3	28.3	28.3	28.2	29.3	29.3	29.0	29.1
16	23.4	23.7	23.8	23.7	23.4	23.4	23.5	23.4	23.5	23.4	26.1	26.1	28.0	28.0
17	47.1	46.9	46.7	46.5	47.1	47.1	47.1	47.1	47.1	47.1	48.7	48.7	46.5	46.6
18	41.7	41.6	42.0	41.9	41.7	41.7	41.8	41.7	41.7	41.7	54.3	54.3	44.5	44.6
19	46.3	46.1	46.5	46.3	46.3	46.3	46.3	46.3	46.3	46.3	72.7	72.7	81.1	81.1
20	30.8	30.7	30.9	30.8	30.8	30.8	30.8	30.8	30.8	30.8	42.0	42.0	35.5	35.6
21	34.0	33.9	34.2	34.1	34.0	34.1	34.1	34.0	34.1	34.0	26.7	26.6	29.0	29.0
22	32.6	32.4	33.2	33.1	32.6	32.6	32.6	32.6	32.6	32.6	37.8	37.7	33.0	33.1
23	28.2	28.1	28.2	28.1	28.2	28.2	28.1	28.2	28.3	28.2	28.2	28.2	28.2	28.2
24	17.2	17.1	17.1	16.8	17.2	17.2	17.0	17.4	17.3	17.4	17.2	17.1	17.0	17.2
25	15.7	15.5	15.5	15.4	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.6	15.6
26	17.5	17.3	17.4	17.3	17.5	17.5	17.6	17.5	17.5	17.5	17.4	17.4	17.5	17.6
27	26.1	26.0	26.2	26.0	26.1	26.1	26.1	26.1	26.1	26.1	24.6	24.5	24.8	24.9
28	176.5	176.3	180.2	180.0	176.5	176.5	176.6	176.5	176.5	176.5	177.0	177.0	177.3	177.3
29	33.1	33.1	33.3	33.1	33.1	33.1	33.1	33.1	33.2	33.1	27.0	27.0	28.7	28.8
30	23.7	23.5	23.7	23.6	23.7	23.7	23.7	23.7	23.7	23.7	16.7	16.6	24.8	24.8

[a] Assignments were based on DQF-COSY, TOCSY, DEPT, HETCOR, NOESY, and HMBC experiments.

1-[(*S*)-*N*-acetyl-α-methylbenzylamino]-1-deoxyalditol acetate derivatives.[3,4] All the monosaccharides were in the pyranose forms, as determined from their ^{13}C NMR data. The β-anomeric configurations for the glucose and xylose units were determined from their $^3J_{H1,H2}$ coupling constants (7.6−8.0 Hz), and the arabinose unit was determined to have an α-configuration on the basis of the $^3J_{H1,H2}$ (6.0 Hz) values observed in the $^4C_1$ forms. These configurations were also confirmed from the NOE relationships between H-1 and H-3 and between H-1 and H-5. For the rhamnose moiety, the anomeric proton was observed as a singlet. The ^{1}H nonsplitting pattern and the three-bond strong HMBC correlations from the anomeric proton to C-3 and C-5 (the dihedral angles between H-1 and C-3 and H-1 and C-5 about 180°) indicated that the anomeric proton was equatorial, thus possessing an α-configuration in the $^1C_4$ form.[5] The sequence of the glycan part connected to C-3 of the aglycon was deduced from the following HMBC correlations: H-1 (δ 5.05) of glucose with C-4 (δ 77.9) of xylose, H-1 (δ 5.28) of xylose with C-3 (δ 83.1) of rhamnose, H-1 (δ 6.24) of rhamnose with C-2 (δ 75.3) of arabinose, H-1 (δ 4.86) of arabinose with C-3 (δ 88.7) of the aglycon (Figure 1). The disaccharide part at C-28 was established by the following HMBC information: the correlations between H-1 (δ 5.04) of glucose (terminal) and C-6 (δ 69.4) of glucose (inner) and between the H-1 (δ 6.27) of glucose (inner) and C-28 (δ 176.5) of the aglycon (Figure 1). The same conclusion with regard to the sugar sequence was also drawn from the NOESY experiments (Figure 1). Further supporting information concerning the sugar sequence was furnished by enzymatic degradation. Hydrolysis of **1** with naringinase for 10 h afforded prosapogenin **1a** and glucose, indicating that both C-3 and C-28 sugar chains possessed terminal β-D-glucoses. Hydrolysis of **1** with naringinase for 2 weeks afforded prosapogenin **1c**,[6] which upon acid hydrolysis yielded oleanolic acid and L-arabinose. On selective cleavage of the ester-glycoside linkage with anhydrous LiI and 2,6-lutidine in anhydrous methanol,[7,8] compound **1** afforded prosapogenin **1b**,[9] which was completely methylated by means of the Hakomori method[10,11] and had a retention time identical with authentic methylated gentiobiose by GLC. Thus, the sugar sequence of C-28 of the aglycon was determined to be β-D-gentiobiose (β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside). On the basis of all the foregoing evidence, scabiosaponin A (**1**) was elucidated as 3-*O*-β-D-glucopyranosyl-(1→4)-β-D-xylopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosyloleanolic acid 28-*O*-β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside.



	R_1	R_2
Prosapogenin **1a**	Xyl(1→3)Rha	Glc
Prosapogenin **1b**	Glc(1→4)Xyl(1→3)Rha	H
Prosapogenin **1c**	H	H

Scabiosaponin B (**2**) had a molecular formula of $C_{69}H_{112}O_{34}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. Its ^{1}H and ^{13}C NMR spectra indicated that compound **2** possessed the same aglycon as that of **1** but differed in the sugar moiety (Tables 2 and 3). The chemical shifts of C-3 and C-28 revealed that **2** was a bisdesmosidic glycoside. The ^{1}H and ^{13}C NMR spectra of **2** exhibited seven anomeric protons and carbons (Tables 2 and 3). Acid hydrolysis afforded oleanolic acid and the component sugars, which were identified as L-arabinose, L-rhamnose, D-xylose, and D-glucose (1:1:2:3). The ^{1}H and ^{13}C NMR chemical shift assignments were accomplished by a combination of DQF-COSY, TOCSY, DEPT, HMQC,

Table 2. ^{13}C NMR Spectroscopic Data (δ) for the Sugar Moieties of **1**−**13**, **1a**, **1b**, and **1c** (125 MHz in pyridine-d_5)[a]

	1	**1a**	**1b**	**1c**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**[b]	**13**[b]
3-*O*-sugar																
arabinose (xylose)																
1	105.1	105.2	105.1	107.4	105.0	105.1	104.8	106.1	106.3	106.2	105.2	105.2	105.3	105.3	106.1	106.0
2	75.3	75.0	75.5	74.5	75.5	75.9	76.5	77.0	77.2	77.0	75.5	75.7	75.6	75.3	77.2	77.4
3	74.5	74.6	74.4	72.8	74.2	74.3	73.7	79.8	79.5	79.6	74.4	74.2	74.3	74.6	79.6	79.5
4	69.2	69.2	69.1	69.4	69.0	79.8	79.3	71.6	71.6	71.5	69.2	69.1	69.2	69.3	71.5	71.5
5	65.5	65.6	65.4	66.6	65.3	65.0	64.2	67.1	67.0	67.0	65.6	65.4	65.6	65.6	67.0	67.0
rhamnose																
1	101.5	101.3	101.5		101.5	101.1	101.8	101.5	101.6	101.5	101.5	101.5	101.6	101.5	101.5	101.5
2	71.9	71.9	71.9		71.9	71.7	72.3	72.0	71.6	71.7	71.7	71.6	71.7	72.0	71.8	71.8
3	83.1	82.9	83.1		83.1	83.1	72.5	83.1	83.4	83.7	83.5	83.3	83.3	83.2	83.2	83.1
4	73.0	72.9	73.0		73.0	72.9	74.1	73.0	73.0	73.1	73.0	72.9	73.0	73.0	72.9	72.9
5	69.7	69.6	69.6		69.7	69.7	69.9	69.7	69.8	69.7	69.7	69.7	69.8	69.7	69.6	69.7
6	18.5	18.3	18.4		18.4	18.5	18.6	18.6	18.6	18.6	18.4	18.4	18.4	18.5	18.6	18.6
xylose																
1	107.2	107.4	107.1		107.1	107.1		107.6						107.2	107.2	107.1
2	75.3	75.5	75.3		75.3	75.2		75.7						75.3	75.3	75.3
3	76.4	78.4	76.3		76.2	76.3		78.5						76.4	76.4	76.2
4	77.9	71.0	77.9		77.6	77.9		71.0						78.0	77.9	77.7
5	64.9	67.4	64.9		64.8	64.9		67.5						65.0	65.0	64.9
glucose																
1	103.7		103.6		103.2	103.6	106.3		106.9	106.7	106.5	106.7	106.8	103.7	103.7	103.2
2	74.3		74.3		74.0	74.3	75.5		76.0	75.5	75.5	75.9	75.9	74.3	74.2	74.0
3	78.2		78.2		76.1	78.2	78.6		78.6	76.8	76.6	78.7	78.4	78.2	78.7	76.1
4	71.7		71.7		80.7	71.7	71.4		71.6	81.1	81.1	71.5	71.5	71.7	71.6	80.7
5	78.8		78.8		76.9	78.8	78.8		78.6	76.8	76.6	78.5	78.5	78.9	78.8	76.9
6	62.6		62.6		61.6	62.7	62.7		62.6	61.1	61.7	62.5	62.5	62.7	62.7	61.7
glucose′ (xylose′)																
1					105.5	106.4				105.0	104.9					105.5
2					74.9	75.5				74.8	74.7					74.9
3					78.3	78.5				78.8	78.8					78.3
4					70.8	71.4				71.5	71.5					70.8
5					67.4	78.7				78.5	78.4					67.4
6						62.6				62.4	62.4					
28-*O*-sugar glucose (inner)																
1	95.7	95.6			95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.8	95.7	95.7
2	73.9	74.0			73.9	73.9	74.0	73.9	74.0	74.0	73.8	73.8	73.9	74.0	73.9	74.0
3	78.8	79.2			78.7	78.7	78.8	78.5	78.4	78.2	78.4	78.4	78.3	78.4	78.2	78.7
4	70.9	71.0			71.0	71.0	71.1	71.2	71.1	71.0	71.1	71.1	71.0	71.0	71.0	71.1
5	78.0	78.8			78.0	78.0	78.0	78.0	78.0	78.0	77.9	77.9	77.9	78.0	78.0	78.0
6	69.4	62.1			69.5	69.5	69.5	69.5	60.5	69.5	69.6	69.6	69.4	69.4	69.5	69.5
glucose (terminal)																
1	105.3				105.2	105.2	105.3	105.3	105.3	105.3	105.3	105.2	105.2	105.4	105.2	105.2
2	75.2				75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.1	75.1	75.2	75.2	75.2
3	78.4				78.4	78.4	78.5	78.8	78.8	78.4	78.2	78.3	78.7	78.4	78.4	78.4
4	71.5				71.6	71.6	71.7	71.6	71.6	71.5	71.6	71.6	71.5	71.6	71.7	71.6
5	78.5				78.4	78.4	78.5	78.4	78.4	78.5	78.4	78.4	78.4	78.5	78.4	78.4
6	62.6				62.7	62.7	62.8	62.7	62.7	62.7	62.7	62.7	62.7	62.6	62.7	62.7

[a] Assignments were based on DQF-COSY, TOCSY, DEPT, HETCOR, HMQC, HMQC-TOCSY, NOESY, and HMBC experiments. [b] Earlier assignments due to sugar moieties (ref 15) were corrected.

HMQC-TOCSY, HMBC, and phase-sensitive NOESY experiments. From its ^1H and ^{13}C NMR data (Tables 2 and 3), it was evident that the sugar structure at C-28 was the same as that in **1** and the remaining five sugars at C-3 were of a linear structure with a terminal xylose linked to C-4 (δ 80.7) of the inner glucose. On the basis of these results, scabiosaponin B (**2**) was established as 3-*O*-β-D-xylopyranosyl-(1→4)-β-D-glucopyranosyl-(1→4)-β-D-xylopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosyloleanolic acid 28-*O*-β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside.

Scabiosaponin C (**3**) had a molecular formula of $C_{70}H_{114}O_{35}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. The overall structure assignment was accomplished using the same protocol as in **1**. Its ^1H and ^{13}C NMR data revealed that **3** was a bisdesmosidic glycoside with the same aglycon (oleanolic acid) as that in **1** and **2**. It contained seven sugars, one more hexose (δ 106.4, δ 5.11, d, J = 7.8 Hz) than **1** (Tables 2 and 3). Acid hydrolysis afforded oleanolic acid and the component sugars, which were identified as L-arabinose, L-rhamnose, D-xylose, and D-glucose (1:1:1:4). Detailed NMR analysis indicated that **3** has the same glycan parts, a gentiobiose at C-28 and an arabinose directly linked to C-3. Most of its remaining ^{13}C NMR signals were almost the same as that in **1** except for C-4 of arabinose, being downfield shifted to δ 79.8 and showing one more set of signals attributed to a terminal glucose. The above information indicated that **3** had a branched glycan part at C-3. Thus, scabiosaponin C (**3**) was elucidated as 3-*O*-[β-D-glucopyranosyl-(1→4)-β-D-xylopyranosyl-(1→3)-α-L-rhamnopyranosy-(1→2)][β-D-glucopyranosyl-(1→4)]-α-L-arabinopyranosyloleanolic acid 28-*O*-β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside.

Table 3. ^{1}H NMR Spectroscopic Data (δ) for the Sugar Moieties of **1**, **1a**, **1b**, **1c**, and **2** (500 MHz in pyridine-d_5)[a]

	1	1a	1b	1c	2
3-*O*-sugar					
arabinose(xylose)					
1	4.86 d (6.0)	4.87 d (5.9)	4.88 d (5.9)	4.78 d (7.1)	4.86 d (6.0)
2	4.58 t (7.1)	4.60 d (7.5)	4.56 t (8.2)	4.43 t (8.5)	4.54 t (6.7)
3	4.26 t (5.7)	4.26 m	4.25 d (8.5)	4.17 dd (8.7, 3.2)	4.25 m
4	4.25 m	4.23 m	4.24 m	4.31 m	4.25 m
5	4.32 dd (10.3, 4.3)	4.29 dd (10.4, 4.3)	4.32 dd (10.0, 5.7)	4.33 dd (13.0, 2.5)	4.29 d (10.0)
	3.82 d (10.3)	3.83 d (10.4)	3.84 d (10.0)	3.84 m	3.81 d (10.4)
rhamnose					
1	6.24 br s	6.32 br s	6.24 br s		6.17 br s
2	4.88 t (5.5)	4.93 m	4.86 t (5.9)		4.86 t (6.0)
3	4.69 dd (9.6, 2.7)	4.76 dd (9.6, 3.0)	4.68 dd (9.4, 3.0)		4.66 dd (9.4, 2.8)
4	4.47 dd (9.6, 3.2)	4.48 d (9.6)	4.47 dd (9.4, 5.0)		4.45 d (9.4)
5	4.62 dq (9.4, 6.2)	4.63 t (7.1)	4.63 dq (9.4, 9.4)		4.59 dq (9.4, 6.0)
6	1.55 d (6.0)	1.55 d (6.0)	1.57 d (6.2)		1.55 d (5.9)
xylose					
1	5.28 d (7.8)	5.38 d (7.5)	5.30 d (7.8)		5.25 d (7.6)
2	4.04 dd (8.5, 7.6)	4.07 t (8.3)	4.03 dd (7.8, 2.5)		4.02 t (8.4)
3	4.19 dd (8.7, 2.8)	4.15 t (8.3)	4.17 dd (9.0, 3.0)		4.16 t (8.4)
4	4.30 m	4.22 m	4.28 m		4.26 m
5	4.41 dd (11.5, 5.3)	4.33 dd (10.1, 5.6)	4.39 dd (11.4, 5.1)		4.38 dd (11.7, 5.2)
	3.64 t (11.5)	3.71 d (10.1)	3.65 d (11.4)		3.63 t (11.2)
glucose					
1	5.05 d (7.8)		5.06 d (8.1)		4.98 d (7.8)
2	4.04 dd (8.5, 7.6)		4.02 dd (6.2, 2.5)		4.02 t (8.4)
3	4.22 m		4.20 dd (6.2, 3.0)		4.18 t (8.4)
4	4.18 dd (8.7, 3.2)		4.17 dd (9.0, 3.0)		4.25 m
5	3.99 m		3.98 m		3.90 m
6	4.55 dd (9.6, 2.5)		4.54 dd (11.7, 2.1)		4.47 d (9.6)
	4.30 m		4.30 m		4.35 m
glucose′ (xylose′)					
1					5.06 d (7.7)
2					3.99 d (8.0)
3					4.07 d (8.7)
4					4.15 ddd (8.7, 5.7, 2.5)
5					4.24 dd (10.3, 5.7)
6					3.65 d (10.3)
28-*O*-sugar					
glucose (inner)					
1	6.27 d (8.0)	6.36 d (8.0)			6.24 d (8.3)
2	4.14 dd (8.9, 8.0)	4.21 m			4.13 m
3	4.23 m	4.05 m			4.20 t (8.7)
4	4.36 m	4.35 m			4.31 dd (8.9, 8.7)
5	4.12 m	4.28 m			4.11 m
6	4.72 br s	4.49 d (9.6)			4.70 d (9.6)
	4.37 d (9.6, 2.5)	4.78 d (9.6, 3.0)			4.35 m
glucose (terminal)					
1	5.04 d (7.6)				5.02 d (7.8)
2	4.02 dd (9.4, 8.0)				3.98 m
3	4.19 m				4.18 dd (8.7, 3.2)
4	4.22 m				4.19 t (8.7)
5	3.89 m				3.87 m
6	4.47 dd (9.4, 3.2)				4.44 d (9.6)
	4.35 m				4.34 m

[a] Assignment were based on DQF-COSY, TOCSY, DEPT, HETCOR, HMQC, HMQC-TOCSY, NOESY, and HMBC experiments.

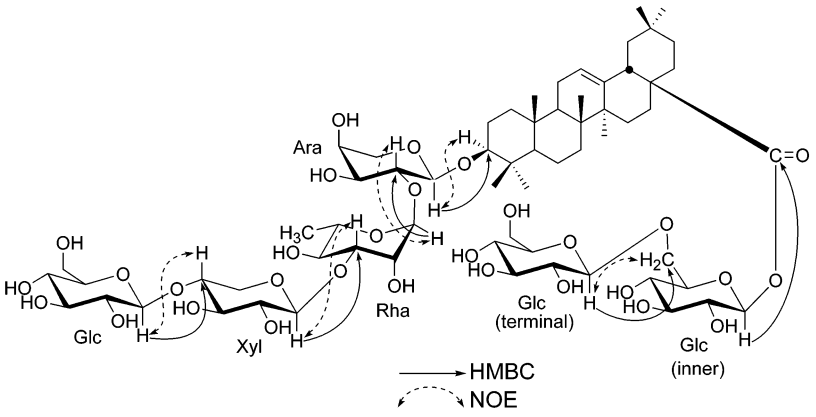


Figure 1. Key HMBC and NOE correlations for the sugar of scabiosaponin A (**1**).

Scabiosaponin D (**4**) had a molecular formula of $C_{59}H_{96}O_{26}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. Its proton and carbon NMR data also indicated that **4** was a bisdesmosidic glycoside based on oleanolic acid and contained five sugars. Acid hydrolysis yielded oleanolic acid and the monosaccharides L-arabinose, L-rhamnose, and D-glucose (1:1:3). Complete ^{1}H and ^{13}C NMR assignments were accomplished by a combination of DQF-COSY, TOCSY, DEPT, HMQC, HMBC, and phase-sensitive NOESY experiments. As with com-

Table 4. ^{1}H NMR Spectroscopic Data (δ) for the Sugar Moieties of **3**−**8** (500 MHz in pyridine-d_5)[a]

	3	**4**	**5**	**6**	**7**	**8**
3-*O*-sugar						
arabinose (xylose)						
1	4.74 d (6.2)	4.79 d (5.7)	4.83 d (7.6)	4.80 d (7.2)	4.81 d (7.3)	4.82 d (5.9)
2	4.48 t (7.8)	4.48 m	4.21 m	4.18 m	4.23 m	4.53 dd (13.1, 6.0)
3	4.21 m	4.26 m	4.19 m	4.14 m	4.16 dd (5.5,6.1)	4.20 dd (5.2)
4	4.25 m	4.29 m	4.19 m	4.12 m	4.22 m	4.22 m
5	4.40 dd (10.8, 4.7)	4.41 dd (12.1, 3.9)	4.35 dd (10.1, 4.8)	4.30 dd (11.0, 5.0)	4.33 dd (10.7, 5.1)	4.29 dd (11.6, 3.6)
	3.78 d (10.8)	3.82 d (10.3)	3.71 d (10.1)	3.67 dd (11.0, 10.7)	3.70 dd (10.4, 10.7)	3.79 d (10.5)
rhamnose						
1	6.18 br s	6.11 br s	6.59 d (1.2)	6.46 br s	6.55 br s	6.18 br s
2	4.13 br s	4.71 dd (8.9, 4.3)	5.00 br s	5.02 br s	5.02 dd (5.0, 3.0)	4.91 br s
3	4.65 dd (9.6, 2.7)	4.58 dd (9.1, 3.0)	4.82 dd (9.6, 3.2)	4.85 dd (9.3, 2.7)	4.84 dd (9.4, 3.0)	4.75 m
4	4.44 d (9.6)	4.27 m	4.54 dd (9.4, 2.5)	4.50 d (9.4)	4.55 dd (9.6, 9.1)	4.48 dd (9.0, 2.6)
5	4.61 dq (9.4, 6.2)	4.59 dq (9.4, 6.3)	4.78 dq (9.4, 6.2)	4.73 dq (9.4, 6.2)	4.78 dq (9.4, 6.2)	4.61 dq (9.2, 6.2)
6	1.56 d (6.2)	1.64 d (6.2)	1.65 d (6.2)	1.62 d (5.9)	1.65 d (6.2)	1.54 d (6.2)
xylose						
1	5.25 d (7.8)		5.39 d (7.5)			
2	3.98 dd (8.7, 3.3)		4.09 t (8.2)			
3	4.15 dd (9.7, 3.0)		4.17 m			
4	4.26 m		4.23 m			
5	4.41 dd (11.7, 4.2)		4.35 dd (10.1, 4.8)			
	3.66 t (11.7)		3.73 d (10.1)			
glucose						
1	5.01 d (7.8)	5.13 d (7.8)		5.47 d (7.8)	5.48 d (7.8)	5.41 d (8.0)
2	4.00 t (8.5)	4.03 t (9.1)		4.09 m	4.12 dd (9.4, 8.0)	4.09 dd (9.2)
3	4.18 m	4.18 m		4.24 t (8.5)	4.29 dd (9.0, 9.0)	4.27 dd (10.1, 9.0)
4	4.13 dd (9.7, 3.0)	4.23 m		4.21 t (9.8)	4.38 dd (10.5, 2.7)	4.37 t (9.1)
5	3.96 m	3.89 m		3.95 m	3.95 ddd (9.4, 6.0, 3.0)	3.91 m
6	4.52 dd (11.5, 1.9)	4.48 m		4.45 dd (9.2, 6.0)	4.57 dd (9.4, 6.0)	4.53 dd (9.1, 5.3)
	4.27 m	4.36 dd (9.8, 3.2)		4.37 dd (9.2, 4.1)	4.42 dd (9.4, 3.6)	4.38 dd (9.1, 2.3)
glucose′ (xylose′)						
1	5.11 d (7.8)				5.22 d (7.8)	5.18 d (7.8)
2	4.01 d (8.5)				4.08 dd (8.4, 8.0)	4.05 dd (8.2, 7.8)
3	4.15 dd (8.7, 3.0)				4.24 m	4.24 m
4	4.20 m				4.20 dd (8.8, 5.7)	4.19 dd (8.8, 5.2)
5	3.88 m				4.00 ddd (11.4, 4.1, 2.4)	3.99 m
6	4.47 m				4.52 dd (7.5, 2.5)	4.51 dd (7.3, 2.6)
	4.34 dd (11.4, 4.6)				4.31 m	4.27 dd (7.3, 5.2)
28-*O*-sugar						
glucose (inner)						
1	6.24 d (8.3)	6.25 d (8.0)	6.26 d (8.3)	6.24 d (8.0)	6.28 d (8.0)	6.23 d (8.0)
2	4.12 t (8.7)	4.13 m	4.15 m	4.12 m	4.14 dd (9.4, 8.2)	4.15 m
3	4.20 m	4.19 m	4.19 m	4.17 m	4.22 dd (8.7, 8.8)	4.21 m
4	4.30 t (9.9)	4.31 m	4.27 t (8.3)	4.30 dd (9.1, 5.9)	4.35 m	4.31 m
5	4.09 m	4.11 m	4.12 m	4.11 m	4.14 m	4.15 m
6	4.69 d (11.4)	4.70 d (8.9, 4.3)	4.72 d (9.6)	4.69 dd (9.2, 6.7)	4.73 d (9.6)	4.72 dd (9.1, 2.7)
glucose (terminal)						
1	5.02 d (7.8)	5.03 d (7.8)	5.04 d (7.8)	5.02 d (7.8)	5.05 d (7.8)	5.06 d (7.8)
2	4.02 t (8.5)	3.99 dd (8.2, 7.8)	4.00 t (8.0)	3.99 dd (8.5, 8.0)	4.01 t (7.1)	4.02 t (6.9)
3	4.16 m	4.17 m	4.17 m	4.20 m	4.20 dd (8.8, 5.7)	4.19 m
4	4.18 m	4.18 m	4.18 m	4.11 m	4.22 dd (8.7, 8.8)	4.25 dd (8.4, 8.0)
5	3.86 m	3.88 m	3.87 m	3.88 m	3.89 m	3.89 m
6	4.45 d (11.5)	4.45 dd (12.1, 3.9)	4.47 d (11.2)	4.45 d (9.6)	4.48 dd (9.6, 2.3)	4.49 dd (9.0, 2.6)
	4.32 dd (11.4, 4.6)	4.35 m	4.33 dd (11.2, 4.6)	4.33 dd (9.6, 5.3)	4.37 dd (9.6, 5.3)	4.36 dd (9.0, 5.0)

[a] Assignment were based on DQF-COSY, TOCSY, DEPT, HETCOR, HMQC, HMQC-TOCSY, NOESY, and HMBC experiments.

pounds **1**−**3**, **4** also possessed a gentiobiose unit at C-28 and an arabinose directly linked to C-3 of the oleanolic acid. The remaining two sugars, L-rhamnose and D-glucose, were determined to be linked to C-2 (δ 76.5) and C-4 (δ 79.3) of the arabinose, the same substitution pattern as in **3**. On the basis of all the foregoing evidence, scabiosaponin D (**4**) was elucidated as 3-*O*-[α-L-rhamnopyranosyl-(1→2)][β-D-glucopyranosyl-(1→4)]-α-L-arabinopyranosyloleanolic acid 28-*O*-β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside.

Scabiosaponin E (**5**) had a molecular formula of $C_{58}H_{94}O_{25}$ determined from its positive ion HRFAB mass spectrum. The aglycon was identified as oleanolic acid. Chemical shifts of C-3 (δ 88.6) and C-28 (δ 176.5) revealed that **5** was a bisdesmosidic glycoside. The ^{1}H and ^{13}C NMR spectra of **5** exhibited five sugar anomeric protons and carbons (Tables 2 and 4). The identity and absolute configurations of these sugars were determined to be L-rhamnose, D-xylose, and D-glucose (1:2:2) by HPLC

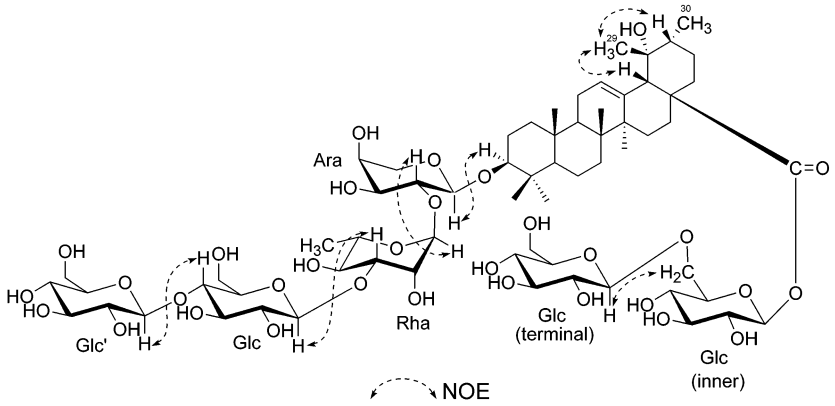


Figure 2. Key NOE correlations of scabiosaponin H (**8**).

analysis following conversion to the 1-[(*S*)-*N*-acetyl-α-methylbenzylamino]-1-deoxyalditol acetate derivatives.[3,4] As a common feature of the saponins from this source, **5** also possessed a gentiobiose unit at C-28. Unlike the previous saponins, **5** possessed a xylose linked to C-3 of the aglycon instead of an arabinose. From the long-range HMBC couplings, it was apparent that C-2 (*δ* 77.0) of the xylose was substituted by an L-rhamnose. The remaining xylose was determined to be linked at C-3 of the rhamnose. Thus, scabiosaponin E (**5**) was elucidated as 3-*O*-*β*-D-xylopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-*β*-D-xylopyranosyloleanolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

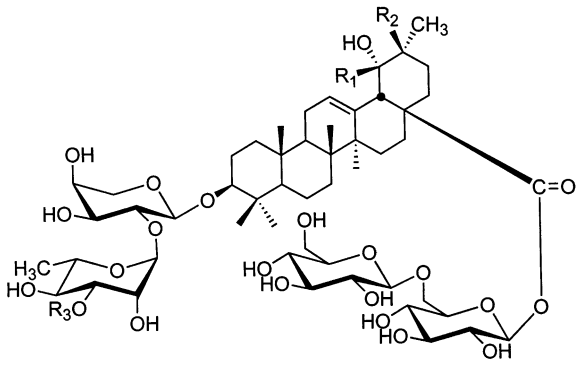
Scabiosaponin F (**6**) had a molecular formula of $C_{59}H_{96}O_{26}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. Five anomeric protons and carbons were displayed in its ^1H and ^{13}C NMR spectra. Acid hydrolysis afforded oleanolic acid and the component sugars L-rhamnose, D-xylose, and D-glucose (1:1:3). Complete ^1H and ^{13}C NMR assignments were furnished by a combination of 2D-NMR experiments. The spectral features indicated that compound **6** was closely related to **5**, in which a gentiobiose unit was linked to C-28 and a xylose attached directly to C-3 of the aglycon. As in **5**, the rhamnose was also linked to C-2 of the xylose, as indicated from the long-range coupling from an HMBC experiment. The remaining glucose was found linked to C-3 of the rhamnose. On the basis of the foregoing evidence, scabiosaponin F (**6**) was elucidated as 3-*O*-*β*-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-*β*-D-xylopyranosyloleanolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

Scabiosaponin G (**7**) had a molecular formula of $C_{65}H_{106}O_{31}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. ^1H and ^{13}C NMR spectra indicated that **7** possessed the same aglycon as **6** but differed in the sugar parts. Six sugar units were indicated, as there were six anomeric protons and carbons displayed in their ^1H and ^{13}C NMR spectra. Acid hydrolysis yielded oleanolic acid and D-xylose, L-rhamnose, and D-glucose (1:1:4). The linkage positions were established using the HMBC and NOESY correlations. As in compound **6**, **7** also contained a gentiobiose unit at C-28 and a xylose directly linked to C-3 of its aglycon. The xylose was substituted at C-2 by a rhamnose, which, in turn, was glycosylated by a glucose at its C-3 position. The C-4 of the glucose resonated at *δ* 81.8, indicating that the remaining glucose was connected to this position. Accordingly, scabiosaponin G (**7**) was elucidated as 3-*O*-*β*-D-glucopyranosyl-(1→4)-*β*-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-*β*-D-xylopyranosyloleanolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

Scabiosaponin H (**8**) had a molecular formula of $C_{65}H_{106}O_{32}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. The IR spectrum exhibited absorptions at 3399 cm^{-1} (−OH), 1731 cm^{-1} (ester carbonyl), and 1646 cm^{-1} (double bond). The seven tertiary methyl groups and one trisubstituted olefinic proton (*δ* 5.54, br s) observed in the ^1H NMR spectrum coupled with the information from the ^{13}C NMR spectrum (seven sp^3 carbons and two sp^2 olefinic carbons at *δ* 128.3 for C-12 and 139.3 for C-13) indicated that the aglycon possessed an urs-12-ene skeleton. From the chemical shifts of C-18 (*δ* 54.3) and C-22 (*δ* 37.8) of the aglycon, the C-30 methyl group was determined to be in α-orientation.[12] Furthermore, the strong NOE correlation between the C-29 methyl and H-18 (*β*-orientated) of the aglycon in the NOESY experiment (Figure 2) indicated the C-29 methyl group on the *β*-face. The C-19 resonated at *δ* 72.7, indicating this carbon was hydroxylated. Thus, the aglycon was identified as pomolic acid,[12] which was further confirmed after hydrolysis with cellulase and NMR analysis.[12] The chemical shifts of C-3 and C-28 revealed that **8** was a bisdesmosidic glycoside. Six sugar anomeric protons and carbons were displayed in its ^1H and ^{13}C NMR spectra. Acid hydrolysis afforded L-arabinose, L-rhamnose, and D-glucose (1:1:4). Detailed NMR analysis indicated that **8** also contained a gentiobiose unit at C-28 and an arabinose at C-3 of the aglycon. The arabinose was substituted at C-2 by a rhamnose, which, in turn, was glycoslyted by a glucose at its C-3 position. The C-4 of the glucose resonated at *δ* 81.8, indicating that the remaining glucose was connected to this position. Thus, scabiosaponin H (**8**) was elucidated as 3-*O*-*β*-D-glucopyranosyl-(1→4)-*β*-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosylpomolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

Scabiosaponin I (**9**) had a molecular formula of $C_{59}H_{96}O_{27}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. The overall structure assignment was made using the same protocol as for **8**. From its completely assigned NMR data, it was apparent that **9** possessed the same aglycon as **8** but differed in the sugar parts. Most of the C-13 resonances were the same except that the signals attributed to the terminal glucose in **8** disappeared. Hydrolysis of **9** with cellulase afforded the aglycon, identified as pomolic acid. The sugars were determined to be L-arabinose, L-rhamnose, and D-glucose (1:1:3) by HPLC analysis. The sequences of the sugar chains were further confirmed from the HMBC and NOESY correlations. On the basis of all the foregoing evidence, scabiosaponin I (**9**) was elucidated as 3-*O*-*β*-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyra-

nosylpomolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.



	R_1	R_2	R_3
8	CH3	H	Glc(1→4)Glc
9	CH3	H	Glc
10	H	CH3	Glc
11	H	CH3	Glc(1→4)Xyl

Scabiosaponin J (**10**) had a molecular formula of $C_{59}H_{96}O_{27}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. The IR spectrum exhibited absorptions at 3428 cm^{-1} (−OH), 1728 cm^{-1} (ester carbonyl), and 1646 cm^{-1} (double bond). The seven tertiary methyl groups and one trisubstituted olefinic proton observed in the ^1H NMR spectrum coupled with the information from the ^{13}C NMR spectrum (seven sp^3 carbons and two sp^2 olefinic carbons at δ 123.0 and 144.3) indicated that the aglycon possessed an olean-12-ene skeleton. After an extensive 2D NMR study, the aglycon was identified as siaresinolic acid.[13] Hydrolysis of **10** with cellulase yielded the aglycon, which showed NMR data identical to those of an authentic sample.[14] Acid hydrolysis of **10** afforded L-arabinose, L-rhamnose, and D-glucose (1:1:3) by HPLC analysis. The complete ^1H and ^{13}C NMR data assignment was achieved by a combination of 2D-NMR experiments. From its ^1H and ^{13}C NMR data, it was apparent that **10** possessed the same sugar structures as that in **9** (Tables 2 and 5). Thus, scabiosaponin J (**10**) was elucidated as 3-*O*-*β*-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosylsiaresinolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

Scabiosaponin K (**11**) had a molecular formula of $C_{64}H_{104}O_{31}$ determined from its positive ion HRFAB mass spectrum and from ^{13}C DEPT NMR data. Hydrolysis of **11** with cellulase afforded siaresinolic acid. Compound **11** possessed the same oligosaccharide chains as **1**, as indicated by the complete agreement of their ^1H and ^{13}C NMR data (Tables 2 and 5). Thus, scabiosaponin K (**11**) was established as 3-*O*-*β*-D-glucopyranosyl-(1→4)-*β*-D-xylopyranosyl-(1→3)-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosylsiaresinolic acid 28-*O*-*β*-D-glucopyranosyl-(1→6)-*β*-D-glucopyranoside.

Additionally, the previously reported compounds hookerosides A (**12**) and B (**13**)[15] were also isolated and identified by detailed NMR analyses.

According to the theory of traditional Chinese Medicine, *S. tschiliensis* has the ability to clear the "heat" from inside the body. Too much "heat" or rather energy accumulated inside the body could lead to obesity or other kinds of illnesses. On the basis of this notion, we decided to conduct a pancreatic lipase inhibitory test on the saponins isolated. It is well known that dietary fat is not directly absorbed from the intestine unless it has been subjected to the action of pancreatic lipase.[16] Pancreatic lipase is a key enzyme for lipid breakdown to absorb fatty acids. The inhibition of dietary fat absorption has been reported to be one effective way of managing obesity. Therefore, the application of a lipase inhibitor such as orlistat[17] has proven its usefulness for the treatment of obesity.

The pancreatic lipase inhibitory action of scabiosaponins A−J (**1**−**10**) and hookerosides A and B (**12**, **13**) was evaluated in an assay system using triolein emulsified with phosphatidylcholine. As shown in Figure 3, scabiosaponins E, F, G, and I (**5**, **6**, **7**, **9**) and hookerosides A and B (**12**, **13**) exhibited strong inhibitory activity on pancreatic lipase. Moreover, prosapogenin **1b** showed the strongest inhibitory activity against pancreatic lipase among the compounds tested (Figure 4). The inhibitory activity of prosapogenin **1b** against pancreatic lipase at 0.12 mg/mL was similar to that of orlistat at 0.005 mg/mL. Experiments are now in progress to clarify the antiobesity action of the pure saponins isolated from *S. tschiliensis* in mice fed a high-fat diet.

Experimental Section

General Experimental Procedures. Melting points were measured using a Yanaco microscope apparatus and are uncorrected. IR spectra were determined using a JASCO 300E FTIR spectrometer. Optical rotations were measured using a JASCO DIP-370 digital polarimeter. ^1H and ^{13}C NMR were recorded using a JEOL ECP-500 NMR spectrometer. Chemical shifts were expressed in δ (ppm) referring to TMS. MALDI-TOF MS and HRFABMS were conducted using a PerSeptive Biosystems Voyager DE-STR and JEOL JMS-700 mass spectrometer, respectively. Diaion HP-20 (ion-exchange resin, Mitsubishi Chemical Corporation, Tokyo, Japan), silica gel (silica gel 60, Merck), and ODS (Chromatorex 1020TM, 100−200 mesh, Fuji Sylisia Chemical, Ltd., Aichi, Japan) were used for column chromatography. Preparative HPLC was performed using ODS columns (PEGASIL ODS, Senshu Pak, 10 mm i.d. × 250 mm, Senshu Scientific Co., Ltd., Tokyo, Japan, and ODS-A, YMC-Pack, 20 mm i.d. × 250 mm, YMC Co., Ltd. Kyoto, Japan, detector, UV 210 nm). GLC, Shimadzu GC-7A; column, silicone OV-17 on Uniport HP (80−100 mesh), 3 mm i.d. × 2.1 m; column temperature, 122 °C; carrier gas, N_2; flow rate, 40 mL/min.

Plant Material. *Scabiosa tschiliensis* was collected from Kaiyuan City, Liaoning Province, People's Republic of China, in August 1999, and identified by Prof. C. Chen (Liaoning Normal University). A voucher specimen (TOHO-ST1999121) has been deposited at the Department of Pharmacognosy, Toho University.

Extraction and Isolation. The air-dried and finely cut whole plants of *S. tschiliensis* (4.8 kg) were extracted with MeOH three times under reflux for 2 h. The combined MeOH extracts were concentrated (760 g), suspended in H_2O, and then partitioned successively between *n*-hexane (85 g), EtOAc (71 g), and *n*-BuOH (270 g). The *n*-BuOH-soluble fraction was applied to a column of Diaion HP-20 and eluted with H_2O and 40, 60, 80, and 100% MeOH. The fractions eluted with 80% MeOH were combined and repeatedly chromatographed over silica gel, ODS open columns, and MPLC to give several saponin fractions. Further HPLC purification (50−68% MeOH in H_2O, UV detector, 210 nm) afforded **1** (250 mg), **2** (49 mg), **3** (28 mg), **4** (10.4 mg), **5** (25 mg), **6** (16 mg), **7** (12.5 mg), **8** (110 mg), **9** (120 mg), **10** (33 mg), **11** (6.8 mg), **12** (50 mg), and **13** (23 mg), respectively.

Scabiosaponin A (1): amorphous solid; mp 216−218 °C; $[\alpha]^{20}_D$ −6.6° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3419, 2935, 1742, 1066 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.42 (1H, br s, H-12), 3.29 (1H, dd, J = 11.7, 4.1 Hz, H-3), 3.20 (1H, dd, J = 13.5, 3.7 Hz, H-18), 1.27 (6H, s, H_3 of C-23, C-27), 1.14 (3H, s, H_3 of C-24), 1.10 (3H, s, H_3 of C-26), 0.90 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1−3; MALDI-TOF

Table 5. ^{1}H NMR Spectroscopic Data (δ) for the Sugar Moieties of **9**−**13** (500 MHz in pyridine-d_5)[a]

	9	**10**	**11**	**12**[b]	**13**[b]
3-*O*-sugar					
arabinose (xylose)					
1	4.82 d (5.9)	4.83 d (6.0)	4.87 d (6.0)	4.82 d (7.3)	4.81 d (7.1)
2	4.49 dd (11.5, 6.2)	4.50 dd (12.1, 6.0)	4.59 dd (10.0, 6.0)	4.20 m	4.19 dd (8.5, 7.7)
3	4.19 m	4.19 m	4.26 m	4.15 m	4.14 m
4	4.22 m	4.22 m	4.25 m	4.15 m	4.13 m
5	4.27 dd (8.3, 2.9)	4.28 dd (10.1, 3.7)	4.35 dd (11.2, 5.7)	4.33 dd (11.0, 4.8)	4.31 dd (11.0, 4.4)
	3.78 d (10.3)	3.80 d (10.1)	3.84 d (10.1)	3.69 d (11.0)	3.67 d (11.0)
rhamnose					
1	6.12 br s	6.15 d (1.2)	6.26 br s	6.51 br s	6.47 br s
2	4.95 m	4.95 br s	4.89 m	4.93 m	4.93 br s
3	4.78 dd (9.4, 2.9)	4.79 dd (9.3, 3.2)	4.68 dd (9.3, 3.0)	4.72 dd (9.3, 3.0)	4.71 m
4	4.47 m	4.46 d (9.3)	4.48 dd (9.4, 2.5)	4.48 dd (9.6, 2.5)	4.46 m
5	4.59 dq (9.4, 6.2)	4.61 dq (9.4, 6.2)	4.64 dq (9.3, 6.1)	4.74 dq (9.8, 6.2)	4.72 dq (9.4, 2.3)
6	1.54 d (5.9)	1.54 d (6.0)	1.55 d (6.2)	1.64 d (6.2)	1.63 d (6.2)
xylose					
1			5.28 d (7.8)	5.28 d (7.6)	5.26 d (7.6)
2			4.03 dd (8.4,8.0)	4.04 dd (8.1, 7.7)	4.02 dd (8.3, 8.2)
3			4.22 m	4.18 m	4.14 m
4			4.30 m	4.29 m	4.25 m
5			4.42 dd (10.7, 5.0)	4.40 dd (10.5, 5.0)	4.39 dd (11.5, 5.2)
			3.66 t (10.8)	3.66 t (10.5)	3.64 dd (11.5, 2.3)
glucose					
1	5.43 d (7.8)	5.44 d (7.8)	5.05 d (7.8)	5.02 d (7.8)	4.97 d (8.1)
2	4.08 m	4.08 m	4.04 dd (8.4, 8.0)	4.03 dd (8.1, 7.7)	4.00 dd (8.2, 8.0)
3	4.22 m	4.26 m	4.21 m	4.20 m	4.18 m
4	4.24 m	4.26 m	4.20 m	4.17 m	4.22 m
5	3.93 m	3.94 m	4.00 ddd (10.7, 5.7, 2.8)	3.96 m	3.88 m
6	4.43 m	4.44 dd (11.2, 2.3)	4.55 br s	4.52 dd (9.2, 6.0)	4.45 m
	4.32 m	4.36 dd (11.2, 4.8)	4.32 dd (8.7, 8.7)	4.29 m	4.33 dd (9.6, 4.4)
glucose′ (xylose′)					
1					5.05 d (7.7)
2					3.97 m
3					4.07 t (8.7)
4					4.13 m
5					4.23 dd (7.3, 5.2)
6					3.63 dd (7.3, 2.3)
28-*O*-sugar					
glucose (inner)					
1	6.21 d (8.0)	6.28 d (8.0)	6.32 d (8.3)	6.24 d (8.2)	6.21 d (8.2)
2	4.15 m	4.13 dd (8.2, 8.2)	4.15 dd (8.4, 8.3)	4.14 m	4.11 m
3	4.21 m	4.19 m	4.23 m	4.18 m	4.18 m
4	4.28 dd (8.3, 2.9)	4.30 m	4.35 dd (11.2, 5.7)	4.28 m	4.28 dd (9.2, 8.2)
5	4.13 m	4.10 m	4.13 ddd (13.7, 6.2, 2.2)	4.12 m	4.09 m
6	4.72 d (9.8)	4.68 d (11.2)	4.72 dd (9.6, 6.9)	4.70 dd (12.6, 2.3)	4.68 dd (9.6, 2.7)
	4.35 dd (9.8, 6.4)	4.34 dd (11.2, 4.8)	4.35 dd (9.6, 8.5)	4.34 dd (12.6, 4.3)	4.33 dd (9.6, 4.4)
glucose (terminal)					
1	5.05 d (7.6)	5.02 d (8.0)	5.04 d (7.6)	5.02 d (7.8)	5.00 d (7.8)
2	4.00 t (6.9)	3.98 t (6.6)	4.02 dd (8.4, 7.7)	4.02 dd (8.1, 7.7)	3.96 m
3	4.19 m	4.20 m	4.20 m	4.16 m	4.15 m
4	4.18 m	4.16 dd (8.2, 8.2)	4.23 m	4.18 m	4.16 m
5	3.91 m	3.88 m	3.90 ddd (10.7, 5.6, 2.5)	3.87 m	3.85 m
6	4.47 dd (11.2, 2.3)	4.45 dd (11.5, 2.3)	4.48 dd (9.4, 2.5)	4.45 d (9.8)	4.43 d (9.7)
	4.36 dd (11.2, 5.3)	4.35 dd (11.5, 5.1)	4.37 dd (9.6, 8.5)	4.32 dd (9.8, 4.3)	4.31 dd (11.0, 4.4)

[a] Assignment were based on DQF-COSY, TOCSY, DEPT, HETCOR, HMQC, HMQC-TOCSY, NOESY, and HMBC experiments. [b] Earlier assignments due to sugar moieties (ref 15) were corrected.

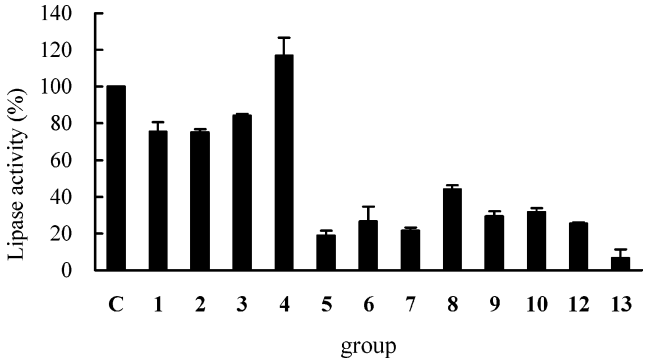


Figure 3. Effects of various saponins isolated from *Scabiosa tschiliensis* on pancreatic lipase activity. Results are expressed as means ± SEM of three experiments. (**C**: control; **1**−**10**: scabiosaponins A−J; **12**, **13**: hookerosides A, B; final concentration: 1 mg/mL).

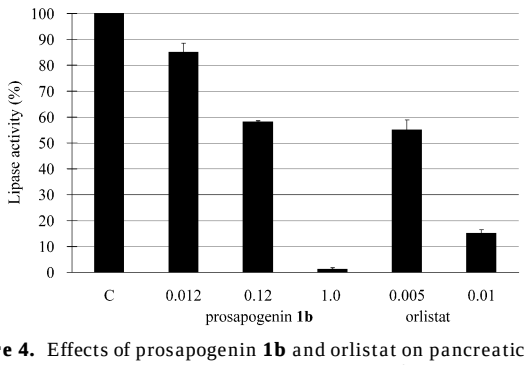


Figure 4. Effects of prosapogenin **1b** and orlistat on pancreatic lipase activity. Results are expressed as means ± SEM of three experiments. (C: control; final concentration: mg/mL).

MS (positive ion mode) *m*/*z* 1375 $[M + Na]^+$, 1391 $[M + K]^+$; HRFABMS (positive ion mode) *m*/*z* 1375.6511 $[M + Na]^+$ (calcd for $C_{64}H_{104}O_{30}$, 1375.6510).

Scabiosaponin B (2): amorphous solid; mp 230−231 °C; $[\alpha]^{25}_D$ −28.9° (*c* 0.30, MeOH); IR (KBr) ν_{max} 3422, 2929, 1737, 1638, 1047 cm^{-1}; ^{1}H NMR (pyridine-d_5, 500 MHz) δ 5.42 (1H, br s, H-12), 3.29 (1H, dd, J = 11.5, 4.2 Hz, H-3), 3.20 (1H, dd, J = 13.5, 3.9 Hz, H-18), 1.26 (6H, s, H_3 of C-23, C-27), 1.12 (3H, s, H_3 of C-24), 1.08 (3H, s, H_3 of C-26), 0.90 (9H, s, H_3 of

C-25, C-29, C-30); other NMR data, see Tables 1−3; HR-FABMS (positive ion mode) *m/z* 1507.6930 $[M + Na]^+$ (calcd for $C_{69}H_{112}O_{34}$, 1507.6933).

Scabiosaponin C (3): amorphous solid; mp 219−220 °C; $[\alpha]^{25}_D$ −19.3° (*c* 0.20, MeOH); IR (KBr) ν_{max} 3420, 2926, 1736, 1638, 1068 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.42 (1H, br s, H-12), 3.25 (1H, dd, *J* = 11.4, 3.9 Hz, H-3), 3.20 (1H, dd, *J* = 13.7, 3.6 Hz, H-18), 1.27 (6H, s, H_3 of C-23, C-27), 1.12 (3H, s, H_3 of C-24), 1.09 (3H, s, H_3 of C-26), 0.90 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1, 2, and 4; HRFABMS (positive ion mode) *m/z* 1537.6992 $[M + Na]^+$ (calcd for $C_{70}H_{114}O_{35}$, 1537.7038).

Scabiosaponin D (4): amorphous solid; mp 228−229 °C; $[\alpha]^{25}_D$ −11.8° (*c* 0.17, MeOH); IR (KBr) ν_{max} 3423, 2923,1743, 1646, 1247, 1030 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.42 (1H, br s, H-12), 3.22 (1H, H-3), 3.20 (1H, H-18), 1.25 (6H, s, H_3 of C-23, C-27), 1.17 (3H, s, H_3 of C-24), 1.10 (3H, s, H_3 of C-26), 0.90 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1, 2, and 4; HRFABMS (positive ion mode) *m/z* 1243.6066 $[M + Na]^+$ (calcd for $C_{59}H_{96}O_{26}$, 1243.6088).

Scabiosaponin E (5): amorphous solid; mp 208−210 °C; $[\alpha]^{20}_D$ −22.9° (*c* 0.56, MeOH); IR (KBr) ν_{max} 3295, 2945, 2745, 1353 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.41 (1H, br t, *J* = 3.3 Hz, H-12), 3.35 (1H, dd, *J* = 11.7, 4.1 Hz, H-3), 3.20 (1H, dd, *J* = 13.5, 3.9 Hz, H-18), 1.39 (3H, s, H_3 of C-23), 1.26 (3H, s, H_3 of C-27), 1.24 (3H, s, H_3 of C-24), 1.09 (3H, s, H_3 of C-26), 0.89 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1, 2, and 4; MALDI-TOF MS (positive ion mode) *m/z* 1213 $[M + Na]^+$, 1229 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1213.5944 $[M + Na]^+$ (calcd for $C_{58}H_{94}O_{25}$, 1213.5982).

Scabiosaponin F (6): amorphous solid; mp 218−219 °C; $[\alpha]^{25}_D$ −11.1° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3410, 2926, 1646, 1533, 1378, 1043 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.40 (1H, br s, H-12), 3.32 (1H, dd, *J* = 11.4, 4.1 Hz, H-3), 3.18 (1H, dd, *J* = 13.3, 3.2 Hz, H-18), 1.38 (3H, s, H_3 of C-23), 1.25 (3H, s, H_3 of C-27), 1.21 (3H, s, H_3 of C-24), 1.08 (3H, s, H_3 of C-26), 0.89 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1, 2, and 4; HRFABMS (positive ion mode) *m/z* 1243.6066 $[M + Na]^+$ (calcd for $C_{59}H_{96}O_{26}$, 1243.6088).

Scabiosaponin G (7): amorphous solid; mp 228−230 °C; $[\alpha]^{21}_D$ −20.3° (*c* 1.28, MeOH); IR (KBr) ν_{max} 3418, 2930,1736, 1643, 1380, 1058 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.41 (1H, br t-like, H-12), 3.33 (1H, dd, *J* = 11.7, 4.1 Hz, H-3), 3.20 (1H, dd, *J* = 13.8, 3.7 Hz, H-18), 1.37 (3H, s, H_3 of C-23), 1.26 (3H, s, H_3 of C-27), 1.23 (3H, s, H_3 of C-24), 1.09 (3H, s, H_3 of C-26), 0.89 (9H, s, H_3 of C-25, C-29, C-30); other NMR data, see Tables 1, 2, and 4; MALDI-TOF MS (positive ion mode) *m/z* 1405 $[M + Na]^+$, 1421 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1405.6616 $[M + Na]^+$ (calcd for $C_{65}H_{106}O_{31}$, 1405.6613).

Scabiosaponin H (8): amorphous solid; mp 230−232 °C; $[\alpha]^{20}_D$ −11.3° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3399, 2928, 1731, 1646, 1378, 1071 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.54 (1H, br s, H-12), 3.28 (1H, dd, *J* = 11.4, 3.9 Hz, H-3), 2.93 (1H, s, H-18), 1.33 (1H, m, H-20), 1.04 (3H, d, *J* = 6.4 Hz, H_3 of C-30), 1.70, 1.36, 1.29, 1.18, 1.16, 0.94 (each 3H, s, H_3 of C-27, C-29, C-23, C-26, C-24, C-25); other NMR data, see Tables 1, 2, and 4; MALDI-TOF MS (positive ion mode) *m/z* 1421 $[M + Na]^+$, 1437 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1421.6602 $[M + Na]^+$ (calcd for $C_{65}H_{106}O_{32}$, 1421.6565).

Scabiosaponin I (9): amorphous solid; mp 213−215 °C; $[\alpha]^{20}_D$ −15.0° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3429, 2928, 1730, 1070 cm^{-1} ; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.55 (1H, br s, H-12), 3.28 (1H, dd, *J* = 11.7, 4.1 Hz, H-3), 2.92 (1H, s, H-18), 1.36 (1H, m, H-20), 1.03 (3H, d, *J* = 6.6 Hz, H_3 of C-30), 1.69, 1.36, 1.30, 1.17, 1.14, 0.94 (each 3H, s, H_3 of C-27, C-29, C-23, C-26, C-24, C-25); other NMR data, see Tables 1, 2, and 5; MALDI-TOF MS (positive ion mode) *m/z* 1259 $[M + Na]^+$, 1275 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1259.6053 $[M + Na]^+$ (calcd for $C_{59}H_{96}O_{27}$, 1259.6036).

Scabiosaponin J (10): amorphous solid; mp 212−214 °C; $[\alpha]^{20}_D$ −6.5° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3429, 2934, 1729, 1646, 1066 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.50 (1H, s, H-12), 3.56 (1H, t-like, H-19), 3.53 (1H, br s, H-18), 3.28 (1H, dd, *J* = 11.7, 4.1 Hz, H-3), 1.63, 1.32, 1.15, 1.13, 1.13, 1.02, 0.91 (each 3H, s, H_3 of C-27, C-23, C-24, C-26, C-29, C-30, C-25); other NMR data, see Tables 1, 2, and 5; MALDI-TOF MS (positive ion mode) *m/z* 1259 $[M + Na]^+$, 1275 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1259.6016 $[M + Na]^+$ (calcd for $C_{59}H_{96}O_{27}$, 1259.6037).

Scabiosaponin K (11): amorphous solid; mp 220−222 °C; $[\alpha]^{20}_D$ −36.0° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3430, 2933, 1739, 1067 cm^{-1} ;^1H NMR (pyridine-d_5, 500 MHz) δ 5.51 (1H, br s, H-12), 3.57 (1H, t-like, H-19), 3.54 (1H, br s, H-18), 3.29 (1H, dd, *J* = 11.7, 4.1 Hz, H-3), 1.65, 1.28, 1.17, 1.02, 0.93 (each 3H, s, H_3 of C-27, C-23, C-24, C-30, C-25), 1.14 (6H, s, H_3 of C-26, C-29); other NMR data, see Tables 1, 2, and 5; MALDI-TOF MS (positive ion mode) *m/z* 1391 $[M + Na]^+$, 1407 $[M + K]^+$; HRFABMS (positive ion mode) *m/z* 1391.6508 $[M + Na]^+$ (calcd for $C_{64}H_{104}O_{31}$, 1391.6460).

Acid Hydrolysis and Determination of the Absolute Configuration of the Monosaccharides. A solution of **1** (10 mg) in 1 M HCl (dioxane−H_2O, 1:1, 2 mL) was heated at 100 °C for 2 h. After dioxane was removed, the solution was extracted with EtOAc (2 mL × 3). The extract was washed with H_2O, dried over $MgSO_4$, and evaporated to give oleanolic acid (3 mg). The H_2O layer was neutralized by passing through an ion-exchange resin (Amberlite MB-3) column and concentrated to furnish a monosaccharide residue. The sugar residue was dissolved in H_2O (1 mL), to which a solution of (*S*)-(−)-1-phenylethylamine (8 mg) and $Na[BH_3CN]$ (16 mg) in EtOH (1 mL) were added. The mixture was allowed to stand overnight, then acidified by addition of glacial HOAc acid (0.3 mL) and evaporated to dryness. The resulting solid was acetylated with Ac_2O anhydride (0.5 mL) in pyridine (0.3 mL) at 100 °C for 1 h. After co-distillation with toluene, H_2O (2 mL) was added to the residue, and the crude mixture was passed through a Sep-pak Plus C18 cartridge (Waters) and washed with H_2O−MeCN (4:1, 1:1, each 5 mL). The H_2O−MeCN (1:1) eluate contained a mixture of the 1-[(*S*)-*N*-acetyl-α-phenylethylamino]-1-deoxyalditol acetate derivatives of the monosaccharides, which were identified by co-HPLC analysis with standard sugars prepared under the same conditions. HPLC conditions: column, PEGASIL ODS, 4.6 × 150 mm; solvent, MeCN−H_2O (33:67); flow rate, 0.8 mL/min; detection, UV 230 nm; temperature, 40 °C. The derivatives of D-glucose, D-xylose, L-rhamnose, and L-arabinose were detected with retention time of 39.1, 26.4, 44.8, and 25.0 min, respectively. Sugars in compounds **2**−**11** were also identified by the same method.

Oleanolic acid: amorphous solid; mp 275−276 °C; $[\alpha]^{21}_D$ +82° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3456, 2940, 1696, 1036 cm^{-1}; spectral data consistent with literature values.[18]

Enzymatic Hydrolysis of Scabiosaponin A (1). 1 (16 mg) dissolved in 0.2 M acetate buffer (pH 4.0, 5 mL) was incubated with naringinase (Sigma Chemical Co., 32 mg). The reaction mixture was stirred at 40 °C for 10 h. Then a small amount of EtOH was added. After concentration, the residue was purified by silica gel column chromatography ($CHCl_3$−MeOH−H_2O, 10:5:1) to give prosapogenin **1a** (8 mg) and D-glucose. The prosapogenin **1c** (2 mg) was obtained when the incubation was prolonged for 2 weeks.

Prosapogenin (1a): amorphous solid; mp 198−200 °C; $[\alpha]^{20}_D$ −12.3° (*c* 0.78, MeOH); IR (KBr) ν_{max} 3415, 2938, 1729, 1068 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.44 (1H, br s, H-12), 3.31 (1H, dd, *J* = 11.7, 3.9 Hz, H-3), 3.22 (1H, dd, *J* = 13.3, 3.7 Hz, H-18), 1.33, 1.29, 1.19, 1.11, 0.93, 0.91, 0.89 (each 3H, s, H_3 of C-23, C-27, C-24, C-26, C-29, C-30, C-25); other NMR data, see Tables 1−3; MALDI-TOF MS (positive ion mode) *m/z* 1051 $[M + Na]^+$, 1067 $[M + K]^+$.

Absolute Configuration of the Glucose by HPLC. The glucose obtained from compound **1** was determined to be of D-type ($[\alpha]^{25}_D$ +37.8°, *c* 0.09, 24 h after dissolution in H_2O) in comparison with an authentic sample under the following HPLC conditions: pump, JASCO-980; detection, Shodex RI-71; column, Asahi Pak NH2P-50, 4.6 × 150 mm; solvent, MeCN−H_2O (75:25); flow rate, 1.0 mL/min; t_R, 11.2 min.

Prosapogenin (1c): amorphous solid; mp 249−252 °C; $[\alpha]^{16}_D$ +64.3° (*c* 0.20, MeOH); IR (KBr) ν_{max} 3427, 2939, 1701,

1650, 1459, 1380, 1074 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.48 (1H, t-like, H-12), 3.35 (1H, dd, J = 11.9, 4.3 Hz, H-3), 3.30 (1H, dd, J = 13.5, 3.7 Hz, H-18), 1.30, 1.28, 1.03, 1.00, 0.96, 0.95, 0.85 (each 3H, s, H_3 of C-23, C-27, C-24, C-26, C-29, C-30, C-25); other NMR data, see Tables 1−3; MALDI-TOF MS (positive ion mode) m/z 611 $[M + Na]^+$, 627 $[M + K]^+$.

Acid Hydrolysis of 1c. Compound **1c** (1 mg) was heated in 1 mL of 1 M HCl (dioxane−H_2O, 1:1) at 100 °C for 2 h. After dioxane was removed, the solution was extracted with EtOAc (2 mL × 3). The extract was washed with H_2O and then concentrated to give oleanolic acid. The monosaccharide portion was neutralized by passing through an ion-exchange resin (Amberlite MB-3) column, concentrated (dried overnight), then treated with 1-(trimethylsilyl)imidazole. The TMSi derivative of the monosaccharide was identified as arabinose by co-GLC analysis with standard arabinose.

Selective Cleavage of Ester−Glycoside Linkage of Scabiosaponin A (1). A solution of **1** (40 mg), anhydrous LiI (40 mg), and 2,6-lutidine (3 mL) in anhydrous MeOH (1 mL) was refluxed for 16 h at 140 °C. A solution of 50% EtOH (2 mL) was added to stop the reaction. The reaction mixture was deionized with Amberlite MB-3 resin and concentrated to dryness. The residue was chromatographed on Si gel [$CHCl_3$−MeOH−H_2O (25:10:1, 15:10:1)] to give prosapogenin **1b** (9 mg) and methyl gentiobiose (4 mg).

Prosapogenin (1b): amorphous solid; mp 214−216 °C; $[\alpha]^{20}_D$ −18.4° (*c* 0.37, MeOH); IR (KBr) ν_{max} 3430, 2936, 1695, 1379, 1074 cm^{-1}; ^1H NMR (pyridine-d_5, 500 MHz) δ 5.49 (1H, br s, H-12), 3.22 (1H, m, H-3), 3.22 (1H, m, H-18), 1.33, 1.30, 1.14, 1.03, 1.00, 0.95, 0.86 (each 3H, s, H_3 of C-23, C-27, C-24, C-30, C-26, C-29, C-25); other NMR data, see Tables 1−3; MALDI-TOF MS (positive ion mode) m/z 1051 $[M + Na]^+$, 1067 $[M + K]^+$.

Methylation of Methyl Gentibiose via Hakomori Method. Compound **1d** was identified as methyl gentiobiose through comparison of the permethyl ether and an authentic sample by GLC.[10,11]

Enzymatic Hydrolysis of 8 and 10. Compound **8** (20 mg) dissolved in EtOH−H_2O (1:9, 3 mL) and 0.01 M NaH_2PO_4 buffer (pH 4.0, 3 mL) was incubated with cellulase (35 mg, Tokyo Kasei) at 37 °C for 2 weeks. EtOH (2 mL) was added to stop the reaction, and the solution was concentrated to dryness. The residue was chromatographed on a silica gel column with $CHCl_3$−MeOH−H_2O (250:40:1) to afford pomolic acid (4 mg). Using the same method, **10** (10 mg) yielded siaresinolic acid (2 mg).

Pomolic acid: mp 298−300 °C; $[\alpha]^{20}_D$ +55.5° (*c* 0.85, THF); IR (KBr) ν_{max} 3400, 1690, 1045, 1025 cm^{-1}; MALDI-TOF MS (positive ion mode) m/z 495 $[M + Na]^+$; ^1H and ^{13}C NMR data consistent with literature values.[12]

Siaresinolic acid: mp 277−279 °C; $[\alpha]^{19}_D$ +33.3° (*c* 0.20, MeOH); IR (KBr) ν_{max} 3625, 1190, 1165 cm^{-1}; MALDI-TOF MS (positive ion mode) m/z 495 $[M + Na]^+$; ^1H and ^{13}C NMR data consistent with literature values.[14]

Measurement of Pancreatic Lipase Activity. Lipase activity was determined by measuring the rate of release of oleic acid from triolein. Briefly, a suspension of triolein (80 mg), phosphatidylcholine (10 mg), and taurocholic acid (5 mg) in 9 mL of 0.1 M *N*-tris(hydroxymethyl)methyl-2-aminoetheanesulfonic acid (TES) buffer (pH 7.0) containing 0.1 M NaCl was sonicated for 5 min. This sonicated substrate suspension (100 μL) was incubated with 50 μL (10 units) of pancreatic lipase and 100 μL of various sample solutions for 30 min at 37 °C in a final volume of 250 μL. The amount of released oleic acid was determined by the method of Zapf et al.[19] with a slight modification.[20] The incubation mixture was added to 3 mL aliquots of a 1:1 (v/v) mixture of $CHCl_3$ and *n*-heptane containing 2% (v/v) MeOH and extracted by shaking the tubes horizontally for 10 min in a shaker. The mixture was centrifuged at 2000*g* for 10 min, and the upper aqueous phase was removed by suction. A copper reagent (1 mL) was then added to the lower organic phase. The tube was shaken for 10 min, the mixture was centrifuged at 2000*g* for 10 min, and 0.5 mL of the upper organic phase, which contained copper salts of the extracted free fatty acids, was treated with 0.5 mL of 0.1% (w/v) bathocuproine in $CHCl_3$ containing 0.05% (w/v) 3(2)-*tert*-butyl-4-hydroxyanisole. The absorbance was then measured at 480 nm. Lipase activity was expressed as micromoles of oleic acid released per milliliter of reaction mixture per hour.

Acknowledgment. The authors are grateful to Dr. Zhonghua Jia (CAS) and Dr. Yangfang Su (Tianjin University, China) for their help and Dr. Y. Asada (Kitasato University, Japan) for HRFABMS measurements.

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NP0304722