Secoiridoid Glycosides from *Gentiana scabra*

Masao Kikuchi,* Rie Kakuda, Masafumi Kikuchi, and Yasunori Yaoita

Department of 2nd Analytical Chemistry, Tohoku Pharmaceutical University, 4-4-1 Komatsushima, Aoba-ku, Sendai, Miyagi 981-8558, Japan

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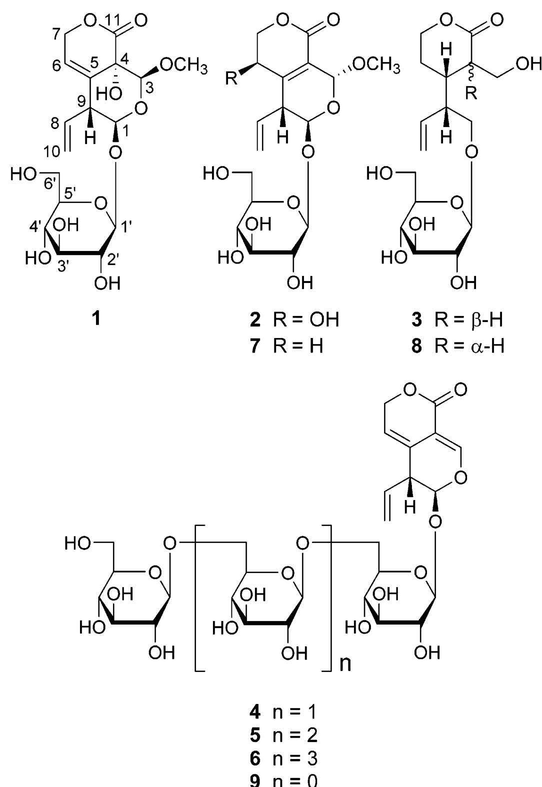
Six new secoiridoid glycosides, gentiascabraside A (**1**), 6β-hydroxyswertiajaposide A (**2**), 1-*O*-β-D-glucopyranosyl-4-epiamplexine (**3**), and scabrans G_3 (**4**), G_4 (**5**), and G_5 (**6**), have been isolated from the rhizomes and roots of *Gentiana scabra* together with a known compound, swertiajaposide A (**7**). The structures of the new compounds were determined by spectroscopic (NMR, MS) and chemical means.

The rhizomes and roots of *Gentiana scabra* Bunge (Gentianaceae) are the crude drug Gentianae Scabrae Radix, used as a stomachic or stimulant of appetite in Japan.[1] The constituents of this crude drug have been previously investigated and shown to contain secoiridoid glycosides.[1−3] It has been reported that several secoiridoid glycosides exhibit smooth muscle relaxing,[4] antibacterial,[5] free radical scavenging,[5] and choleretic activities.[6] In previous papers, we reported the isolation and structural elucidation of secoiridoid glycosides[7] and triterpenoids[8,9] from the rhizomes and roots of *G. scabra*. Here, we report the isolation and structure elucidation of six new secoiridoid glycosides, gentiascabraside A (**1**), 6β-hydroxyswertiajaposide A (**2**), 1-*O*-β-D-glucopyranosyl-4-epiamplexine (**3**), and scabrans G_3 (**4**), G_4 (**5**), and G_5 (**6**), together with a known compound **7** from the rhizomes and roots of *G. scabra*. Compound **7** was identified as swertiajaposide A by direct comparison with an authentic sample.[10]



* To whom correspondence should be addressed. Tel: +81-22-234-4181. Fax: +81-22-275-2013. E-mail: mkikuchi@tohoku-pharm.ac.jp.

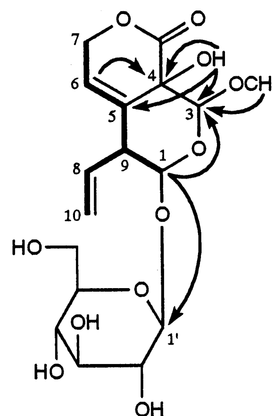


Figure 1. ^{1}H−^{1}H COSY (bold lines) and HMBC (arrows) correlations for **1**.

Results and Discussion

Gentiascabraside A (**1**) was obtained as an amorphous powder. Its molecular formula was determined as $C_{17}H_{24}O_{11}$ by HRFABMS. Acid hydrolysis of **1** gave D-glucose, which was confirmed by optical rotation using chiral detection by HPLC analysis. The ^{1}H NMR spectrum in DMSO-d_6 showed signals due to a methine [δ 3.27 (1H, m, H-9)], a methoxyl group [δ 3.51 (3H, s)], an oxymethylene [δ 4.79 (1H, dd, J = 12.5, 2.2 Hz, H-7a), 4.95 (1H, dd, J = 12.5, 2.2 Hz, H-7b)], two acetal methines [δ 4.88 (1H, s, H-3), 5.25 (1H, d, J = 7.0 Hz, H-1)], a terminal vinyl group [δ 5.15 (1H, dd, J = 16.9, 1.2 Hz, H-10a), 5.20 (1H, dd, J = 9.9, 1.2 Hz, H-10b), 5.76 (1H, ddd, J = 16.9, 9.9, 7.0 Hz, H-8)], a trisubstituted double bond [δ 5.99 (1H, dd, J = 2.2, 2.2 Hz, H-6)], and a hydroxyl proton [δ 6.58 (1H, s, OH-4)]. Furthermore, an anomeric proton signal [δ 4.56 (1H, d, J = 8.1 Hz, H-1′)] was recognized. The coupling constant of an anomeric proton indicated that the glycosyl linkage is of β-configuration. The ^{13}C NMR spectrum (DMSO-d_6) showed signals due to a β-D-glucopyranosyl group [δ 61.1 (C-6′), 70.0 (C-4′), 73.0 (C-2′), 76.7 (C-3′), 77.0 (C-5′), 97.9 (C-1′)] and a carbonyl group [δ 168.4 (C-11)]. By ^{1}H−^{1}H COSY and HMBC spectra, the planar structure of **1** was deduced to be as shown in Figure 1. Next, NOESY and difference ROE experiments were carried out on **1** in order to determine the stereochemistry of the molecule (Figure 2). In the NOESY spectrum (CD_3OD), cross-peaks were observed between H-1α and H-3α and between H-1′ and the methoxyl group at C-3, suggesting that the β-D-glucopyranosyl moiety at C-1 and the methoxyl group at C-3 occurred on the same face (β) of the ring system. In the difference ROE experiment (DMSO-d_6), irradiation at δ 6.58 (OH-4) produced ROE enhancement in the signal of

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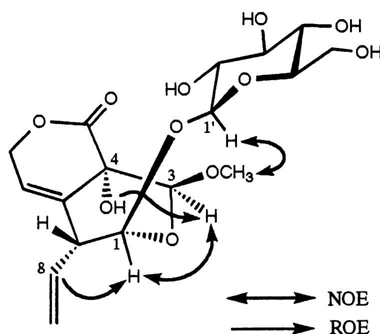

Figure 2. NOEs and ROEs of **1**.

H-3α (δ 4.88), whereas irradiation at δ 5.76 (H-8) caused ROE enhancement in the signal of H-1α (δ 5.25), establishing that the hydroxyl group at C-4 and the terminal vinyl group at C-9 were on the same face (α) of the ring system. From the above data, gentiascabraside A was elucidated to be as shown in formula **1**.

6β-Hydroxyswertiajaposide A (**2**) was obtained as an amorphous powder. Acid hydrolysis of **2** gave D-glucose in the above manner. Compound **2** showed a very similar signal pattern to that of **7** in the ^{13}C NMR spectrum. However, in contrast to **7**, one more oxygenated methine signal was observed instead of a methylene one. The molecular formula was determined as $C_{17}H_{24}O_{11}$ from HRFABMS. Consequently, **2** was deduced to be a compound in which the hydrogen in **7** was replaced by a hydroxyl group. The methylene carbon signal (δ 27.3) assignable to C-6 of **7** was shifted down to δ 61.8 in **2**, suggesting that an additional hydroxyl group was located at the C-6 position. This was confirmed by the $^{1}H-^{1}H$ COSY spectrum, in which a cross-peak was observed between H-6 and H_2-7. The configuration of the hydroxyl group at C-6 was determined to be β from the difference ROE experiment, in which irradiation at δ 5.78 (H-8) caused ROE enhancement in the signal of H-6α. Accordingly, 6β-hydroxyswertiajaposide A was characterized as **2**.

1-*O*-β-D-Glucopyranosyl-4-epiamplexine (**3**) had the molecular formula $C_{16}H_{26}O_9$ on the basis of HRFABMS. Acid hydrolysis of **3** gave D-glucose in the above manner. The ^{1}H and ^{13}C NMR data of **3** closely resembled those of 1-*O*-β-D-glucopyranosylamplexine (**8**)[11] except for some signals surrounding C-4. The $^{1}H-^{1}H$ COSY, HMQC, and HMBC data provided evidence of the same planar structure for **3** as that of **8**. The difference between **3** and **8** was traced to differences in the stereochemistry of the hydroxymethyl group at C-4. In the NOESY spectrum, a cross-peak was observed between H-4β and H-5β, and the configuration of the hydroxymethyl group at C-4 was determined to be α. Therefore, 1-*O*-β-D-glucopyranosyl-4-epiamplexine was a C-4 epimer of **8** as shown in formula **3**.

Scabran G_3 (**4**) was obtained as an amorphous powder. Its molecular formula was determined as $C_{28}H_{40}O_{19}$ by HRFABMS. The ^{13}C NMR spectrum of **4** was similar to that of 6′-*O*-β-D-glucopyranosylgentiopicroside (**9**) isolated from the same plant,[7] except for the presence of an additional hexosyl moiety and a difference in the chemical shift at the C-6″ position [δ 70.1 (+7.3 ppm)] due to glycosylation.[12] Acid hydrolysis of **4** gave only D-glucose in the above manner. In the ^{1}H NMR spectrum of **4**, three anomeric proton signals [δ 4.36 (1H, d, J = 7.8 Hz), 4.37 (1H, d, J = 7.8 Hz), and 4.67 (1H, d, J = 8.1 Hz)] were recognized. The coupling constants of three anomeric protons indicated that the glycosyl linkages are of β-configuration. These indicated that the additional β-D-glucopyranosyl moiety in **4** is attached to the hydroxyl group at C-6″ in **9**. Consequently, the structure of scabran G_3 was determined to be **4**.

Scabran G_4 (**5**) had the molecular formula $C_{34}H_{50}O_{24}$ on the basis of HRFABMS. The ^{13}C NMR spectrum of **5** was similar to that of **4**, except for the presence of an additional hexosyl group and a difference in the chemical shift at C-6‴ [δ 70.1 (+7.3 ppm)] due to glycosylation.[12] In the ^{1}H NMR spectrum of **5**, four anomeric proton signals [δ 4.37 (1H, d, J = 8.1 Hz), 4.38 (1H, d, J = 8.1 Hz), 4.40 (1H, d, J = 8.1 Hz), and 4.67 (1H, d, J = 8.1 Hz)] were recognized. Acid hydrolysis proved that four sugars in **5** are D-glucose in the above manner, and those linking forms were deduced to be β from the J value of those anomeric proton signals. Thus, scabran G_4 was elucidated to be as shown in formula **5**.

Scabran G_5 (**6**) was assigned the molecular formula $C_{40}H_{60}O_{29}$ using HRFABMS. The ^{13}C NMR spectrum of **6** was similar to that of **5**, except for the presence of an additional hexosyl moiety and a difference in the chemical shift at C-6⁗ [δ 70.0 (+7.2 ppm)] due to glycosylation.[12] In the ^{1}H NMR spectrum of **6**, five anomeric proton signals [δ 4.39 (1H, d, J = 8.1 Hz), 4.40 (1H, d, J = 8.1 Hz), 4.41 (1H, d, J = 8.1 Hz), 4.42 (1H, d, J = 8.1 Hz), and 4.68 (1H, d, J = 8.1 Hz)] were observed. Acid hydrolysis proved that five sugars in **6** are D-glucose. Therefore, scabran G_5 was characterized as **6**.

Experimental Section

General Experimental Procedures. ^{1}H (600 MHz) and ^{13}C (150 MHz) NMR spectra were recorded on a JEOL JNM-LA 600 spectrometer with TMS as internal standard. Optical rotations were determined using a JASCO DIP-360 digital polarimeter. UV spectra were recorded with a Beckman DU-64 spectrophotometer. HRFABMS (positive ion mode) were recorded on a JEOL JMS-DX 303 mass spectrometer, using a glycerin matrix. Column chromatography was carried out on Kieselgel 60 (230−400 mesh, Merck) and Diaion HP-20 (Mitsubishi-Chemical). HPLC was performed by using a system comprised of a CCPS pump (Tosoh), an RI-8020 detector (Tosoh), and a JASCO OR-2090 plus chiral detector.

Plant Material. The dried rhizomes and roots of *Gentiana scabra* (from Jilin, China) were purchased from Uchida Wakanyaku Co., Ltd., Tokyo, Japan, in 1999. A voucher specimen (1999-08) is deposited in the laboratory of Tohoku Pharmaceutical University.

Extraction and Isolation. Dried rhizomes and roots of *G. scabra* (1.5 kg) were extracted with MeOH at room temperature. The MeOH extract (160.0 g) was successively extracted with $CHCl_3$, EtOAc, *n*-BuOH, and H_2O. The H_2O-soluble fraction was passed through a Diaion HP-20 column, and absorbed material was eluted with H_2O and MeOH. The MeOH elute fraction was concentrated. The residue (35.0 g) was chromatographed on a silica gel column using $CHCl_3$−MeOH−H_2O (30:10:1), and the eluate was separated into 73 fractions. Fraction 10 was purified by preparative HPLC [column, TSKgel ODS-120T (7.8 mm i.d. × 30 cm, Tosoh); column temperature, 40 °C; mobile phase, MeOH−H_2O (1:8); flow rate, 1.0 mL/min; detection, RI] to give **1** (2.3 mg), **2** (1.7 mg), **3** (2.2 mg), and **7** (3.0 mg). Fraction 56 was purified by preparative HPLC [column, TSKgel Amide-80 (7.8 mm i.d. × 30 cm, Tosoh); column temperature, 40 °C; mobile phase, CH_3CN−H_2O (3:1); flow rate, 1.5 mL/min; detection, RI] to give **4** (0.8 mg), **5** (0.7 mg), and **6** (0.5 mg).

Gentiascabraside A (1): amorphous powder; $[\alpha]_D^{22}$ −9.1° (*c* 0.2, MeOH); ^{1}H NMR (DMSO-d_6, 600 MHz) δ 6.58 (1H, s, OH-4), 5.99 (1H, dd, J = 2.2, 2.2 Hz, H-6), 5.76 (1H, ddd, J = 16.9, 9.9, 7.0 Hz, H-8), 5.25 (1H, d, J = 7.0 Hz, H-1), 5.20 (1H, dd, J = 9.9, 1.2 Hz, H-10b), 5.15 (1H, dd, J = 16.9, 1.2 Hz, H-10a), 4.95 (1H, dd, J = 12.5, 2.2 Hz, H-7b), 4.88 (1H, s, H-3), 4.79 (1H, dd, J = 12.5, 2.2 Hz, H-7a), 4.56 (1H, d, J = 8.1 Hz,

H-1′), 3.51 (3H, s, OCH_3), 3.27 (1H, m, H-9); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 168.4 (C, C-11), 135.8 (CH, C-8), 132.3 (C, C-5), 124.2 (CH, C-6), 118.6 (CH_2, C-10), 100.5 (CH, C-3), 97.9 (CH, C-1′), 94.4 (CH, C-1), 77.0 (CH, C-5′), 76.7 (CH, C-3′), 73.0 (CH, C-2′), 70.0 (CH, C-4′), 67.5 (CH_2, C-7), 66.2 (C, C-4), 61.1 (CH_2, C-6′), 55.0 (CH_3, OCH_3), 46.9 (CH, C-9); HRFABMS (positive ion mode) *m/z* 405.1428 ($[M + H]^+$, calcd for $C_{17}H_{25}O_{11}$, 405.1397).

6*β*-Hydroxyswertiajaposide A (2): amorphous powder; $[\alpha]_D^{22}$ −88.1° (*c* 0.2, MeOH); UV (MeOH) λ_{max} (log ε) 212 (3.9) nm; ^{1}H NMR (CD_3OD, 600 MHz) δ 5.78 (1H, ddd, *J* = 16.9, 10.3, 8.8 Hz, H-8), 5.54 (1H, d, *J* = 1.2 Hz, H-3), 5.43 (1H, d, *J* = 4.1 Hz, H-1), 5.35 (1H, dd, *J* = 10.3, 1.5 Hz, H-10b), 5.33 (1H, ddd, *J* = 16.9, 1.5, 0.7 Hz, H-10a), 4.69 (1H, d, *J* = 7.8 Hz, H-1′), 4.44 (1H, dd, *J* = 12.7, 1.7 Hz, H-7b), 4.40 (1H, dd, *J* = 12.7, 2.7 Hz, H-7a), 4.14 (1H, dd, *J* = 2.7, 1.7 Hz, H-6), 3.87 (1H, dd, *J* = 12.0, 2.0 Hz, H-6′b), 3.66 (1H, dd, *J* = 12.0, 5.6 Hz, H-6′a), 3.51 (3H, s, OCH_3), 3.18 (1H, dd, *J* = 9.3, 8.1 Hz, H-2′); ^{13}C NMR (CD_3OD, 150 MHz) δ 163.3 (C, C-11), 153.0 (C, C-5), 134.6 (CH, C-8), 125.4 (C, C-4), 121.6 (CH_2, C-10), 99.2 (CH, C-1′), 99.5 (CH, C-3), 95.3 (CH, C-1), 78.5 (CH, C-5′), 78.0 (CH, C-3′), 74.7 (CH, C-2′), 73.4 (CH_2, C-7), 71.7 (CH, C-4′), 62.8 (CH_2, C-6′), 61.8 (CH, C-6), 56.7(CH_3, OCH_3), 46.8 (CH, C-9); HRFABMS (positive ion mode) *m/z* 427.1224 ($[M + Na]^+$, calcd for $C_{17}H_{24}O_{11}Na$, 427.1216).

1-*O*-*β*-D-Glucopyranosyl-4-epiamplexine (3): amorphous powder; $[\alpha]_D^{22}$ −42.8° (*c* 0.3, MeOH); ^{1}H NMR (CD_3OD, 600 MHz) δ 5.80 (1H, ddd, *J* = 17.3, 10.5, 7.6 Hz, H-8), 5.24 (1H, ddd, *J* = 17.3, 1.2, 1.2 Hz, H-10b), 5.16 (1H, dd, *J* = 11.5, 1.2 Hz, H-10a), 4.29 (1H, dd, *J* = 11.5, 6.1 Hz, H-1b), 4.24 (1H, d, *J* = 7.8 Hz, H-1′), 4.17 (1H, dd, *J* = 11.5, 10.5 Hz, H-1a), 3.97 (1H, dd, *J* = 11.5, 6.2 Hz, H-3b), 3.85 (1H, dd, *J* = 11.7, 1.8 Hz, H-6′b), 3.74 (1H, dd, *J* = 11.5, 7.0 Hz, H-3a), 3.67 (1H, dd, *J* = 11.0, 11.0 Hz, H-6′a), 3.00 (1H, dd, *J* = 7.0, 6.2 Hz, H-4), 2.75 (1H, m, H-9), 2.39 (1H, m, H-5), 1.86 (1H, m, H-6b), 1.47 (1H, m, H-6a); ^{13}C NMR (CD_3OD, 150 MHz) δ 176.2 (C, C-11), 138.3 (CH, C-8), 117.7 (CH_2, C-10), 104.3 (CH, C-1′), 78.1 (CH, C-5′), 78.0 (CH, C-3′), 75.1 (CH, C-2′), 71.7 (CH, C-4′), 70.9 (CH_2, C-1), 67.9 (CH_2, C-7), 62.9 (CH_2, C-6′), 59.9 (CH_2, C-3), 44.6 (CH, C-4), 43.3 (CH, C-9), 35.8 (CH, C-5), 31.6 (CH_2, C-6); HRFABMS (positive ion mode) *m/z* 363.1506 ($[M + H]^+$, calcd for $C_{16}H_{27}O_9$, 363.1655).

Scabran G_3 (4): amorphous powder; $[\alpha]_D^{22}$ −81.5° (*c* 0.5, MeOH); UV (MeOH) λ_{max} (log ε) 252 (3.8), 270 (3.9) nm; ^{1}H NMR (CD_3OD, 600 MHz) ^{1}H NMR (CD_3OD, 600 MHz) δ 7.45 (1H, d, *J* = 1.2 Hz, H-3), 5.77 (1H, ddd, *J* = 17.3, 10.5, 6.8 Hz, H-8), 5.64 (1H, d, *J* = 3.2 Hz, H-1), 5.61 (1H, m, H-6), 5.24 (1H, ddd, *J* = 17.3, 1.5, 1.5 Hz, H-10b), 5.23 (1H, ddd, *J* = 10.5, 1.5, 1.1 Hz, H-10a), 5.07 (1H, ddd, *J* = 17.6, 1.5, 1.2 Hz, H-7b), 5.00 (1H, ddd, *J* = 17.6, 3.4, 1.2 Hz, H-7a), 4.67 (1H, d, *J* = 8.1 Hz, H-1′), 4.37, 4.36 (each 1H, d, *J* = 7.8 Hz, H-1″, H-1‴), 4.16, 4.15 (each 1H, dd, *J* = 11.7, 2.0 Hz, H-6′b, H-6″b), 3.87 (1H, dd, *J* = 12.0, 2.0 Hz, H-6‴b), 3.77, 3.76 (each 1H, dd, *J* = 11.7, 5.6 Hz, H-6′a, H-6″a), 3.67 (1H, dd, *J* = 12.0, 5.4 Hz, H-6‴a); ^{13}C NMR (CD_3OD, 150 MHz) δ 166.4 (C, C-11), 150.9 (CH, C-3), 135.0 (CH, C-8), 127.2 (C, C-5), 118.8 (CH_2, C-10), 117.2 (CH, C-6), 105.2 (CH, C-1″), 105.0 (C, C-4), 104.9 (CH, C-1‴), 100.5 (CH, C-1′), 99.0 (CH, C-1), 78.1 (CH, C-3′, C-3″), 78.0 (CH, C-5‴), 77.9 (CH, C-3‴), 77.3, 77.1 (CH, C-5′, C-5″), 75.1 (CH, C-2″, C-2‴), 74.6 (CH, C-2′), 71.7 (CH, C-4′, C-4″), 71.6 (CH, C-4‴), 70.9 (CH_2, C-7), 70.6 (CH_2, C-6′), 70.1 (CH_2, C-6″), 62.8 (CH_2, C-6‴), 46.7 (CH, C-9); HRFABMS (positive ion mode) *m/z* 681.2259 ($[M + H]^+$, calcd for $C_{28}H_{41}O_{19}$, 681.2242).

Scabran G_4 (5): amorphous powder; $[\alpha]_D^{29}$ −58.7° (*c* 0.06, MeOH); UV (MeOH) λ_{max} (log ε) 252 (3.9), 270 (3.9) nm; ^{1}H NMR (CD_3OD, 600 MHz) δ 7.46 (1H, d, *J* = 1.1 Hz, H-3), 5.77 (1H, ddd, *J* = 17.3, 10.5, 6.8 Hz, H-8), 5.64 (1H, d, *J* = 2.9 Hz, H-1), 5.61 (1H, m, H-6), 5.24 (1H, ddd, *J* = 17.3, 1.5, 1.5 Hz, H-10b), 5.22 (1H, ddd, *J* = 10.5, 1.5, 1.1 Hz, H-10a), 5.07 (1H, ddd, *J* = 17.6, 1.5, 1.1 Hz, H-7b), 5.01 (1H, ddd, *J* = 17.6, 3.3, 1.1 Hz, H-7a), 4.68 (1H, d, *J* = 8.1 Hz, H-1′), 4.40, 4.38, 4.38 (each 1H, d, *J* = 8.1 Hz, H-1″, H-1‴, H-1⁗), 4.16 (3H, br d, *J* = 11.7 Hz, H-6′b, H-6″b, H-6‴b), 3.87 (1H, dd, *J* = 11.7, 2.2 Hz, H-6⁗b), 3.77 (3H, m, H-6′a, H-6″a, H-6‴a), 3.68 (1H, dd, *J* = 11.7, 5.5 Hz, H-6⁗a); ^{13}C NMR (CD_3OD, 150 MHz) δ 166.4 (C, C-11), 150.9 (CH, C-3), 135.0 (CH, C-8), 127.2 (C, C-5), 118.8 (CH_2, C-10), 117.2 (CH, C-6), 105.1 (CH, C-1″, C-1‴), 105.0 (C, C-4), 104.9 (CH, C-1⁗), 100.5 (CH, C-1′), 99.0 (CH, C-1), 78.0 (CH, C-3′, C-3″, C-3‴, C-5⁗), 77.9 (CH, C-3⁗), 77.2, 77.1, 77.0 (CH, C-5′, C-5″, C-5‴), 75.1 (CH, C-2″, C-2‴, C-2⁗), 74.6 (CH, C-2′), 71.7 (CH, C-4′, C-4″, C-4‴), 71.6 (CH, C-4⁗), 70.9 (CH_2, C-7), 70.7, 70.5 (CH_2, C-6′, C-6″), 70.1 (CH_2, C-6‴), 62.8 (CH_2, C-6⁗), 46.7 (CH, C-9); HRFABMS (positive ion mode) *m/z* 865.2588 ($[M + Na]^+$, calcd for $C_{34}H_{50}O_{24}Na$, 865.2590).

Scabran G_5 (6): amorphous powder; $[\alpha]_D^{29}$ −52.2° (*c* 0.1, MeOH); UV (MeOH) λ_{max} (log ε) 252 (3.8), 270 (3.9) nm; ^{1}H NMR (CD_3OD, 600 MHz) δ 7.47 (1H, d, *J* = 1.1 Hz, H-3), 5.77 (1H, ddd, *J* = 17.3, 10.5, 6.8 Hz, H-8), 5.64 (1H, d, *J* = 2.9 Hz, H-1), 5.61 (1H, m, H-6), 5.24 (1H, ddd, *J* = 17.3, 1.5, 1.5 Hz, H-10b), 5.22 (1H, ddd, *J* = 10.5, 1.5, 1.1 Hz, H-10a), 5.07 (1H, ddd, *J* = 17.6, 1.5, 1.1 Hz, H-7b), 5.00 (1H, ddd, *J* = 17.6, 3.3, 1.1 Hz, H-7a), 4.68 (1H, d, *J* = 8.1 Hz, H-1′), 4.42, 4.41, 4.40, 4.39 (each 1H, d, *J* = 8.1 Hz, H-1″, H-1‴, H-1⁗, H-1′′′′′), 4.17 (4H, br d, *J* = 11.4 Hz, H-6′b, H-6″b, H-6‴b, H-6⁗b), 3.88 (1H, dd, *J* = 12.1, 2.2 Hz, H-6′′′′′b), 3.79 (4H, m, H-6′a, H-6″a, H-6‴a, H-6⁗a), 3.69 (1H, dd, *J* = 12.1, 5.1 Hz, H-6′′′′′a); ^{13}C NMR (CD_3OD, 150 MHz) δ 166.5 (C, C-11), 150.9 (CH, C-3), 134.9 (CH, C-8), 127.0 (C, C-5), 118.8 (CH_2, C-10), 117.2 (CH, C-6), 105.0 (C, C-4), 104.9 (CH, C-1″, C-1‴, C-1⁗), 104.8 (CH, C-1′′′′′), 100.4 (CH, C-1′), 99.0 (CH, C-1), 77.9 (CH, C-3′, C-3″, C-3‴, C-3⁗, C-5′′′′′), 77.8 (CH, C-3′′′′′), 77.1, 77.0, 76.9, 76.8 (CH, C-5′, C-5″, C-5‴, C-5⁗), 75.0 (CH, C-2″, C-2‴, C-2⁗, C-2′′′′′), 74.4 (CH, C-2′), 71.6 (CH, C-4′, C-4″, C-4‴, C-4⁗), 71.5 (CH, C-4′′′′′), 70.9 (CH_2, C-7), 70.6, 70.5, 70.4 (CH_2, C-6′, C-6″, C-6‴), 70.0 (CH_2, C-6⁗), 62.6 (CH_2, C-6′′′′′), 46.6 (CH, C-9); HRFABMS (positive ion mode) *m/z* 1027.3116 ($[M + Na]^+$, calcd for $C_{40}H_{60}O_{29}Na$, 1027.3118).

Acid Hydrolysis of 1−6. Each of the compounds, **1** − **6** (ca. 0.3 mg), was refluxed with 5% HCl for 2 h. The reaction mixture was neutralized with Ag_2CO_3 and filtered. The solution was concentrated in vacuo and dried to give a sugar fraction. The sugar fraction was analyzed by HPLC under the following conditions: column, TSKgel Amide-80 (7.8 mm i.d. × 30 cm, Tosoh); column temperature, 45 °C; mobile phase, CH_3CN-H_2O (3:1); flow rate, 1.5 mL/min; chiral detection. Identification of D-glucose present in the sugar fraction was carried out by the comparison of its retention time and optical rotation with that of an authentic sample; t_R (min) 38.4 (D-glucose, positive optical rotation).

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References and Notes

(1) Ikeshiro, Y.; Tomita, Y. *Planta Med*. **1983**, *48*, 169−173.
(2) Inouye, H.; Nakamura, Y. *Yakugaku Zasshi* **1971**, *91*, 755−759.
(3) Ikeshiro, Y.; Mase, I.; Tomita, Y. *Planta Med*. **1990**, *56*, 101−103.
(4) Rojas, A.; Bah, M.; Rojas, J. I.; Gutierrez, D. M. *Planta Med*. **2000**, *66*, 765−767.
(5) Kumarasamy, Y.; Nahar, L.; Sarker, S. D. *Fitoterapia* **2003**, *74*, 151−154.
(6) Oeztuerk, N.; Herekman-Demir, T.; Oeztuerk, Y.; Bozan, B.; Baser, K. H. C. *Phytomedicine* **1998**, *5*, 283−288.
(7) Kakuda, R.; Iijima, T.; Yaoita, Y.; Machida, K.; Kikuchi, M. *J. Nat. Prod*. **2001**, *64*, 1574−1575.
(8) Kakuda, R.; Iijima, T.; Yaoita, Y.; Machida, K.; Kikuchi, M. *Phytochemistry* **2002**, *59*, 791−794.
(9) Kakuda, R.; Ueno, C.; Kobayashi, N.; Kikuchi, Masaf.; Yaoita, Y.; Kikuchi, M. *Nat. Med*. **2004**, *58*, 22−26.
(10) Kikuchi, M.; Kikuchi, M. *Chem. Pharm. Bull*. **2005**, *53*, 48−51.
(11) Rasoanaivo, P.; Nicoletti, M.; Multari, G.; Palazzino, G.; Galeffi, C. *Fitoterapia* **1994**, *65*, 38−43.
(12) Kasai, R.; Suzuo, M.; Asakawa, J.; Tanaka, O. *Tetrahedron Lett*. **1977**, 175−178.

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