Three Adducts of Butenolide and Apigenin Glycoside from the Leaves of *Machilus japonica*

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Chemical investigation of the EtOH extract of the leaves of *Machilus japonica* var. *kusanoi* resulted in the isolation of three compounds with a unique skeleton, i.e., apigenosylides A−C (**4**−**6**), together with five known flavonoid glycosides. Some of these compounds possess moderate inhibitory activity against α-glucosidase. The structures of the new compounds were elucidated on the basis of spectrometric analyses. They possess an unprecedented skeleton comprising the adduct of a butenolide moiety and apigenin glycoside linked via a 1,2-dioxane moiety.

Machilus japonica Sieb. & Zucc. var. *kusanoi* (Hayata) Liao (Lauraceae) is a large evergreen tree widely distributed in the broad-leafed forests from lowlands to an altitude of 1400 m throughout the Taiwan Island.[1] Past studies on its chemical constituents resulted in the isolation of two alkaloids, L-(−)-*N*-norarmepavine and *dl*-coclaurine.[2,3] Our recent screening of this plant indicated the EtOH extract of its leaves to be active against α-glucosidase, an enzyme that degrades saccharides. Bioactivity-directed screening for inhibitors of this specific enzyme would be an approach in developing lead compounds for hypoglycemic agents. Therefore, this work was aimed at exploring the active constituents of the leaves of the title plant by adopting this approach.

Results and Discussion

Bioassay-guided fractionation of the EtOH extract of the leaves of *M. japonica* indicated the BuOH-soluble fraction to be active against α-glucosidase with 84.5% inhibition at a concentration of 100 μg/mL. Further separation of this active fraction via gel filtration (Sephadex LH-20), centrifugal partition chromatography, and reversed-phase chromatography led to the isolation of eight compounds.

Compound **1** is an apigenin glycoside analogue, as evidenced by its ^{1}H NMR data, showing an AA′XX′ system (J = 8.9 Hz) for H-2′(6′) (δ 7.91) and H-3′(5′) (δ 7.22), an AX system (J = 2.1 Hz) for H-6 (δ 6.19) and H-8 (δ 6.43), a singlet for H-3 (δ 6.62), and an anomeric proton at δ 5.03 (d, J = 7.5 Hz). It was identified as apigenin 4′-β-*O*-D-glucopyranoside by comparison of its physical data with those reported.[4] Similar coupling patterns in the aromatic region were observed in the spectra of compounds **2** and **3** (Table 1S) except for the absence of signals from either H-6 or H-8, indicating both compounds to be a C-8- or C-6-substituted apigenin analogue. Both spectra also revealed signals for two anomeric protons (**2**: δ 5.21, brs and 4.94 d, J = 9.8 Hz; **3**: δ 5.09, d, J = 1.1 Hz and 5.02, d, J = 10.0 Hz) and one methyl doublet (**2**: δ 0.73, d, J = 6.1 Hz; **3**: δ 0.64, J = 6.1 Hz). The signals at δ 102.4 and 73.8 for **2** and at δ 102.4 and 73.7 for **3** (Table 2S) were assigned to anomeric carbons, on the basis of the ^{1}H/ ^{13}C shift correlations in their respective HMQC spectra. Accordingly, both compounds were *C*-glycosides that contain a rhamnosyl unit. They were identified as 2″-*O*-α-L-rhamnopyranosylisovitexin (**2**)[5] and 2″-*O*-α-L-rhamnopyranosylvitexin (**3**),[6] respectively, by comparison of their physical data ($[\alpha]_D$, UV, NMR, MS) with reported data. Similar comparisons identified compounds **7** and **8** as quercetin-3-*O*-β-D-galactoside[8] and quercetin-3-*O*-β-D-glucoside,[9] respectively.

Compound **4**, an amorphous solid, had a molecular formula of $C_{43}H_{54}O_{18}$, as deduced from the molecular ion peak in its HR-FABMS. Comparison of the ^{1}H NMR spectrum of **4** with that of **2** revealed almost identical signals in the aromatic region except for the absence of H-8, which was replaced by additional signals in the aliphatic region, comprised of two methine protons (δ 4.68, t, J = 8.1 Hz and 4.59, q, J = 6.7 Hz), a methyl group (δ 1.36, d, J = 6.7 Hz), and a long-chain alkyl group with the terminal methyl at δ 0.87 (t, J = 7.0 Hz). These additional signals suggested a structural moiety similar to those of a long-chain alkylated butenolide such as litsenolide C_1, occurring commonly in some Lauraceous plants.[10] Comparison of the ^{13}C NMR data of **4** (Table 1) and **2** (Table 2S) also supported the fact that **4** contained an apigenin skeleton and a *C*-diglycoside moiety, although the carbon chemical shifts in ring C were significantly different, attributable to the distinct substitutents in this ring. This was reflected in additional signals for a long-chain alkyl group and five distinct carbons: a lactonic (δ 181.4, s, C-11) and a ketonic (δ 191.4, s, C-13) carbonyl moiety, two oxygenated (δ 97.8, s, C-12; 77.1, d, C-14) carbons, and a methyl carbon (δ 18.1, q, C-15). The latter five signals, together with the ^{1}H NMR data at δ 4.59 (1H, q, C-14) and 1.36 (3H, d, C-15) (J = 6.7 Hz), suggested the presence of a 4-methyl-3-oxo-2-oxygenated butanolide moiety. This was further confirmed by the shift correlations in the HMBC spectrum of **4**: H-15/C-14, C-13 and H-14/C-11, C-13, C-15 (Table 1). A methine proton at δ 4.68 (t, J = 8.1 Hz) correlated with a carbon at δ 28.9 (d, C-16) in an HMQC spectrum, and the same proton was long-range coupled to the lactonic (C-11), ketonic (C-13), and oxygenated quaternary (δ 97.8, C-12) carbons in the butanolide moiety and to two methylene carbons (δ 31.6, C-17; 29.1, C-18) in the long-chain alkyl group, as observed in an HMBC spectrum (Table 1). Thus, this carbon (C-16) belonged to the alkyl side chain and should link to C-2 of the butanolide. Subtraction of the carbon numbers of these structure units, C_{15} for the apigenin, C_{12} for the *C*-glycone [L-α-rha(1→2)-D-β-glc], and C_5 for the 4-methylbutanolide, from the molecular formula ($C_{43}H_{54}O_{18}$) left a C_{11} unit for the long-chain alkyl group. These correlations and calculation thus established the structure of the 2-undecyl butanolide moiety as depicted in Figure 1. The NOESY spectrum of **4** as listed in Table 1 revealed the proximity of the methine proton (H-16, δ 4.68) to the lactonic proton (δ 4.59, H-14) and H-2′/H-6′ (δ 8.22, B-ring of apigenin), suggesting a *cis*-relationship for H-14 and H-16 and linkage of C-16 to C-8 of the apigenin skeleton. In addition, the HMBC spectrum showed correlation of H-16/C-7, C-8, C-9 besides those carbon signals (C-11, C-12, C-13, C17, and C-18) indicated above, and the glucosyl H-1″ was correlated with C-5, C-6, and C-7 of the apigenin moiety (Table 1). These HMBC data further confirmed the linkage of the diglycosyl moiety to C-6 and the alkylbutanolide to C-8 of the apigenin moiety. The ^{13}C NMR data indicated an oxygenated C-2 of the butanolide (i.e., C-12) (δ 97.8). If this carbon was hydroxylated, the molecular formula of **4** would have two hydrogen atoms more than the number obtained by HRFABMS ($C_{43}H_{54}O_{18}$). To rationalize the difference, C-7 and C-12 should be

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Table 1. ^{1}H and ^{13}C NMR Data of Compounds **4** and **6**,[a,b] and HMBC and NOESY Data of **4** (methanol-d_4, 400 MHz)

	4				**6**			**4**			**6**	
no.	δ_C m	δ_H m (*J*/Hz)	HMBC (C#)	NOESY	δ_C m	δ_H m (*J*/Hz)	no.	δ_C m	δ_H m (*J*/Hz)	HMBC (C#)[c]	NOESY[d]	δ_C m	δ_H m (*J*/Hz)
2	166.4 s				166.2 s		15	18.1 q	1.36 d (6.7)	13, 14	14	18.3 q	1.38 d (6.6)
3	102.8 d	6.57 s	2, 4,10, 1′	2′, 6′	103.2 d	6.64 s	16	28.9 d	4.68 t (8.1)	7, 8, 9, 11, 12, 13, 17, 18	2′/6′, 14,17	29.1 d	4.64 t (8.4)
4	184.7 s				184.5 s		17	31.6 t	2.10 m	16, 18	16, 18	31.5 t	1.9 m
5	160.1 s				160.8 s		1′	123.5 s				126.5 s	
6	112.9 s				103.2 d	6.22 s	2′,6′	130.3 d	8.22 d (8.8)	2, 4′	3,16,3′/5′	129.9 d	8.30 d (8.8)
7	165.8 s				166.2 s		3′,5′	117.0 d	6.95 d (8.8)	1′, 4′	2′/6′	118.0 d	7.28 d (8.8)
8	112.6 s				112.9 s		4′	162.7 s				162.0 s	
9	155.9 s				156.3 s		1″	74.3 d	5.18 d (9.9)	5, 6, 7, 2″, 3″	3″,5″	101.8 d	5.05 d (7.5)
10	104.9 s				105.3 s		2″	78.9 d	4.55 t-like (9.3)	6, 1″, 3″, 1‴	4″,1‴	74.8 d	3.52 m
11	181.4 s				181.0 s		3″	81.4 d	3.55 t-like (8.8)	2″, 4″	1″,5″	78.0 d	3.44 m
12	97.8 s				97.6 s		4″	72.1 d	3.44 t-like (9.1)	3″, 5″, 6″		71.2 d	3.65 m
13	191.3 s				191.3 s		5″	82.4 d	3.38 m		1″	78.2 d	3.5 m
14	77.1 d	4.60 q (7.0)	11, 13, 15	15, 16	77.3 d	4.50 q (7.0)	6″a	63.1 t	3.72 dd (5.4, 12.0)	4″		62.4 t	3.75 dd (5.1, 12.0)
							6″b		3.86 m				3.88 m

[a] ^{1}H and ^{13}C NMR data for the rhamnosyl group in **4**: δ_H 5.08 (brs, H-1‴), 3.85 (brs, H-2‴), 3.44 (brd, *J* = 9.1 Hz, H-3‴); 3.01 (t-like, *J* = 9.6 Hz, H-4‴), 2.68 (m, H-5‴), 0.51 (d, *J* = 6.0 Hz, H-6‴); δ_C 102.8 (d, C-1‴), 72.6 (d, C-2‴), 72.1 (d, C-3‴), 73.9 (d, C-4‴), 70.0 (d, C-5‴), 17.9 (q, C-6‴). [b] ^{1}H and ^{13}C NMR data for part of the alkyl side chain in **4** and **6**: δ_H 1.20 (m, H-18−24), 1.27 (m, H-25), 0.87 (t, *J* = 7.0 Hz, H-26); δ_C 29.1 (t, C-18), 33.1 (t, C-24), 23.7 (t, C-25), 14.4 (q, C-26); 30.0 (t), 30.4 (t), 30.6 (t), 30.64 (t), 30.7 (t) (C-19−C-23). [c] Other HMBC for **4**: H-1‴ (rha H-1) to C-2″, C-3‴, and C-5‴; H-2‴ to C-4‴; H-4‴ to C-3‴, C-5‴, and C-6‴; H-6‴ to C-4‴ and C-5‴; H-26 to C-24 and C-25. [d] Other NOESY for **4**: H-25 to H-26; H-1‴ (rha H-1) to H-2″ and H-2‴; H-2‴ to H-1‴; H-4‴ to H-6‴; H-5‴ to H-3‴ and H-6.

Figure 1. Structures of compounds **1**−**6**.

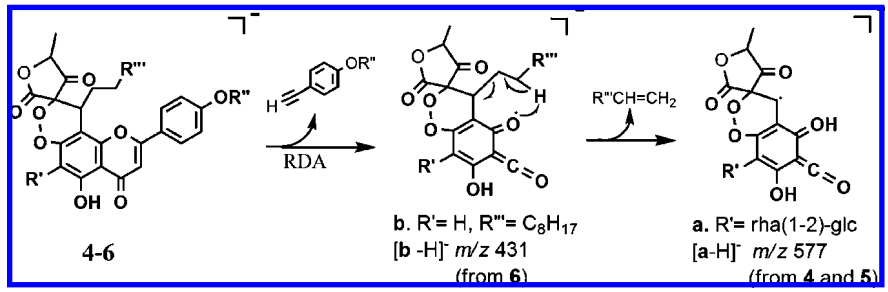
linked by a peroxide, which together with C-8 and C-16 constituted a 1,2-dioxane ring. Accordingly, the structure of **4** was established (Figure 1), leaving the configuration at C-12, C-14, and C-16 to be defined.

Compound **5**, isolated as an amorphous solid, had a molecular formula of $C_{41}H_{50}O_{18}$, as deduced from HRFABMS, which was a C_2H_4 unit less than **4**. The ^{1}H and ^{13}C NMR spectra of compound **4** and **5** were almost superimposable and differed only in the number of protons resonating around δ 1.25 (Tables 1 and 1S). Therefore, compound **5** was a homologue of **4** and possessed a nonyl (C_9) side chain (Figure 1). Further analysis of the 2D NMR spectra of **5**, whose NOESY and HMBC correlations are depicted in Figure 1S, also confirmed this suggestion.

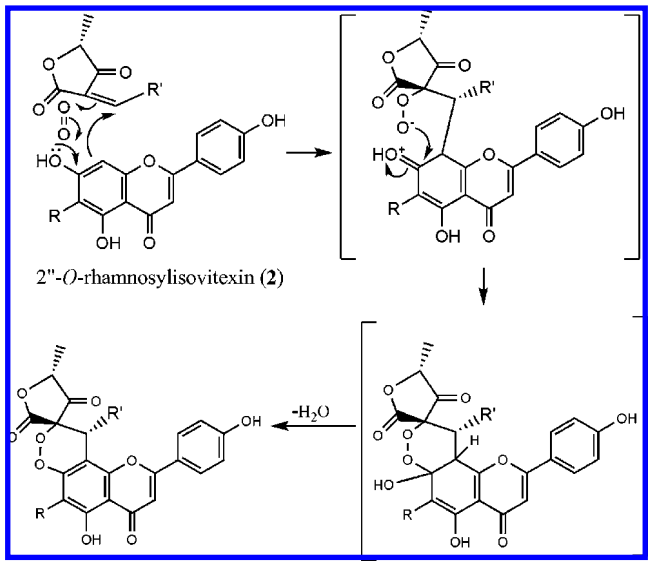
Compound **6**, isolated as a yellowish solid, had a molecular formula of $C_{37}H_{44}O_{14}$, as deduced from HRFABMS, which was 146 Da fewer than **4**, corresponding to the absence of a rhamnosyl moiety. The ^{1}H NMR spectrum of **6** was similar to that of **4** except for the absence of the characteristic signals for a rhamnosyl residue and the presence of an additional singlet in the aromatic region (δ 6.22, 1H). Compound **6** contained an *O*-β-D-glucopyranosyl residue, as exemplified by the almost identical ^{1}H and ^{13}C NMR data (Table 1) to those in the corresponding residue in **1** (Tables 1S and 2S). This β-glucosyl moiety was linked to the oxygen at C-4′, as evidenced by the observation of a correlation between its anomeric H-1 (δ 5.50) and C-4′ (δ 162.0) in the HMBC spectrum (Figure 2S). Since the NOE correlations of H-16 (δ 4.64) to H-14 (δ 4.50) and H-2′/ H-6′ (δ 8.30) (Figure 2S) were also observed, the linkage of the undecylbutanolide to the flavone and the orientation of H-14 and H-16 were the same as those in **4**. By elimination, the aromatic singlet at δ 6.22 was assigned to H-6. The correlation of this signal and that of H-16 with those of C-7 (δ 166.2) and C-8 (δ 112.9) in the HMBC spectrum (Figure 2S) supported this assignment. Accordingly, the structure of **6** was established (Figure 1), leaving the stereochemistry to be determined.

The CD curves of the positional isomers **2** and **3** showed distinct Cotton effects (CE) around 265 nm, (+)-CE for **2** and (−)-CE for **3**, typical for 6-*C*-D-β-glycosylflavones and 8-*C*-D-β-glycosylflavones, respectively.[11] The CD spectrum of the 8-monosubstituted flavone **6** showed a (+)-CE at 276 nm. Hence the chirality at the C-16 of **6** was assumed to be *R*, opposite that of the glucose C-1 in **3** (*S*). Gaffield et al.[11] have reported a positive exciton-like coupling for 6,8-di-*C*-D-β-glycosylflavones possessing *S*- chiralty at both anomeric carbons, by showing a (+)-CE around 270 nm and a (−)-CE around 250 nm. The CD spectra of the 6,8-disubstituted **4** and **5** showed two large Cotton effects around 280 nm (−) and 250 nm (+), which were opposite in shape of those of 6,8-di-*C*-glycosylflavones. Hence, the configuration at one of the benzylic positions (C-1″ and C-16) in **4** and **5** should be different from that in 6,8-di-*C*-glycosylflavones. Compounds **4** and **5** are analogues of **2**, and they were isolated from the same plant. Therefore, these two compounds are assumed to possess an identical *C*-D-β-glycosyl moiety to **2**. Since the configuration of the β-D-glucose C-1 (C-1″) is *S*, we assigned an *R*-configuration to C-16. If **4** and **5** are formed via the pericyclization mechanism shown in Scheme 2, the C-16/H-16 and the C-11/C-12 bond should point

Scheme 1. Major ESIMS (negative) Fragmentation Pathways of Compounds **4**−**6**



Scheme 2. Plausible Biosynthesis Pathway to Apigenosylides A and B (**4** and **5**)



upward, and the C-12/O-12 and the C-8/C-16 bond are oriented as depicted in Figure 1; that is, C-12 has an *S*-configuration.[12a,b] As indicated above, H-14 and H-16 are *cis*-oriented. Thus, the configuration at C-14 is assigned *R*, which is consistent with the configuration observed for alkylbutenolides isolated from Lauraceous plants such as 3-epilitsenolide D_2 from *Alseodaphne andersonii*[13] and litsenolide C_1 from *Litsea akoensis*.[10] The conformation of **4** with minimized energy calculated by the MM2 program indicated the spatial distance from H-16 to H-2′ (H-6′) and from H-16 to H-14 to be 3.554 and 3.424 Å (Figure 3S), respectively, accounting for the significant NOE observed in the NOESY spectrum. Final confirmation of the absolute configuration would require X-ray diffraction studies. Attempts to recrystallize **4**−**6** from various solvent systems, however, were not successful.

Complete ^{1}H and ^{13}C NMR assignments for **4**−**6** were made by the analysis of their 2D NMR spectra and are listed in Tables 1, 1S, and 2S. The mass spectra showed major fragment ions at *m/z* 577 ([**a** − H]$^-$) from **4** and **5** and 431 ([**b**− H]$^-$) from **6**, due to typical RDA cleavage of flavones and benzylic cleavage assisted by a carbonyl radical (Scheme 1). These data are supportive of the presence of a 1,2-dioxane skeleton and the established structures.

Compounds **4**−**6**, named apigenosylide A−C, are adducts of 2-alkylbutenolides and flavone glycosides. Their skeleton could be formed via a [2+2]-pericyclization with the involvement of one oxygen molecule[14] (Scheme 2). This mechanism also accounts for the orientation of the C-16 substituent, i.e., the alkyl side chain, and the γ-lactone moiety as shown in Figure 1.

The compounds were assayed against α-glucosidase type IV from *Bacillus stearothermophilus*.[15] Compounds **1**, **5**, and **6** exhibited inhibitory activity of 18.7, 93.7, and 64.7%, respectively, at a concentration of 100 μg/mL, but did not show any activity at the 10 μg/mL level. Since the alkylbutenolide litsenolide C_1 had been demonstrated to possess cytotoxic activity,[10] apigenosylide A (**4**) was tested against the PC-3 cell line. However, its IC_{50} value was found to be higher than 30 μg/mL.

Experimental Section

General Experimental Procedures. IR spectra (KBr disk) were recorded using a Jasco Fourier Transform infrared spectrometer (Jasco FT/IR-410). Optical rotations (MeOH) were recorded using a JASCO DIP-370 polarimeter. UV spectra were measured in MeOH using a Hitachi 150-20 double beam spectrophotometer. ^{1}H, ^{13}C, and 2D NMR spectra were obtained on a Bruker AV400 spectrometer (methanol-d_4, δ_H 3.30 and δ_C 49.0 ppm) using standard pulse programs. HPLC (Agilent 1100 system) separation was performed on an RP-18 column (Phenomenex_ Prodigy ODS-3, 250 × 10 mm, 5 μm). MS data were measured on an Esquire 2000 ion trap mass spectrometer (Bruker Daltonik) with an electrospray ion source. HRFAB mass data were measured using a JEOL JMS-700 (Japan) mass spectrometer. TLC analyses were carried out on silica gel plates (KG_{60}-F254, Merck). Centrifugal partition chromatography (CPC) was carried out on a Sanki CPC (model LLB-M, 110 mL). The microplate spectrophotometer SPECTRAmax_ PLUS (Molecular Devices, USA) was used for visualization.

Plant Material. The leaves of *Machilus japonica* were collected in September 2005, in Fu-Shan botanical garden, Ilan County, Taiwan. A specimen was authenticated by Mr. Jer-Tone Lin, Associate Researcher, Taiwan Forestry Research Institute. A voucher specimen (NTU09B2005) was stored in the herbarium of the School of Pharmacy, National Taiwan University.

Extraction and Isolation. The powdered, dry leaves (636 g) were percolated with EtOH (95%, 3.5 L × 4) at room temperature and then extracted with hot EtOH (95%, 3 L) to give the EtOH extract (100.0 g). A suspension of this extract in H_2O (700 mL) was partitioned between CH_2Cl_2 (700 mL × 3), EtOAc (700 mL × 1), and *n*-BuOH (700 mL × 3) to give fractions soluble in CH_2Cl_2 (24.0 g), EtOAc (26.1 g), and *n*-BuOH (20.3 g).

The *n*-BuOH-soluble fraction (9.5 g) was fractionated on a Sephadex LH-20 column (2.56 L, MeOH) to give eight fractions, analyzed by silica gel TLC. Further fractionation of fr.-2 (276 mg) on a Sephadex LH-20 column (276 mL, MeOH−H_2O, 3:1) gave three subfractions. Subfr.-2 (179 mg) was chromatographed over an RP-18 Lobar column (type B, Merck) eluted with 28−50% MeOH in H_2O, flow rate 2.5 mL/min, to give **2** (84.7 mg) and **3** (68.4 mg). Fr.-4 (350 mg) was chromatographed over an RP-18 Lobar column (type B) eluted with 70% MeOH and MeOH, flow rate 1 mL/min, to give three subfractions, of which subfr.-2 (22.9 mg) and subfr.-3 (104 mg) were chromatographed over a semipreparative RP-18 column [Prodigy ODS(3) 100A, 5 μm, 10 × 250 mm], eluted with 35% and 38% MeCN−0.1%TFA, respectively, flow rate 3 mL/min, to give **4** (12.1 mg) (from subfr.-3) and **5** (4.2 mg) (from subfr.-2). Fr.-6 (320 mg) was further separated via a CPC using the lower layer of $CHCl_3$−MeOH−H_2O−*n*-PrOH (9:12:8:1) as mobile phase, flow rate 1.5 mL/min, to give four subfractions. Subfr.-4 was compound **1** (6.7 mg, yellow solid). Subfr.-2 yielded **6** (4.7 mg) after purification on two successive Sephadex LH-20 columns (250 mL, MeOH−H_2O, 1:1; 60 mL, MeOH−H_2O, 3:1). Fr.-7 (320 mg) was fractionated on a Sephadex LH-20 column (250 mL, MeOH−H_2O, 9:1), followed by CPC using the same conditions as shown above to give two subfractions. Subfr.-2 (20.2 mg) was chromatographed over a semipreparative RP-18 column, eluted with MeOH−MeCN−H_2O (20:3:77), flow rate 2.4 mL/min, to yield **7** (2.6 mg) and **8** (1.7 mg) as yellow solids.

Apigenosylide A (4): yellow solid; $[\alpha]^{27}_D$ +60 (*c* 0.2, MeOH); IR (KBr) ν_{max} 3394, 2925, 2854, 1648, 1606, 1570, 1456, 1365, 1286, 1248, 1178, 1041, 837 cm^{-1}; UV (MeOH) λ_{max} (log ε) 341.0 (4.25), 260.5 (4.35), 219.5 (4.47) nm; CD (MeOH, *c* 1.16 × 10^{-5} M), $[\theta]_{249}$ +39 375, $[\theta]_{279}$ −48 324, $[\theta]_{312}$ +10 177; ^{1}H and ^{13}C NMR, HMBC, and NOESY data, see Table 1; $^-$ESIMS *m/z* (rel int %) *m/z* 857.4 (100, [M − H]$^-$), 577.2 (60, [**a** − H]$^-$); HRFABMS *m/z* 859.3385 [M + H]$^+$ (calcd for $C_{43}H_{54}O_{18}$+H, 859.3388).

Apigenosylide B (5): yellow solid; $[\alpha]^{27}_D$ +55 (*c* 0.2, MeOH); IR (KBr) ν_{max} 3393 (brs, OH), 2927, 2855, 1648, 1606, 1574, 1456, 1364, 1286, 1244, 1205, 1179, 1042, 838 cm^{-1}; UV (MeOH) λ_{max} (log ε) 341.0 (4.18), 261.0 (4.32), 216.5 (4.49) nm; CD (MeOH, *c* 1.20 × 10^{-5} M) $[\theta]_{249}$ +34 602, $[\theta]_{280}$ −34 173, $[\theta]_{304}$ +10 560; ^{1}H and ^{13}C NMR data, see Tables 1S and 2S; HMBC and NOESY, see Figure 1S; $^-$ESIMS *m/z* (rel int %) *m/z* 829.3 (100, [M − H]$^-$), 577.2 (94, [**a** − H]$^-$); HRFABMS *m/z* 830.2994 [M]$^+$ (calcd for $C_{41}H_{50}O_{18}$, 830.2997).

Apigenosylide C (6): yellow solid; $[\alpha]^{27}_D$ −25 (*c* 0.2, MeOH); IR (KBr) ν_{max} cm^{-1} 3418 (brs, OH), 2923, 2852, 1650, 1605, 1507, 1361, 1237, 1184, 1073, 833; UV (MeOH) λ_{max} (log ε) 341.0 (4.47), 277.0 (4.37), 259.5 (4.14) nm; CD (MeOH, *c* 1.40 × 10^{-5} M) $[\theta]_{226}$ +4020, $[\theta]_{250}$ −7019, $[\theta]_{276}$ +13 925, $[\theta]_{314}$ −1395; ^{1}H and ^{13}C NMR data, see Table 1; NOESY and HMBC, see Figure 2S; $^-$ESIMS *m/z* (rel int %) *m/z* 711.3 (100, [M − H]$^-$), 430.8 (89, [**b** − H]$^-$); HRFABMS *m/z* 712.2728 [M]$^+$ (calcd for $C_{37}H_{44}O_{14}$, 712.2731).

Additional data for 2″-L-α-rhamnosylisovitexin (2): CD (MeOH, *c* 1.40 × 10^{-5} M) $[\theta]_{222}$ −3076, $[\theta]_{265}$ +6936, $[\theta]_{329}$ −1748.

Additional data for 2″-L-α-rhamnosylvitexin (3): CD (MeOH, *c* 1.40 × 10^{-5} M) $[\theta]_{220}$ +27 739, $[\theta]_{268}$ −13 073, $[\theta]_{303}$ +4944.

Assay for α-Glucosidase Activity. Compounds **1**−**6** were dissolved in 10% MeOH, and their inhibitory activities against α-glucosidase (type IV from *Bacillus stearothermophilus*, Sigma-Aldrich Co., Germany) were measured following the reported procedure.[15] The positive control was Acarbose (Bayer), which was found to have an IC_{50} value of 33 nM against the same enzyme.

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Supporting Information Available: UV data of **2** and **3**, ^{1}H (Table 1S) and ^{13}C NMR (Table 2S) data of compounds **1**−**3** and **5**, HMBC and NOESY correlations of **5** and **6** (Figures 1S and 2S), and minimized energy conformation of **4** (Figure 3S) are available free of charge via the Internet at http://pubs.acs.org.

References and Notes

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