Two New Glycosidic Acids, Quamoclinic Acids G and H, of the Resin Glycosides (Convolvulin) from the Seeds of *Quamoclit pennata*

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Two new glycosidic acids, quamoclinic acids G and H, were isolated from the glycosidic acid fraction afforded by alkaline hydrolysis of the ether-insoluble resin glycoside (convolvulin) fraction from the seeds of *Quamoclit pennata* BOJER. Both compounds are the first examples of bisdesmosides of glycosidic acid having the sugar linkages at C-3 of 3,11-dihydroxytetradecanoic acid (ipurolic acid) as well as at its C-11.

Key words resin glycoside; convolvulin; *Quamoclit pennata*; Convolvulaceae; glycosidic acid; bisdesmoside

The so-called resin glycosides are well known as purgative ingredients and can be roughly divided into an ether-soluble resin glycoside called jalapin and an ether-insoluble one called convolvulin.[1)] Almost all jalapins hitherto isolated and characterized had common intramolecular macrocyclic ester structures composed of one mol of glycosidic acids partially acylated by some organic acids at the sugar moiety; only six examples were ester-type dimmers.[2—4)] On the other hand, convolvulin is regarded as an oligomer of a variety of acylated glycosidic acids.[2,5)] However, no pure convolvulin has thus far been isolated, and chemical investigations of the component organic and glycosidic acids formed by alkaline hydrolysis of their mixtures have been carried out to obtain the structural information of genuine convolvulins.[6—9)]

In a previous paper,[10)] we reported the isolation and structural elucidation of a new glycosidic acid, quamoclinic acid A, which was obtained along with three organic acids, 2*S*-methylbutyric, *n*-decanoic, and *n*-dodecanoic acids, upon alkaline hydrolysis of the jalapin fraction of the seeds of *Quamoclit pennata* BOJER, and isolation and structural elucidation of four genuine jalapins, quamoclins I, II, III, and IV, from the fraction. Further, we reported the structures of five glycosidic acids, quamoclinic acids B, C, D, E, and F, as well as six organic acids, isobutyric, 2*S*-methylbutyric, tiglic, 2*R*,3*R*-nilic, 7*S*-hydroxydecanoic, and 7*S*-hydroxydodecanoic acids, which were formed by alkaline hydrolysis of the convolvulin fraction of the seeds.[11)] As part of an ongoing study of the resin glycoside from this plant, this paper is concerned with the structural elucidation of two new component glycosidic acids of the convolvulin fraction.

The fractions 14 and 19 reported previously[11)] were subjected to HPLC to give two phenacyl esters (**1a**, **2a**) of glycosidic acids.

Alkaline hydrolysis of **1a** furnished a new glycosidic acid, quamocilnic acid G (**1**). On acidic hydrolysis, **1** gave an aglycone and a monosaccharide mixture. The product of the former treated with diazomethane–ether was identified methyl 3,11-dihydroxytetradecanoate (methyl ipurolate) using gas chromatography (GC). The absolute configurations at C-3 and C-11 of ipurolic acid of this plant had been determined as 3*S*,11*S* in the previous paper.[11)] The latter was converted into trimethylsilyl ethers of diastereomeric thiazolidine derivatives and then analyzed using GC, according to the process reported by Hara *et al.*[12)] Derivatives of D-glucose, D-quinovose, D-fucose, and L-rhamnose were detected. In the negative-ion FAB-MS, **1** exhibited an $[M-H]^-$ ion peak at *m*/*z* 1329 along with fragment ion peaks at *m*/*z* 1183 $[1329-146$ (6-deoxyhexose unit)$]^-$, 1167 $[1329-162$ (hexose unit)$]^-$, 1149 $[1329-162-H_2O$ (18)$]^-$, 1021 $[1167-146]^-$, 859 $[1021-162]^-$, and 841 $[1021-162-18]^-$. The ^{1}H-NMR spectrum of **1a** indicated signals due to seven anomeric protons and four secondary methyl groups assignable to H_3-6 of 6-deoxyhexose units, as well as two nonequivalent methylene protons adjacent to one carbonyl group and one primary methyl group ascribable to an aglycone moiety together with signals due to one phenacyl group. The ^{13}C-NMR spectrum of **1a** afforded signals due to seven anomeric carbons and one carbonyl carbon along with signals due to one phenacyl group. These NMR signals were assigned with the help of ^{1}H–^{1}H correlation spectroscopy (COSY) and ^{1}H–^{13}C heteronuclear shift-correlated 2D-NMR (HETCOR) method, as represented in Tables 1 and 2. On the basis of these data, it was elucidated that **1** was composed of 3 mol of glucose, 2 mol of quinovose, and 1 mol each of rhamnose, fucose, and ipurolic acid. The coupling constants of the anomeric and methine proton signals as well as the chemical shifts of ^{13}C-signals[13,14)] due to the sugar moiety indicated that all the monosaccharide units are of the pyranose type, and further, the mode of glycosidic linkages of the fucose, glucose, and quinovose units were β in the $^4C_1$ conformations, and that of the rhamnose unit was α in the $^1C_4$ conformation. The ^{13}C-NMR data of **1a** were compared with those

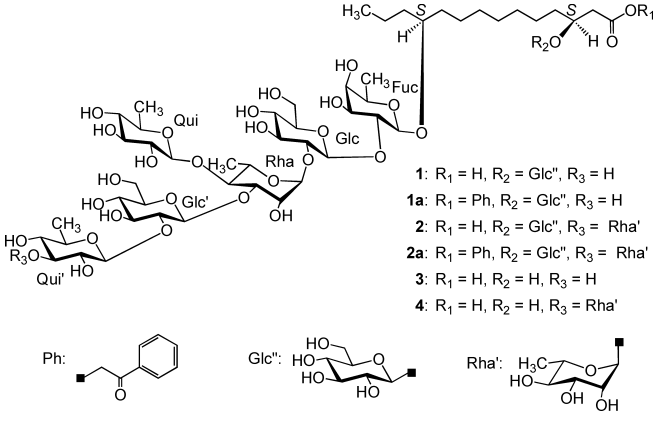

Fig. 1. Structures of **1**, **1a**, **2**, **2a**, **3**, and **4**

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Table 1. ^{1}H-NMR Spectral Data for **1a** and **2a** (in Pyridine-d_5, 600 MHz)

	1a	**2a**		**1a**	**2a**
Fuc-1	4.78 d (7.0)	4.85[a)]	Qui′-1	5.10 d (8.0)	5.02 d (8.0)
2	*ca.* 4.49	*ca.* 4.52	2	*ca.* 4.13	*ca.* 4.05
3	*ca.* 4.49	*ca.* 4.52	3	*ca.* 3.99	*ca.* 4.09
4	4.11 d (4.0)	4.11 d (4.0)	4	*ca.* 3.69	*ca.* 3.62
5	*ca.* 3.86	*ca.* 3.97	5	*ca.* 3.71	3.77 dq (9.5, 6.0)
6	1.40 d (6.5)	1.44 d (6.5)	6	1.64 d (5.5)	1.74 d (6.0)
Glc-1	5.60 d (7.5)	5.70 d (7.5)	Rha′-1		6.09 d (1.5)
2	*ca.* 4.19	*ca.* 4.22	2		4.66 dd (1.5, 3.5)
3	*ca.* 4.13	4.17 dd (9.0, 9.0)	3		*ca.* 4.51
4	4.01 dd (9.0, 9.0)	*ca.* 4.05	4		*ca.* 4.30
5	3.63 ddd (3.0, 5.5, 9.0)	*ca.* 3.64	5		*ca.* 4.95
6	4.31 dd (3.0, 11.5)	*ca.* 4.31	6		1.68 d (6.0)
	ca. 4.17	*ca.* 4.22	Glc″-1	5.03 d (7.5)	5.08 d (7.5)
Rha-1	6.30 s	6.34 d (1.5)	2	*ca.* 3.99	*ca.* 4.04
2	4.93 d (3.0)	*ca.* 4.95	3	*ca.* 4.23	*ca.* 4.27
3	5.17 dd (3.0, 9.5)	5.22 dd (3.0, 9.5)	4	*ca.* 4.22	*ca.* 4.27
4	4.69 dd (9.5, 9.5)	4.77 dd (9.5, 9.5)	5	3.91 ddd (2.5, 5.0, 9.5)	*ca.* 3.95
5	5.05 dq (9.5, 6.0)	*ca.* 5.04	6	*ca.* 4.47	*ca.* 4.51
6	1.91 d (6.0)	1.97 d (6.0)		4.35 ddd (5.0, 11.5)	4.41 dd (5.0, 11.0)
Glc′-1	5.97 d (7.5)	6.16 d (8.0)	Ag-2	3.14 dd (6.5, 15.5)	3.17 dd (7.0, 15.5)
2	*ca.* 3.98	*ca.* 3.94		2.95 dd (5.5, 15.5)	2.97 dd (5.5, 15.5)
3	4.39 dd (9.5, 9.5)	4.44 dd (9.0, 9.0)	3	4.62 m	4.65 m
4	*ca.* 4.10	4.13 dd (9.0, 9.0)	11	*ca.* 3.86	3.88 m
5	*ca.* 3.99	*ca.* 4.04	14	0.89 t (7.5)	0.89 t (7.5)
6	*ca.* 4.46	*ca.* 4.51	Ph-2,6	8.01 dd (1.0, 8.0)	8.02 dd (1.5, 8.0)
	ca. 4.17	*ca.* 4.21	3,5	7.39 dd (8.0, 8.0)	7.39 dd (8.0, 8.0)
Qui-1	5.75 d (9.0)	5.87 d (7.5)	4	7.51 tt (1.0, 8.0)	7.51 tt (1.5, 8.0)
2	3.94 dd (9.0, 9.0)	*ca.* 3.99	8	5.73 d (17.0)	5.76 d (17.0)
3	4.27 dd (9.0, 9.0)	*ca.* 4.27		5.66 d (17.0)	5.68 d (17.0)
4	3.67 dd (9.0, 9.0)	3.71 dd (9.0, 9.0)			
5	*ca.* 3.99	*ca.* 4.05			
6	1.57 d (6.0)	1.62 d (6.0)			

δ in pp from tetramethylsilane (TMS) (coupling constants (J) in Hz are given in parentheses). Fuc, fucopyranosyl; Glc, glucopyranosyl; Rha, rhamnopyranosyl; Qui, quinovopyranosyl; Ag, aglycone; Ph, phenacyl. *a*) Signals were deformed by virtual coupling.

of methyl pyranosides[13,14)] and methyl ipurolate[6)] in the literatures. Glycosylation shifts[15,16)] were observed at C-3 (+8.3 ppm) and C-11 (+6.0 ppm) of aglycone moiety, C-2 (+6.5 ppm) of the fucose residue (Fuc), C-2 (+3.0 ppm) of the first glucose residue (Glc), C-3 (+6.6 ppm) and C-4 (+6.0 ppm) of the rhamnose residue (Rha), and C-2 (+9.7 ppm) of the second glucose residue (Glc′). These data suggested that the sugar linkages in **1a** were formed at OH-3 and OH-11 of aglycone moiety, OH-2 of Fuc, OH-2 of Glc, OH-3 and OH-4 of Rha, and OH-2 of Glc′. To determine the sequence of the sugar moiety, the nuclear Overhauser and exchange spectroscopy (NOESY) and the heteronuclear multiple-bond correlation (HMBC) spectra of **1a** were recorded. Three of the cross peaks observed in the NOESY spectrum were assigned as those between H-1 of Glc′ and H-3 of Rha, H-1 of the first quinovose (Qui) and H-4 of Rha, and H-1 of the third glucose (Glc″) and H-3 of aglycone moiety, while the counterparts of H-1 of Fuc, H-1 of Glc, H-1 of Rha, and H-1 of the second quinovose (Qui′) could not be defined because the signals are overlapping. In the HMBC spectrum of **1a**, key cross-peaks were observed between H-1 of Fuc and C-11 of aglycone moiety, H-1 of Glc and C-2 of Fuc, H-1 of Glc′ and C-3 or C-4 of Rha, H-1 of Qui and C-4 or C-3 of Rha, H-1 of Qui′ and C-2 of Glc′, and H-1 of Glc″ and C-3 of aglycone moiety. From the above-mentioned data, **1** was considered to be a derivative of quamoclinic acid C (**3**),[11)] in which the hydroxyl group at C-3 of aglycone moiety was glycosylated with a glucose. This assumption was confirmed by the enzymatic hydrolysis of **1a** with β-glucosidase from sweet almonds to give **3**.

Accordingly, the structure of **1** was concluded to be 11-*O*-β-D-quinovopyranosyl-(1→2)-*O*-β-D-glucopyranosyl-(1→3)-[*O*-β-D-quinovopyranosyl-(1→4)]-*O*-α-L-rhamnopyranosyl-(1→2)-*O*-β-D-glucopyranosyl-(1→2)-β-D-fucopyranosyl-(3*S*,11*S*)-ipurolic acid 3-*O*-β-D-glucopyranoside (Fig. 1).

Quamoclinic acid H (**2**) was obtained on alkaline hydrolysis of **2a**. In the negative-ion FAB-MS, **2** gave an $[M-H]^-$ ion peak at *m*/*z* 1475, which was 146 mass units larger than that of **1**, along with fragment ion peaks at *m*/*z* 1329 $[1475-146]^-$, 1313 $[1475-162]^-$, 1183 $[1329-146]^-$, 1021 $[1183-162]^-$, and 841 $[1021-162-18]^-$. The components formed by the acidic hydrolysis of **2** were found to be ipurolic acid, D-glucose, D-quinovose, D-fucose, and L-rhamnose in the same manner as that used for **1**. The ^{1}H-NMR spectrum of **2a** was similar to that of **1a**, except for the appearance of signals due to one more rhamnopyranosyl unit. The ^{13}C-NMR spectrum of **2a** gave eight anomeric carbons and one carboxyl carbon along with one phenacyl group. These NMR signals were assigned in detail with the help of 2D-NMR techniques, as done for **1a**. From these data, it was elucidated that **2** was composed of 3 mol of glucose, 2 mol each of qinovose and rhamnose, and 1 mol each of fucose and ipurolic acid, and that the mode of glycosidic linkages of the glucose, quinovose, and fucose units were β and that of

Table 2. ^{13}C-NMR Spectral Data for **1a** and **2a** (in Pyridine-d_5, 150 MHz)

	1a	**2a**		**1a**	**2a**		**1a**	**2a**
Fuc-1	102.4	102.4	Glc′-1	101.2	101.7	Rha′-1		102.7
2	78.5	78.7	2	84.5	85.0	2		72.4
3	76.0	76.1	3	77.2	77.4	3		72.6
4	72.9	73.0	4	71.6	71.9	4		74.1
5	71.0	71.0	5	78.0	78.2	5		69.9
6	17.1	17.2	6	62.6	62.7	6		18.6
Glc-1	102.5	102.5	Qui-1	102.9	102.7	Glc″-1	103.8	103.9
2	77.8	77.9	2	76.5	76.6	2	75.2	75.3
3	79.1	79.1	3	78.4	78.5	3	78.3	78.5
4	72.5	72.5	4	77.2	77.4	4	71.7	71.8
5	77.2	77.3	5	72.4	72.3	5	78.2	78.3
6	63.1	63.1	6	18.6	18.7	6	62.8	62.9
Rha-1	100.9	101.0	Qui′-1	105.1	105.9	Ag-1	171.7	171.7
2	71.7	72.0	2	75.8	76.5	3	76.5	76.6
3	79.1	78.3	3	77.7	83.0	11	80.2	80.1
4	79.3	79.7	4	76.6	74.9	14	14.5	14.5
5	68.2	68.4	5	73.7	73.9	Ph-1	134.8	134.9
6	19.2	19.3	6	18.6	18.6	2,6	128.2	128.2
						3,5	129.2	129.1
						4	134.0	134.0
						7	193.1	193.1
						8	67.0	67.0

δ in ppm from TMS. Fuc, fucopyranosyl; Glc, glucopyranosyl; Rha, rhamnopyranosyl; Qui, quinovopyranosyl; Ag, aglycone; Ph, phenacyl.

the rhamnose unit was α (Tables 1, 2). The glycosylation shifts[15,16] in the ^{13}C-NMR data of **2a** were observed at C-3 (+8.4 ppm) and C-11 (+9.5 ppm) of aglycone moiety, C-2 (+6.7 ppm) of Fuc, C-2 (+3.1 ppm) of Glc, C-3 (+5.8 ppm) and C-4 (+6.1 ppm) of Rha, C-2 (+10.2 ppm) of Glc′, and C-3 (+5.0 ppm) of Qui′. The NOESY spectrum of **2a** showed four cross peaks between H-1 of Fuc and H-11 of aglycone moiety, H-1 of Glc′ and H-3 of Rha, H-1 of Qui and H-4 of Rha, and H-1 of Glc″ and H-3 of aglycone moiety. The HMBC spectrum of **2a** indicated correlations between H-1 of Rha′ and C-3 of Qui′ and H-1 of Glc″ and C-3 of aglycone moiety. In addition, **2a** gave quamoclinic acid F (**4**)[11] on enzymatic hydrolysis similar to that used for **1a**. Based on these data, **2** was elucidated to be a bisdesmoside attaching 1 mol glucose to 3-OH of ipurolic acid in **4**.

Thus the structure of **2** was defined to be 11-*O*-α-L-rhamnopyranosyl-(1→3)-*O*-β-D-quinovopyranosyl-(1→2)-*O*-β-D-glucopyranosyl-(1→3)-[*O*-β-D-quinovopyranosyl-(1→4)]-*O*-α-L-rhamnopyranosyl-(1→2)-*O*-β-D-glucopyranosyl-(1→2)-β-D-fucopyranosyl-(3*S*,11*S*)-ipurolic acid 3-*O*-β-D-glucopyranoside (Fig. 1).

Quamoclinic acids G and H are the first examples of bisdesmosides of glycosidic acid having the sugar linkages at C-3 of ipurolic acid as well as at its C-11. Further, quamoclinic acid H is the first instance of octaglycoside of glycosidic acid.

Experimental

The instruments and materials used were as cited in the preceding report[17,18] unless otherwise specified.

Isolation of 1a and 2a Fraction 14 (95 mg) and fraction 19 (111 mg), which were obtained previously[11] from the glycosidic acid fraction treated with phenacylbromide in dimethylformamide, were combined, and subjected to HPLC [column, (Inertsil octadecyl silica (ODS), 6 mm i.d.×25 cm)+(Cosmosil 5C18-Ar, 6 mm i.d.×25 cm); solvent, 70% MeOH] to yield **1a** (67 mg) and **2a** (47 mg).

1a: Amorphous powder, ^{1}H-NMR δ: see Table 1. ^{13}C-NMR δ: see Table 2.

2a: Amorphous powder, ^{1}H-NMR δ: see Table 1. ^{13}C-NMR δ: see Table 2.

Preparation of 1 and 2 Compounds **1a** (15 mg) and **2a** (42 mg) were each heated with 1 M KOH (3 ml) at 95 °C for 1 h. After cooling, the mixture was acidified (pH 3) with 1 M HCl, then extracted with ether (3 ml×3). The aqueous layer was subjected to MCI gel CHP 20 (H_2O, acetone) to give **1** (9 mg) and **2** (21 mg), respectively.

1: Amorphous powder, $[\alpha]_D^{26}$ −42.2° (c=0.9, MeOH). Negative-ion FAB-MS m/z: 1329 $[M-H]^-$, 1183 $[1329-146]^-$, 1167 $[1329-162]^-$, 1149 $[1329-162-18]^-$, 1021 $[1167-146]^-$, 859 $[1021-162]^-$, 841 $[1021-162-18]^-$. ^{1}H-NMR (in pyridine-d_5, 500 MHz) δ: 6.28 (1H, s, H-1 of Rha), 5.99 (1H, d, J=8.0 Hz, H-1 of Glc′), 5.76 (1H, d, J=8.0 Hz, H-1 of Qui), 5.59 (1H, d, J=7.5 Hz, H-1 of Glc), 5.18 (1H, dd, J=2.0, 9.0 Hz, H-3 of Rha), 5.12 (1H, d, J=8.0 Hz, H-1 of Qui′), 5.06 (1H, d, J=8.0 Hz, H-1 of Glc″), 4.95 (1H, d, J=2.0 Hz, H-2 of Rha), 4.77 (1H, Signal was deformed by virtual coupling, H-1 of Fuc), 4.70 (1H, dd, J=9.0, 9.0 Hz, H-4 of Rha), 4.59 (1H, m, H-3 of aglycone moiety), 3.00 (1H, dd, J=6.0, 15.0 Hz, Ha-2 of aglycone moiety), 2.90 (1H, dd, J=5.0, 15.0 Hz, Hb-2 of aglycone moiety), 1.91 (3H, d, J=6.5 Hz, H_3-6 of Rha), 1.65 (3H, d, J=5.5 Hz, H_3-6 of Qui′), 1.58 (3H, d, J=6.5 Hz, H_3-6 of Qui), 1.40 (3H, d, J=6.5 Hz, H_3-6 of Fuc), 0.89 (3H, t, J=7.0 Hz, H_3-14 of aglycone moiety). *Anal.* Calcd for $C_{56}H_{98}O_{35}\cdot 3H_2O$: C, 48.28; H, 7.41. Found: C, 48.55; H, 7.57.

2: Amorphous powder, $[\alpha]_D^{24}$ −44.6° (c=1.5, MeOH). Negative-ion FAB-MS m/z: 1475 $[M-H]^-$, 1329 $[1475-146]^-$, 1313 $[1475-162]^-$, 1295 $[1475-162-18]^-$, 1183 $[1329-146]^-$, 1167 $[1313-146]^-$, 1021 $[1167-146]^-$, 841 $[1021-162-18]^-$. ^{1}H-NMR (in pyridine-d_5, 500 MHz) δ: 6.26 (1H, s, H-1 of Rha), 6.10 (1H, d, J=7.5 Hz, H-1 of Glc′), 6.06 (1H, s, H-1 of Rha′), 5.78 (1H, d, J=8.0 Hz, H-1 of Qui), 5.62 (1H, d, J=7.5 Hz, H-1 of Glc), 5.18 (1H, dd, J=2.0, 9.0 Hz, H-3 of Rha), 5.04 (1H, d, J=7.5 Hz, H-1 of Glc″), 5.02 (1H, d, J=8.0 Hz, H-1 of Qui′), 4.91 (1H, br s, H-2 of Rha), 4.79 (1H, signal was deformed by virtual coupling, H-1 of Fuc), 4.72 (1H, dd, J=9.0, 9.0 Hz, H-4 of Rha), 4.68 (1H, br s, H-2 of Rha′), 4.57 (1H, m, H-3 of aglycone moiety), 2.95 (2H, br s, H_2-2 of aglycone moiety), 1.92 (3H, d, J=6.5 Hz, H_3-6 of Rha), 1.69 (3H, d, J=6.5 Hz, H_3-6 of Qui′), 1.65 (3H, d, J=6.5 Hz, H_3-6 of Rha′), 1.59 (3H, d, J=6.5 Hz, H_3-6 of Qui), 1.43 (3H, d, J=6.5 Hz, H_3-6 of Fuc), 0.88 (3H, t, J=7.0 Hz, H_3-14 of aglycone moiety). *Anal.* Calcd for $C_{62}H_{108}O_{39}$: C, 50.40; H, 7.37. Found: C, 50.31; H, 7.41.

Acidic Hydrolysis of 1 and 2 Compounds **1** (5 mg) and **2** (5 mg) were each heated with 1 M HCl (1 ml) at 95 °C for 1 h. The reaction mixture was diluted with H_2O (4 ml) and extracted with ether (5 ml×3). The extractive dried over $MgSO_4$ and concentrated *in vacuo* to give a residue. The residue was treated with diazomethane-ether and subjected to GC [column, Silicone OV-17 Uniport HP 80/100, 3.2 mm i.d.×3 m; carrier N_2, 1.5 kg/cm^2; column

temperature, 220 °C, retention time (t_R) (min): 8.82 (methyl ipurolate) from **1** and **2**].

The aqueous layer was neutralized with 1 M KOH, and the mixture was evaporated. Desalting of the residue by chromatography on Sephadex LH-20 (MeOH) column followed by evaporation gave a monosaccharide faction (3 mg from **1**; 3 mg from **2**). The each monosaccharide fraction (1 mg) was subjected to GC analysis [Hitachi G-3000 gaschromatograph equipped with 30 : 1 splitter and flame ionizing detector; column, fused silica capillary column Bonded MPS-50 (Quadrex), 50 m×0.25 mm, 0.25 μm film thickness; carrier gas, He (30 ml/min); column temperature, 220 °C] as the trimethylsilyl ether of the thiazolidine derivatives, as reported by Hara *et al.*[4] The retention times (t_R, min) of both derivatives formed from **1** and **2** were identical with those of the D-quinovose derivative (t_R, 17.1), L-rhamnose derivative (t_R, 17.6), D-fucose derivative (t_R, 19.0), and D-glucose derivative (t_R, 24.3).

Enzymatic Hydrolysis of 1a and 2a Compounds **1a** (5 mg) and **2a** (5 mg) were each suspended in H_2O (1 ml), and β-glucosidase (from sweet almonds, 12.6 U/mg, Lot. No. 13261, Toyobo, 10 mg for **1a**, 7 mg for **2a**) was added. The mixture was left to stand at 36 °C (**1a**, for 17 d; **2a**, for 4 d). After the removal of solvent *in vacuo*, the residue was extracted with MeOH, and the MeOH extract was chromatographed over silica gel column [$CHCl_3$–MeOH–H_2O (8 : 2 : 0.2, 7 : 3 : 0.5, 6 : 4 : 1)] to yield **3** (2 mg) from **1a**, and **4** (1 mg) from **2a**. Compounds **3** and **4** were identified as quamoclinic acids C and F, respectively, by comparison of their ^{1}H-NMR spectra with those of authentic samples.[11]

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