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GLYCOSYLATION OF PANAXADIOL

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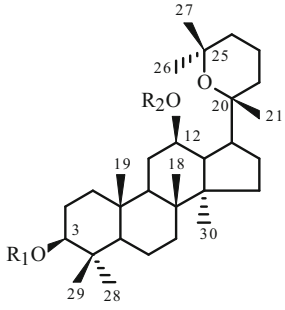
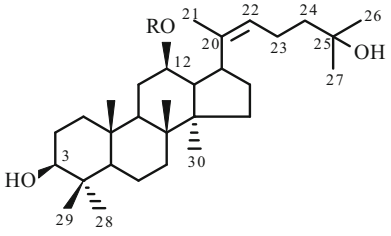
*Glycosylation of 3β,12β-dihydroxy-20*R*,25-epoxydammarane (panaxadiol) (**1**) under Koenigs–Knorr, Helferich, and ortho-ester reaction conditions was studied. Condensation of panaxadiol and 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosylbromide (**2**) in the presence of silver oxide and 4-Å molecular sieves in dichloroethane gave a mixture of acetylated panaxadiol 3- and 12-*O*-β-D-glucopyranosides (3:1 ratio). Reaction of diol **1** and D-glucose* tert*-butylorthoacetate (**3**) in the presence of 2,4,6-collidinium perchlorate in chlorobenzene resulted in regioselective formation of panaxadiol 12-*O*-β-D-glucopyranoside tetraacetate. Reaction of equimolar amounts of **1** and glycosyl donor **2** in the presence of Hg(II) cyanide in nitromethane at 90°C was accompanied by opening of the tetrahydropyran ring and gave 3β,12β,25-trihydroxydammar-20(22)*E*-ene 12-*O*-β-D-glucopyranoside tetraacetate. Panaxadiol 3- and 12-*O*-β-D-glucopyranosides and 3β,12β,25-trihydroxydammar-20(22)*E*-ene 12-*O*-β-D-glucopyranoside tetraacetate were synthesized for the first time.*

Keywords: dammarane-type triterpenoids, panaxadiol, glycosylation, *Panax ginseng*, panaxadiol 3-*O*-*β*-D-glucopyranoside, panaxadiol 12-*O*-*β*-D-glucopyranoside, 3*β*,12*β*,25-trihydroxydammar-20(22)*E*-ene 12-*O*-*β*-D-glucopyranoside.

One of the methods for studying the relationship between the chemical structure of compounds and their biological activity consists of the synthesis of compounds with a given structure and an investigation of their biological properties. In order to evaluate the influence of an additional 6*α*-OH group in panaxatriol on the biological activity of its semi-synthetic glycosides [1, 2], it became necessary to synthesize the corresponding panaxadiol monoglucosides. Panaxadiol (3*β*,12*β*-dihydroxy-20*R*,25-epoxydammarane) (**1**) is the acid-hydrolysis product of the glycoside fraction of *Panax ginseng* C. A. Meyer root. Its molecule has no C-6 hydroxyl, in contrast with panaxatriol [3–5]. Exhaustive glycosylation of **1** was performed previously under conditions of the ortho-ester method [6]. However, proof of the structures and purities of the isomeric monoglucosides was not given.



1, 4 - 6, 8, 9



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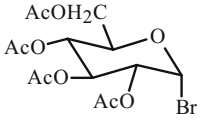
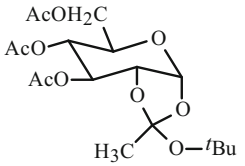


2



3

1: $R_1 = R_2 =$ H; **4:** R_1 = Ac, R_2 = H; **5:** R_1 = $GlcAc_4$, R_2 = H
6: R_1 = H, R_2 = $GlcAc_4$; **7:** R = $GlcAc_4$; **8:** R_1 = Glc, R_2 = H
9: R_1 = H, R_2 = Glc; **10:** R = Glc

The molecule of **1** has two hydroxyls on C-3 and C-12, the reactivity of which depends on the glycosylation conditions. A strong intramolecular H-bond (IMHB) between the 12*β*-OH proton and the O atom of the tetrahydropyran ring [3–5] increases the nucleophilicity of the 12*β*-OH O atom and makes it possible to glycosylate it regioselectively [7, 8].

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TABLE 1. Panaxadiol (**1**) Glycosylation Conditions and Results

Starting materials				Product, %*	Starting matl. recovery, %*
alcohol, mmol	glycosyl donor, mmol	HBr acceptor (catalyst), mmol, mg	solvent, mL		
		Expt. 1			
1, 1.0	**2**, 1.0	Ag_2O, 1.0; 4-Å mol. sieves, 0.5 g	Dichloroethane, 15	**5**, 21.5 **6**, 7.6	**1**, 69.6
		Expt. 2			
1, 1.0	**3**, 1.0	2,4,6-Collidinium perchlorate, 4 mg	Chlorobenzene, 10–15	**6**, 24.0 **4**, 11.2	**1**, 39.1
		Expt. 3			
1, 1.0	**2**, 1.0	$Hg(CN)_2$, 1.0	Nitromethane, 40	**7**, 22.8	**1**, 34.8

*Yields are given for chromatographically pure compounds.

Herein we continue research on the synthesis of glycosides from tetracyclic triterpenoids of the dammarane type. The goal was to study glycosylation of **1** under Koenigs–Knorr, Helferich, and ortho-ester reaction conditions.

The glycosylation was carried out using equimolar amounts of **1** and glycosyl donors **2** or **3** (Table 1). Condensation of **1** and 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosylbromide (α-acetobromoglucose) (**2**) in the presence of silver oxide and 4-Å molecular sieves in dichloroethane at room temperature gave a mixture of acetylated panaxadiol 3- and 12-*O*-β-D-glucopyranosides (**5** and **6**) in a 3:1 ratio (Table 1, expt. 1). Reaction of **1** and D-glucose *tert*-butylorthoacetate (**3**) in the presence of 2,4,6-collidinium perchlorate with azeotropic distillation in chlorobenzene resulted in regioselective formation of panaxadiol 12-*O*-β-D-glucopyranoside (**6**) (Table 1, expt. 2). Moreover, panaxadiol monoacetate (C-3, **4**) (Table 1, expt. 2), the appearance of which was probably due to conversion of an intermediate orthoester isomeric with glycoside **5**, was isolated from the reaction mixture under orthoester-reaction conditions [8–10]. An attempt at regioselective glycosylation of the 12β-OH group of **1** under Helferich reaction conditions, which we performed successfully earlier using 20*S*,24*R*-epoxydammaran-3,12β,25-triols as an example [7], gave the following result. Condensation of **1** with **2** in the presence of Hg(II) cyanide in nitromethane at 90°C was accompanied by opening of the tetrahydropyran ring and formation of 3β,12β,25-trihydroxydammar-20(22)*E*-ene 12-*O*-β-D-glucopyranoside tetraacetate (**7**). Starting **1** was unchanged by Hg(II) cyanide under the reaction conditions.

Deacetylation of **5–7** by MeONa in MeOH (0.1N) gave a quantitative yield of the corresponding free β-D-glucopyranosides **8–10**.

The structures of all compounds were established using IR, PMR, ^{13}C NMR, and 2D spectroscopy. Doublets for anomeric protons of the sugar component in acetylated glucosides **5–7** in $CDCl_3$ appeared in PMR spectra at δ 4.49–4.52 ppm ($J_{1',2'}$ = 7.8–8.0 Hz) whereas they were observed at 4.97–5.08 ($J_{1',2'}$ = 7.7 Hz) for free glucosides **8**–**10** in deuteropyridine. Chemical shifts and spin–spin coupling constants of glucose anomeric protons indicated that the glycoside bond had the *trans*-configuration in all glycosides. The attachment site of the glucose moiety was confirmed by comparing PMR and ^{13}C NMR spectra of **1** and **5**–**10** (Table 2). Resonances of the 12β-OH proton, which was involved in an IMHB, appeared in PMR spectra of **5** and **8** as singlets at 6.28 and 6.04, respectively. This indicated unambiguously that the glucose was located on C-3. The structures of glucosides **7** and **10** were established using PMR, ^{13}C NMR, and 2D spectra of **6**, **7**, **9**, and **10**. A comparison of PMR spectra of **6** and **7** showed significant differences in the chemical shifts of the side-chain methyls (Me-21, Me-26, Me-27) and differences in the chemical shifts of C-20–C-27 in ^{13}C NMR spectra (Table 2). Therefore, glucosides **6** and **7** and the free glucosides **9** and **10** corresponding to them differed only in the side-chain structure. ^{13}C NMR spectra of **7** and **10** suggested the presence in the side chain of a tri-substituted double bond (Table 2). A singlet (3H) at 1.52 in the PMR spectrum of **7** and a singlet at 1.83 in that of **10** belonged to protons (Me-21) of a methyl on the double bond.

These resonances in homonuclear 2D ^{1}H–^{1}H COSY spectra of **7** and **10** were correlated with resonances of the H-22 olefinic proton at 5.14 and 5.67, respectively. The configuration of the C-20–C-22 double bond in **7** and **10** was determined as *E* based on the fact that a nuclear Overhauser effect was not seen between the Me-21 methyl protons and the H-22 olefinic proton in NOESY spectra of **7** and **10**. Furthermore, the resonances for the C-21 methyl C atoms of **7** and **10** in ^{13}C NMR spectra were observed at 12.8 and 13.8 ppm, respectively. This was characteristic of a double bond with the *E*-configuration according to the literature [11, 12].

TABLE 2. ^{13}C NMR Chemical Shifts for **1** and **5**–**10** and the Sugar Component of **5**–**10** (δ, ppm vs. TMS)

C atom	**1**	**5**	**6**	**7**	**8**	**9**	**10**
1	38.90	38.82	39.17	39.25	39.19	39.07	39.12
2	27.49	25.91	27.34	27.33	26.76	28.28	28.26
3	78.92	90.84	78.88	78.84	88.77	78.03	78.01
4	38.90	38.99	38.99	38.99	39.70	39.56	39.55
5	55.90	56.19	56.04	55.98	56.38	56.48	56.42
6	18.31	18.18	18.35	18.25	18.48	18.83	18.71
7	34.89	34.86	34.62	34.95	35.22	35.08	35.28
8	39.79	39.79	39.67	39.92	40.04	39.99	40.12
9	49.94	49.94	50.68	50.45	50.14	51.02	50.72
10	37.13	36.83	37.23	37.36	36.99	37.48	37.52
11	30.55	30.55	28.66	27.39	31.23	29.19	28.13
12	69.91	69.92	78.80	77.19	70.21	77.41	77.13
13	49.18	49.12	46.40	47.83	49.86	47.12	49.47
14	51.21	51.20	52.68	50.87	51.34	52.90	51.16
15	31.13	31.12	32.76	32.34	31.31	33.25	32.75
16	25.17	25.15	26.83	28.93	25.40	27.40	29.65
17	54.72	54.72	51.33	49.20	54.98	51.77	49.62
18	15.62	15.61	15.56	15.65	15.83	15.81	15.74
19	16.08	16.12	16.23	16.27	16.38	16.55	16.45
20	76.66	76.64	76.60	138.47	76.90	76.99	138.58
21	19.41	19.38	27.24	12.80	19.62	27.74	13.77
22	35.75	35.73	31.69	123.64	35.82	32.19	125.04
23	16.26	16.25	16.55	23.07	16.51	16.97	23.77
24	36.46	36.44	37.04	44.22	36.55	37.16	44.80
25	73.07	73.09	70.76	70.91	73.00	70.64	69.79
26	32.99	33.01	33.60	29.14	33.19	33.99	30.18
27	27.14	27.09	27.68	28.83	27.34	27.84	29.75
28	28.02	27.63	27.99	28.02	28.18	28.64	28.66
29	15.32	16.03	15.28	15.34	16.81	16.24	16.29
30	17.06	17.02	18.96	16.87	17.27	19.35	17.17
$\underline{C}H_3CO$		20.73	20.72	20.78			
		20.69	20.65	20.73			
		20.62	20.59	20.56			
		20.59	20.59	20.56			
$CH_3\underline{C}O$		170.63	170.53	170.59			
		170.37	170.26	170.31			
		169.40	169.46	169.47			
		169.13	169.04	169.16			
				Sugar component			
1′		102.96	98.23	97.31	106.97	101.65	101.17
2′		71.63	71.45	71.77	75.83	75.31	75.31
3′		72.88	73.07	73.15	78.80	78.87	78.62
4′		68.81	68.83	68.86	71.89	72.34	72.40
5′		71.51	71.37	71.15	78.39	78.16	77.87
6′		62.32	62.11	62.30	63.09	63.28	63.59

The results indicated that the 3*β*-OH group was more reactive than the 12*β*-OH group for glycosylation of **1** under Koenigs–Knorr reaction conditions. However, the 12*β*-OH group was the most reactive under ortho-ester and modified Helferich reaction conditions.

EXPERIMENTAL

PMR and ^{13}C NMR spectra of **1**, **4**, and **5**-**7** were recorded in $CDCl_3$ on a Bruker Avance-500 spectrometer at operating frequencies 500 MHz (^1H) and 125 (^{13}C) at 30°C; of **8**–**10**, in deuteropyridine on a Bruker Avance-700 spectrometer

at operating frequencies 700 MHz (^{1}H) and 175 (^{13}C). Chemical shifts are given on the δ-scale vs. TMS. The multiplicities of ^{13}C resonances were found using DEPT-135 experiments and the standard method. Homonuclear 2D proton–proton correlation COSY-45 and NOESY spectra and 2D heteronuclear HSQC and HMBC correlation spectra were also obtained using standard methods. The HMBC experiments were optimized for $^nJ_{HC}$ ~ 10 Hz. IR spectra were recorded in $CHCl_3$ on a Bruker Vector 22 spectrophotometer. Optical rotations were determined in a 10-cm cuvette at 20°C on a Perkin–Elmer 343 polarimeter. Melting points were measured on a Boetius stage. Column chromatography was performed over KSK silica gel (120–150 mesh) using hexane:acetone (20:1→6:1). Purities of compounds were monitored using TLC on Sorbfil plates (Russia) and hexane:acetone (3:1) and C_6H_6:$CHCl_3$:MeOH (6:4:1 and 3:2:1) with detection by H_2SO_4 (10%) in EtOH and heating at 100–200°C. Elemental analyses of all newly prepared compounds agreed with those calculated.

Panaxadiol (3*β*,12*β*-dihydroxy-20*R*,25-epoxydammarane) (**1**) was prepared by acid hydrolysis of the total glycoside fraction of *P. ginseng* root extract according to the literature method [13, 14] with subsequent chromatography over silica gel and crystallization from EtOAc, mp 237–240°C (lit. [3, 4] mp 250°C). IR spectrum (ν, cm^{-1}): 3281 (OH), 3605 (OH).

PMR spectrum (500 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.778 (3H, s, Me-29), 0.882 (6H, s, Me-19, Me-30), 0.974 (3H, s, Me-28), 0.981 (3H, s, Me-18), 1.183 (3H, s, Me-21), 1.220 (3H, s, Me-26), 1.267 (3H, s, Me-27), 3.19 (1H, dd, J = 11.2, 4.9, H-3*α*), 3.52 (1H, td, J = 10.3, 10.3, 5.1, H-12*α*), 6.22 (1H, s, 12*β*-OH).

Condensation of Panaxadiol (1) and 2,3,4,6-Tetra-*O*-acetyl-*α*-D-glucopyranosylbromide (2) in the Presence of Silver Oxide. A solution of **1** (0.46 g) in dichloroethane (15 mL) was treated with Ag_2O (0.24 g) and 4-Å molecular sieves (0.5 g), stirred, treated with *α*-acetobromoglucose (**2**, 0.42 g), stirred at room temperature (20–22°C) for 5 h until **2** disappeared (TLC monitoring), diluted with $CHCl_3$, and filtered to remove insoluble silver compounds and molecular sieves. Solvent was distilled at reduced pressure. The solid was worked up three times with hot water in order to remove water-soluble glucose derivatives, dried, and chromatographed over a column of silica gel with elution by hexane:acetone (20:1→6:1) to afford **1** (0.32 g, 69.6%), **5** (0.17 g, 21.5%), and **6** (0.06 g, 7.6%).

3*β*-(2′,3′,4′,6′-Tetra-*O*-acetyl-*β*-D-glucopyranosyloxy)-12*β*-hydroxy-20*R*,25-epoxydammarane (5). $C_{44}H_{70}O_{12}$, mp 224–226°C (MeOH), $[\alpha]_D^{20}$ +2.0° (*c* 0.9, $CHCl_3$). IR spectrum (ν, cm^{-1}): 1756 (CH_3C=O), 3284 (OH).

PMR spectrum (500 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.741 (3H, s, Me-29), 0.869 (3H, s, Me-30), 0.874 (3H, s, Me-19), 0.897 (3H, s, Me-28), 0.969 (3H, s, Me-18), 1.179 (3H, s, Me-21), 1.217 (3H, s, Me-26), 1.266 (3H, s, Me-27), 2.004 (3H, s, OAc), 2.023 (3H, s, OAc), 2.028 (3H, s, OAc), 2.069 (3H, s, OAc), 3.07 (1H, dd, J = 11.8, 5.0, H-3*α*), 3.52 (1H, td, J = 10.4, 10.4, 5.2, H-12*α*), 3.68 (1H, ddd, J = 10.1, 5.9, 2.6, H-5′), 4.09 (1H, dd, J = 12.0, 2.6, H-6′), 4.25 (1H, dd, J = 12.0, 5.9, H-6′), 4.52 (1H, d, $J_{1',2'}$ = 8.0, H-1′), 5.028 (1H, t, J = 9.6, H-4′), 5.034 (1H, dd, J = 9.6, 8.0, H-2′), 5.20 (1H, t, J = 9.6, H-3′), 6.28 (1H, s, 12*β*-OH).

3*β*-Hydroxy-12*β*-(2′,3′,4′,6′-tetra-*O*-acetyl-*β*-D-glucopyranosyloxy)-20*R*,25-epoxydammarane (6). $C_{44}H_{70}O_{12}$, mp 214–216°C (EtOH), $[\alpha]_D^{20}$ +0.7° (*c* 1.0, $CHCl_3$). IR spectrum (ν, cm^{-1}): 1756 (CH_3C=O), 3605 (OH).

PMR spectrum (500 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.787 (3H, s, Me-29), 0.861 (6H, s, Me-30, Me-19), 0.941 (3H, s, Me-18), 0.981 (3H, s, Me-28), 1.104 (3H, s, Me-26), 1.205 (3H, s, Me-27), 1.309 (3H, s, Me-21), 2.000 (3H, s, OAc), 2.027 (3H, s, OAc), 2.037 (3H, s, OAc), 2.065 (3H, s, OAc), 3.21 (1H, dd, J = 11.0, 4.7, H-3*α*), 3.56 (1H, td, J = 10.7, 10.7, 4.7, H-12*α*), 3.63 (1H, ddd, J = 9.9, 4.6, 3.0, H-5′), 4.14 (1H, dd, J = 12.3, 2.7, H-6′), 4.19 (1H, dd, J = 12.2, 4.7, H-6′), 4.51 (1H, d, $J_{1',2'}$ = 8.0, H-1′), 4.89 (1H, dd, J = 9.6, 8.0, H-2′), 5.05 (1H, t, J = 9.6, H-4′), 5.18 (1H, t, J = 9.6, H-3′).

Condensation of Panaxadiol (1) and D-Glucose *tert*-Butylorthoacetate (3) in the Presence of 2,4,6-Collidinium Perchlorate. 2,4,6-Collidinium perchlorate (4 mg) in anhydrous chlorobenzene (10–12 mL) was dried by azeotropic distillation of chlorobenzene. The resulting solution was treated with **1** (0.46 g, 1 mmol). Several additional milliliters of solvent were distilled. Orthoester (**3**, 0.41 g, 1 mmol) was added in two portions 10 min apart. The mixture was heated another 15 min with azeotropic distillation of chlorobenzene and evaporated. The dry solid was chromatographed over a column of silica gel with elution by hexane:acetone (20:1→10:1) to afford **4** (0.06 g, 11.9%), **1** (0.18 g, 39.1%), and **6** (0.19 g, 24.0%).

3*β*-Acetoxy-12*β*-hydroxy-20*R*,25-epoxydammarane (4), mp 214–215°C (acetone) (lit. [3] mp 215°C).

PMR spectrum (500 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.852 (6H, s, Me-29, Me-28), 0.879 (3H, s, Me-30), 0.908 (3H, s, Me-19), 0.981 (3H, s, Me-18), 1.183 (3H, s, Me-21), 1.220 (3H, s, Me-26), 1.266 (3H, s, Me-27), 2.04 (3H, s, OAc), 3.53 (1H, td, J = 10.3, 10.3, 5.3, H-12*α*), 4.48 (1H, dd, J = 10.5, 6.0, H-3*α*), 6.23 (1H, s, 12*β*-OH).

Condensation of Panaxadiol (1) and *α*-Acetobromoglucose (2) in the Presence of Hg(II) Cyanide. A homogeneous solution of **1** (0.46 g, 1 mmol) in anhydrous nitromethane (30 mL) at 90°C was treated with $Hg(CN)_2$ (0.25 g, 1 mmol), held at 90–95°C for 1 h, treated dropwise over 10 min with a solution of **2** (0.41 mg, 1 mmol) in anhydrous nitromethane (10 mL), and held for 1 h at 90–95°C. Solvent was distilled at reduced pressure. The solid was dissolved in $CHCl_3$ and filtered to

remove Hg salts. The filtrate was washed with water, dried over anhydrous Na_2SO_4, and evaporated. The dry solid was chromatographed over a column of silica gel with elution by hexane:acetone (20:1→6:1) to afford **1** (0.16 g, 34.8%) and **7** (0.18 g, 22.8%).

3β,25-Dihydroxy-12β-(2′,3′,4′,6′-tetra-*O*-acetyl-β-D-glucopyranosyloxy)-dammar-20(22)*E*-ene (7). $C_{44}H_{70}O_{12}$, mp 135–137°C (EtOH), $[\alpha]_D^{20}$ –1.5° (*c* 0.5, $CHCl_3$). IR spectrum (ν, cm^{-1}): 1756 (CH_3C=O), 3605 (OH).

PMR spectrum (500 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.787 (3H, s, Me-29), 0.868 (6H, s, Me-30, Me-19), 0.985 (3H, s, Me-28), 0.994 (3H, s, Me-18), 1.272 (3H, s, Me-26), 1.276 (3H, s, Me-27), 1.521 (3H, s, Me-21), 1.970 (3H, s, OAc), 2.018 (3H, s, OAc), 2.020 (3H, s, OAc), 2.101 (3H, s, OAc), 2.49 (1H, td, J = 10.5, 10.5, 6.1, H-17), 3.21 (1H, dd, J = 11.5, 4.8, H-3α), 3.64 (2H, m, H-12α, H-5′), 4.12 (1H, dd, J = 12.1, 2.7, H-6′), 4.28 (1H, dd, J = 12.1, 4.8, H-6′), 4.49 (1H, d, $J_{1',2'}$ = 7.8, H-1′), 4.82 (1H, dd, J = 9.5, 8.0, H-2′), 5.07 (1H, t, J = 9.6, H-4′), 5.13 (1H, t, J = 9.5, H-3′), 5.14 (1H, t, J = 7.0, H-22).

Deacetylation of **5-7** was carried out using MeONa in MeOH (0.1N) at room temperature for 1–1.5 h.

3β-(β-D-Glucopyranosyloxy)-12β-hydroxy-20*R*,25-epoxydammarane (8). $C_{36}H_{62}O_8$, amorph., $[\alpha]_D^{20}$ –8.8° (*c* 0.9, C_5H_5N).

PMR spectrum (700 MHz, C_5D_5N, δ, ppm, J/Hz): 0.836 (3H, s, Me-19), 0.939 (3H, s, Me-30), 0.984 (3H, s, Me-18), 1.017 (3H, s, Me-29), 1.227 (3H, s, Me-21), 1.231 (3H, s, Me-27), 1.282 (3H, s, Me-26), 1.337 (3H, s, Me-28), 3.39 (1H, dd, J = 12.0, 4.5, H-3α), 3.79 (1H, m, H-12α), 4.04 (1H, ddd, J = 9.2, 5.3, 2.6, H-5′), 4.06 (1H, dd, J = 8.8, 7.9, H-2′), 4.24 (1H, t, J = 9.0, H-4′), 4.28 (1H, t, J = 9.0, H-3′), 4.44 (1H, dd, J = 11.8, 5.6, H-6′), 4.62 (1H, dd, J = 11.8, 2.6, H-6′), 4.97 (1H, d, $J_{1',2'}$ = 7.7, H-1′), 6.04 (1H, s, 12β-OH).

3β-Hydroxy-12β-(β-D-glucopyranosyloxy)-20*R*,25-epoxydammarane (9). $C_{36}H_{62}O_8$, amorph., $[\alpha]_D^{20}$ –6.4° (*c* 0.9, C_5H_5N).

PMR spectrum (700 MHz, C_5D_5N, δ, ppm, J/Hz): 0.842 (3H, s, Me-19), 0.931 (3H, s, Me-30), 1.043 (6H, s, Me-29, Me-18), 1.210 (3H, s, Me-27), 1.221 (3H, s, Me-26), 1.230 (3H, s, Me-28), 1.537 (3H, s, Me-21), 3.45 (1H, dd, J = 11.3, 5.1, H-3α), 4.01 (1H, ddd, J = 9.4, 5.8, 2.8, H-5′), 4.07 (1H, dd, J = 9.0, 7.7, H-2′), 4.13 (1H, td, J = 10.7, 10.7, 4.5, H-12α), 4.21 (1H, t, J = 9.1, H-4′), 4.28 (1H, t, J = 9.0, H-3′), 4.35 (1H, dd, J = 11.5, 5.8, H-6′), 4.58 (1H, dd, J = 11.3, 2.8, H-6′), 5.08 (1H, d, $J_{1',2'}$ = 7.7, H-1′).

3β,25-Dihydroxy-12β-(β-D-glucopyranosyloxy)-dammar-20(22)*E*-ene (10). $C_{36}H_{62}O_8$, amorph., $[\alpha]_D^{20}$ –1.9° (*c* 1.1, C_5H_5N).

PMR spectrum (700 MHz, $CDCl_3$, δ, ppm, J/Hz): 0.774 (3H, s, Me-19), 0.877 (3H, s, Me-30), 0.959 (3H, s, Me-18), 1.030 (3H, s, Me-29), 1.230 (3H, s, Me-28), 1.397 (3H, s, Me-26), 1.399 (3H, s, Me-27), 1.830 (3H, s, Me-21), 1.93 (2H, m, 2H-24), 2.04 (1H, t, J = 10.8, H-13), 2.46 (2H, m, 2H-23), 2.85 (1H, td, J = 10.5, 10.5, 5.8, H-17), 3.43 (1H, dd, J = 11.5, 4.8, H-3α), 3.98 (2H, m, H-2′, H-5′), 4.18 (1H, m, H-12α), 4.20 (1H, t, J = 9.2, H-4′), 4.29 (1H, t, J = 9.0, H-3′), 4.39 (1H, dd, J = 11.3, 5.8, H-6′), 4.60 (1H, dd, J = 11.3, 3.0, H-6′), 5.03 (1H, d, $J_{1',2'}$ = 7.7, H-1′), 5.67 (1H, t, J = 6.8, 6.8, H-22).

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