TRITERPENE GLYCOSIDES FROM *Astragalus* AND THEIR GENINS. LXXX. CYCLOMACROSIDE D, A NEW BISDESMOSIDE*

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The structure of the new cycloartane glycoside cyclomacroside D, which was isolated from Astragalus macropus *Bunge (Leguminosae) and is 24*R*-cycloartan-1*α*,3*β*,7*β*,24,25-pentaol 3*-O-α*-L-rhamnopyranoside-24*-O-β*-D-xylopyranoside, was proved.*

Key words: cyclomacroside D, cyclomacrogenin B, cyclomacroside C, cycloartane triterpenoids, *Astragalus macropus* Bunge, Leguminosae, PMR, ^{13}C NMR, DEPT, COSY, HSQC, and HMBC spectra.

In continuation of research on cycloartane triterpenoids from plants of the genus *Astragalus* (Leguminosae) [1], we determined the structure of the new compound H [2], which was isolated from *Astragalus macropus* Bunge and which we called cyclomacroside D (**1**).

PMR and ^{13}C NMR spectra of **1** (Table 1) indicated the presence of a 1,1,2,2-tetrasubstituted 9,19-three-membered ring (1H doublets for an AX system at δ 0.44 and 0.89 with SSCC ^{2}J = 4 Hz, C-9 and C-10 singlets, and C-19 triplet). This classified the studied glycoside as a triterpenoid of the cycloartane series [3-6].

Comparison of the ^{13}C NMR spectra of **1** and the genin **3** showed that cyclomacroside D was a derivative of cyclomacrogenin B.

Acid hydrolysis of cyclomacroside D and subsequent analysis of the carbohydrate part of the hydrolysate by paper chromatography detected D-xylose and L-rhamnose. The PMR and ^{13}C NMR spectra of **1** contained two sets of resonances for monosaccharide units. Therefore, **1** was a bioside containing D-xylose and L-rhamose in a 1:1 ratio.

As expected, the native genin cyclomacrogenin B could not be detected in the genin part of the acid hydrolysate of the glycoside. The presence of the 1α-hydroxyl, which is easily eliminated in acidic medium, caused migration of the 9,19-bond to a 1,19-bond and generated a 9(11) double bond [3].

Enzymatic hydrolysis of cyclomacroside D by gastric juice of the grapevine snail (*Helix pomatia*) formed progenin **2**, which was identified as cyclomacroside C [1]. This indicated that the L-rhamnose was bonded to the genin at C-3 of the α-glycoside bond and that the monosaccharide has the $^{1}C_{4}$-conformation. In agreement with this, the HMBC spectrum contained a cross-peak between resonances for the anomeric H atom of the α-L-rhamnose unit and C-3 of the genin. The resonance for H-1 of D-xylose in the same HMBC spectrum correlated with the resonance of C-24, indicating the site of attachment of the pentose.

In fact, C-3 and C-24 experienced a glycosylation effect and resonated at δ 84.19 and 89.56.

Chemical shifts of H and C atoms and SSCC of D-xylose in the PMR and ^{13}C NMR spectra of **1** indicated the pyranose form, the $^{4}C_{1}$-conformation, and the β-configuration of the studied monosaccharide.

Thus, cyclomacroside D has the structure 24*R*-cycloartan-1α,3β,7β,24,25-pentaol 3-*O*-α-L-rhamnopyranoside-24-*O*-β-D-xylopyranoside.

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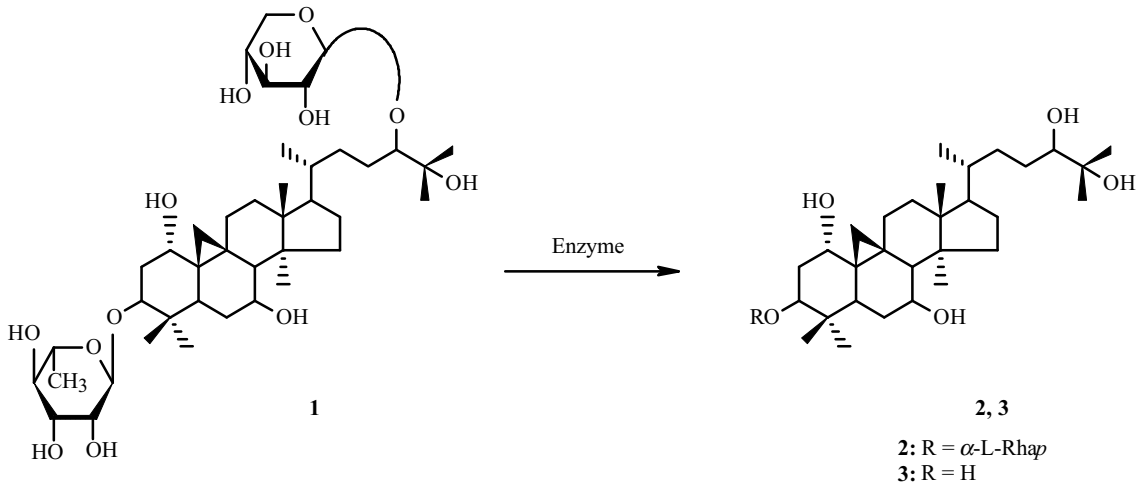
TABLE 1. Chemical Shifts of C and H Atoms and Parameters of DEPT, ^{1}H-^{1}H COSY, HSQC, and HMBC Spectra of Cyclomacroside D (**1**) and Chemical Shifts of C Atoms of Cyclomacroside C (**2**) and Cyclomacrogenin B (**3**) (C_5D_5N, CD_3OD, δ, ppm, J/Hz)

C atom	**1**					**2**		**3** [2]
	DEPT	δ_C (C_5D_5N)	δ_H (C_5D_5N)	HMBC (C_5D_5N) (C atom)	δ_C (CD_3OD)	δ_C [1] (C_5D_5N)	δ_C (CD_3OD)	δ_C (C_5D_5N)
1	CH	72.39	3.85 br.s		73.73	72.40	73.74	72.65
2	CH_2	37.07	1.99, 2.49		36.95	37.07	36.97	38.95
3	CH	84.19	4.15 dd (10.5, 5.2)		85.06	84.22	85.08	72.96
4	C	40.79	-		41.45	40.80	41.46	40.98
5	CH	39.16	2.59		40.04	39.18	40.06	39.36
6	CH_2	32.05	1.29, 2.03		32.02	32.08	32.05	32.31
7	CH	69.99	3.94		71.14	70.02	71.12	70.14
8	CH	55.59	1.88		55.98	55.32	56.01	55.21
9	C	21.01	-		21.99	21.00	22.00	21.00
10	C	30.94	-		31.36	30.94	31.35	31.32
11	CH_2	26.40	1.54, 2.54		27.00	26.37	26.99	26.47
12	CH_2	33.18	1.67, 1.73		33.98	33.23	33.99	33.30
13	C	46.00	-		46.85	45.99	46.85	45.99
14	C	49.05	-		*	49.06	*	49.13
15	CH_2	37.95	1.57, 1.88		38.49	37.92	38.48	37.86
16	CH_2	29.52	*		29.63	28.99[a]	29.59	28.98[a]
17	CH	52.17	1.92		53.01	52.37	53.20	52.38
18	CH_3	17.93	1.12 s	12, 13, 14, 17	18.25	17.98	18.28	17.91
19	CH_2	28.95	0.44 d (4), 0.89 d (4)		29.29	28.99[a]	29.32	28.98[a]
20	CH	36.79	1.48		37.66	36.43	37.20	36.43
21	CH_3	19.01	0.96 d	17, 22	18.84	18.67	18.92	18.68
22	CH_2	33.55	1.48, 1.61		34.40	34.21	34.56	34.22
23	CH_2	28.20	2.06, 2.06		29.47	28.27	28.90	28.20
24	CH	89.56	3.81 m		89.19	79.06	79.78	79.06
25	C	71.92	-		73.48	72.72	73.90	72.72
26	CH_3	25.66[a]	1.41 s	24, 25, 27	25.13	25.92	24.94	25.94
27	CH_3	26.73	1.47 s	24, 25, 26	26.47	26.04	25.70	26.19
28	CH_3	18.57	1.19 s	8, 13, 14, 15	19.25	18.98	19.21	19.02
29	CH_3	25.66[a]	0.96 s	3, 4, 5, 30	26.00	25.67	26.01	26.03
30	CH_3	14.40	0.92 s	3, 4, 5, 29	14.47	14.41	14.47	13.98
				α-L-Rha*p* (R)				
1	CH	104.80	5.35 s	3, R3	104.30	104.48	104.34	
2	CH	72.30	4.56 br.s		72.44	72.31	72.46	
3	CH	72.86	4.47 dd (7.6, 3.8)		72.54	72.86	72.53	
4	CH	74.05	4.27 t (7)		74.09	74.06	74.08	
5	CH	69.74	4.31 m		69.91	69.75	69.93	
6	CH_3	18.36	1.56 d (5.4)	R4, R5	17.81	18.36	17.81	
				β-D-Xyl*p* (X)				
1	CH	106.05	4.90 d (7.6)	24	105.34			
2	CH	75.10	3.98 t (7.6)		75.15			
3	CH	78.38	4.12 t (8.7)		77.85			
4	CH	70.89	4.13		71.14			
5	CH_2	67.20	3.69 t (9.5) 4.33		66.98			

Chemical shifts given without multiplicities and SSCC were found from 2D spectra.

*Chemical shifts were not found. Resonance of C-14 in spectra recorded in CD_3OD obviously overlapped the solvent resonance.

[a]Resonances overlap each other.



EXPERIMENTAL

General comments have been published [7]. We used the following solvent systems: $CHCl_3$:CH_3OH (20:1, 1), $CHCl_3$:CH_3OH:H_2O (70:12:1, 2; 70:23:4, 3), *n*-butanol:pyridine:water (6:4:3, 4).

NMR spectra were recorded on Bruker AM 300 (in deuteropyridine) and UNITYplus 400 (in deuteromethanol) spectrometers; 2D spectra, using standard Bruker programs. ^{13}C NMR spectra were obtained with full C—H decoupling and under DEPT conditions. Spectra in deuteropyridine were recorded without internal standard; in deuteromethanol, with HMDS internal standard. Chemical shifts of protons were measured relative to the resonance of residual β-protons of deuteropyridine with chemical shift vs. TMS of δ 7.19. Chemical shifts in ^{13}C NMR spectra were measured relative to the resonance of β-C atoms of deuteropyridine with chemical shift δ 123.493 vs. TMS.

Cyclomacroside D (1), compound H [2]. $C_{41}H_{70}O_{13}$, mp 151-153°C (CH_3OH). IR spectrum (KBr, ν, cm^{-1}): 3412 (OH), 3040 (CH_2 of cylcopropane ring).

PMR spectrum (400 MHz, CD_3OD, δ, ppm, J/Hz, 0 = HMDS): 0.36 and 0.71 (2H-19, d, $^2J = 4.4$), 0.76 (CH_3, s), 0.86 (CH_3-21, d, $^3J = 6.4$), 0.91, 0.96, 0.99, 1.08, 1.09 (5 × CH_3, s), 1.18 (CH_3 of L-rhamnose, d, $^3J = 6.4$), 4.23 (H-1 of D-xylose, d, $^3J = 7.5$), 4.69 (H-1 of L-rhamnose, $^3J = 1.7$).

Table 1 lists the PMR and ^{13}C NMR, DEPT, ^1H—^1H COSY, HSQC, and HMBC spectra.

Acid Hydrolysis of 1. Cyclomacroside D (**1**, 50 mg) was hydrolyzed by methanolic H_2SO_4 (5 mL, 2.5%) for 2.5 h on a water bath and diluted with water. The methanol was evaporated. The resulting precipitate was filtered off, washed with water, and dried. TLC using system 1 and an authentic sample of cyclomacrogenin B (**3**) showed that **3** was absent in the genin part of the hydrolysate.

The aqueous part of the hydrolysate was concentrated to 5 mL and heated on a water bath for 1 h, after which the solution was neutralized with barium carbonate. The precipitate was filtered off. Paper chromatography using system 4 and authentic samples detected D-xylose and L-rhamnose.

The PMR and ^{13}C NMR spectra of **1** showed that it contained D-xylose and L-rhamnose in a 1:1 ratio.

Enzymatic Hydrolysis of 1. Glycoside **1** (50 mg) in water (30 mL) was treated with lyophilized dried gastric juice of grapevine snail (*Helix pomatia*) (35 mg) and benzene (2 drops), left at 35-37°C for 1 month, and treated with *n*-butanol. The butanol extract was evaporated. The solid was chromatographed over a column of silica gel using system 2 to afford **2** (18 mg), mp 281-283°C (CH_3OH), which was identified as cyclomacroside C by TLC and PMR and ^{13}C NMR spectra [1].

PMR spectrum (400 MHz, CD_3OD, δ, ppm, J/Hz, 0 = HMDS): 0.37 (H-19, d, $^2J = 4.7$), 0.71 (H-19, d, $^2J = 4.5$), 0.76 (CH_3, s), 0.86 (CH_3-21, d, $^3J = 6.4$), 0.91, 0.97, 0.99, 1.07, 1.10 (5 × CH_3, s), 1.17 (CH_3 of L-rhamnose, d, $^3J = 6$), 4.69 (H-1 of L-rhamnose, d, $^3J = 1.7$).

Table 1 lists the ^{13}C NMR spectrum.

Continued elution of the column by system 3 afforded starting **1** (15 mg).

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