Pergamon

0031-9422(95)00348-7

Phytochemistry, Vol. 40, No. 3, pp. 853–855, 1995

0031-9422/95 $9.50 + 0.00

BOARIOSIDE, A EUDESMANE GLUCOSIDE FROM *MAYTENUS BOARIA*

O. MUÑOZ, C. GALEFFI,* E. FEDERICI,* J. A. GARBARINO,† M. PIOVANO† and M. NICOLETTI‡§

Universidad de Chile, Santiago, Chile; *Istituto Superiore di Sanità, V. le R. Margherita 299, 00161, Roma, Italy; †Universidad T. Federico Santa Maria, Valparaiso, Chile; ‡Dipartimento di Biologia Vegetale, Università 'La Sapienza', 00185, Roma, Italy

(*Received* 6 *March* 1995)

Key Word Index — *Maytenus boaria*; Celastraceae; eudesmane glucosides; boarioside.

Abstract—A eudesmane glucoside, named boarioside, whose aglucone is structurally related to the typical dihydro-β-agarofuran sesquiterpenes of Celastraceae, was isolated from *Maytenus boaria* and its structure determined by chemical and spectroscopic means.

INTRODUCTION

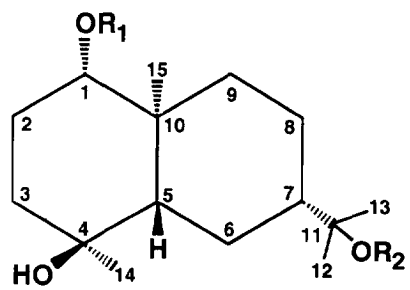
Maytenus boaria Mol. is an endemic tree of Chile. Its aerial parts are used in traditional medicine as a febrifuge, a purgative and a treatment for skin eruptions [1–3]. The methanolic extract showed a mild antipyretic and anti-inflammatory activity [4]. Previous phytochemical studies established the presence of several apolar components [5, 6], including typical dihydro-β-agarofuran sesquiterpenes of Celastraceae [7–9]. Examination of the more polar constituents has led to the isolation of a new glucoside (**1**), named boarioside, whose aglucone is closely related to the aforementioned sesquiterpenes.

RESULTS AND DISCUSSION

Boarioside (**1**), $C_{21}H_{38}O_8$, $[M-H]^-$ at *m/z* 417 (FAB-MS), gave rise to the prominent ^{1}H NMR signals of four tertiary methyl groups (δ1.33 (×2), 1.19 and 1.08) and of an anomeric hydrogen (δ4.40, *d*, J = 8.0 Hz) of a monose. The resonance of the corresponding ^{13}C NMR signal, C-1′, was at δ106.4 (CD_3OD, Table 1), whereas the aglucone carbon engaged in the glucosidic linkage was at δ91.3 (doublet in the ^{1}H-coupled spectrum). Two out of the four methyls (δ29.0 and 29.6) were assigned to a dimethylcarbinol unit (carbinol signal at δ75.2) and one (δ22.1) to a methylcarbinol unit (carbinol signal at δ72.5); the fourth (δ14.5) was angular. On acetylation with acetic anhydride–pyridine at room temperature, **1** gave a tetra-acetyl derivative, **2**, $C_{21}H_{34}O_8(Ac)_4$, wherein only the alcoholic functions of the monose moiety were acylated.

On enzymatic hydrolysis with β-glucosidase, boarioside afforded D-glucose and the aglucone **3**, $C_{15}H_{28}O_3$, whose EI-mass spectrum did not show the molecular ion, but contained fragment ions at *m/z* 239 $[M-17]^+$ (1%), 221 $[M-17-18]^+$ (100%) and 203 $[M-17-18-18]^+$ (70%) which accounted for the three hydroxyl groups. The ^{1}H NMR spectrum of **3** clearly showed the signal of the hydroxymethine (δ3.30, *dd*, J = 11.2 and 4.1 Hz) involved in the glucosidic linkage. The corresponding carbon resonance was at δ80.0. In the homonuclear ^{1}H–^{1}H COSY analysis of **3**, the hydroxymethine signal was coupled with a methylene (δ1.68 and 1.50, *m*), which was further on coupled with another methylene (centred at *ca* δ2.00), devoid of further coupling and close to the aforementioned methylcarbinol unit. This sequence and the presence of an isopropyl group in the second ring of **3** were in accord with the eudesmane skeleton of *Maytenus* sesquiterpenes [6–8].

On acylation of **3** with *p*-bromobenzoyl chloride–pyridine, the 1-*p*-bromobenzoyl ester, **4**, and the 1,11-bis (*p*-bromobenzoyl) ester, **5**, were obtained. The ^{13}C NMR spectrum of **4**, on comparison with that of **3**, showed the deshielding of H-1 and C-1 and the shielding β-effect on



	R_1	R_2
1	β-D-Glucopyranose	H
2	β-D-Glucopyranose $(Ac)_4$	H
3	H	H
4	*p*-Bromobenzoyl	H
5	*p*-Bromobenzoyl	*p*-Bromobenzoyl

§Author to whom correspondence should be addressed.

Table 1. ^{13}C NMR data for compounds **1–6**

	1		2	3	4	5	6
C	CD_3OD	DMSO-d_6	$CDCl_3$	$CDCl_3$	$CDCl_3$	$CDCl_3$	$CDCl_3$
1	91.3	89.1	90.9	80.0	82.4	82.1	n.o.
2	28.6	27.5	27.3	28.6	25.4	25.4	35.5
3	38.8	37.1	37.5	37.7	37.5	37.6	32.7
4	72.5	72.7	72.8	72.0	71.6	71.6	74.6*
5	48.6	47.0	47.3	47.3	47.4	47.8	47.3
6	21.6	20.4	20.8*	20.9*	20.9*	20.2*	21.4†
7	43.0	41.3	41.0	41.3	41.2	40.9	40.5
8	21.6	20.4	20.7*	20.6*	20.3*	20.0*	21.1†
9	41.9	41.1	41.0	41.2	41.0	40.2	41.5
10	40.2	38.7	38.8	38.7	38.4	38.0	46.2
11	75.2	74.0	74.6	74.8	74.7	87.8	75.0*
12	29.6†	29.9†	29.6†	29.7	29.8	25.4†	29.7‡
13	29.0†	29.0†	29.5†	29.7	29.6	25.4†	29.6‡
14	22.1	22.0	22.1	22.2	21.8	22.4	23.5
15	14.5	13.6	13.6	13.2	14.2	15.0	20.0
Glucose							
1′	106.4	105.1	102.7				
2′	75.6	70.2	71.4				
3′	78.1‡	76.9‡	71.6‡				
4′	71.6	69.8	68.7				
5′	77.6‡	76.6‡	71.4‡				
6′	62.7	61.3	62.1				
Others							
			170.6, 170.3		165.6	165.5, 165.2	
			169.4, 169.1		127.6	127.9, 127.5	
			20.6, 20.5		131.6	131.7, 131.6	
			20.3		131.0	131.0, 130.9	
					129.6	129.4	

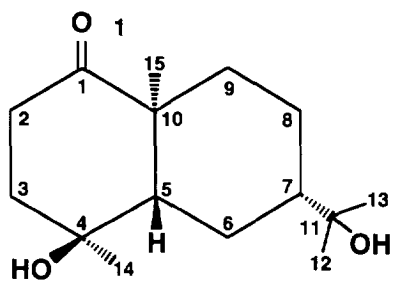
*, †, ‡ Assignments in the same column may be interchanged.
n.o. = not obtained.

C-2, whereas in **5** the additional deshielding of C-11 and the shielding β-effect on C-12 and C-13 were observed. In accord with the NMR data of the aforementioned sesquiterpenes [9, 10], in **3** the shielding of the ^1H and ^{13}C NMR resonances of Me-10 and Me-4 (δ_H0.90 and 1.10, respectively) indicated in the *trans*-decalin model an 1,3-diaxial interaction of the two methyl groups [11].

The chemical shift values of C-5 and C-9 (δ47.3 and 41.2, respectively) accounted for the equatorial configuration of the 7-isopropyl group by virtue of the absence of the δ-*syn*-axial effect of the 11-hydroxyl group on C-5 and C-9 which would otherwise be observed [12].

On oxidation of the secondary hydroxyl group of **3** with manganese dioxide, the *trans*-decal-1-one **6** was obtained. Its positive Cotton effect at 298 nm ([Θ] = + 560) in the circular dichroism curve accounted for an atom predominance in the positive octans which was consistent with the α-orientation of Me-10. The relative and absolute configuration of boarioside and its derivatives was thus fully demonstrated.

Unlike the other eudesmane sesquiterpenes isolated from Celastraceae, the dimethylcarbinol unit of boarioside is not arranged with C-5 in the dihydro-β-agarofuran skeleton. Boarioside is the first eudesmane glucoside isolated from *Maytenus* spp.



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EXPERIMENTAL

A Craig Post apparatus (200 stages, 10 ml:10 ml, upper and lower phase) was used for the sepn by counter-current distribution (CCD); ^1H and ^{13}C NMR: Bruker AM 500 (TMS as int. ref.); EI-MS: HP 5989A; FAB-MS: glycerol as matrix.

Plant material, extraction and separation. The aerial part of *M. boaria* (1 kg) was collected in November 1987 in the Parque Nacional V. Pérez Rosales (IX Region), Chile, and a voucher sample is deposited at the Museo de Historia Natural de Santiago. The methanolic extract (36 g) was partitioned against H_2O (400 ml), followed by EtOAc (300 ml) and then *n*-BuOH (300 ml). The residue of the latter was submitted, in 5 g portions, to CCD between H_2O–EtOAc–*n*-BuOH (5:4:1) and boarioside (K_r = 0.3, 0.93 g) was obtained.

Boarioside (**1**). Mp 200–203° from EtOH and EtOAc. $[\alpha]_D^{20}$ = + 3.1 (MeOH, *c* 0.8); FAB-MS (negative ion mode) *m/z*: 417 $[M-H]^-$, $C_{21}H_{38}O_8$; ^{1}H NMR (CD_3OD): δ4.40 (1H, *d*, *J* = 8.0 Hz, H-1′), 3.93 (1H, *dd*, *J* = 12.3 and 1.5 Hz, H-6′a), 3.75 (1H, *dd*, *J* = 12.3 and 4.7 Hz, H-6′b), 3.45–3.33 (3H, H-3′, H-4′ and H-5′), 3.32 (1H, partially overlapped with other signals, H-1), 3.25 (1H, *dd*, *J* = 8.0 and 9.2 Hz, H-2′), 1.33 (6H, *s*, 2Me-11), 1.19 (3H, *s*, Me-4), 1.08 (3H, *s*, Me-10); ^{13}C NMR: Table 1.

Acetylation of boarioside to give tetraacetylboarioside (**2**). Boarioside was acetylated with a 1:1 mixt. of Ac_2O and pyridine at room temp. overnight. After evaporation of the reagents *in vacuo*, the residue was recrystallized from *n*-hexane, mp 126–128°. $[\alpha]_D^{20}$ = + 9.5 ($CHCl_3$; *c* 0.9); ^{1}H NMR ($CDCl_3$): δ5.09 (1H, *t*, *J* = 9.2 Hz, H-4′), 4.95 (1H, *t*, *J* = 9.2 Hz, H-3′), 4.90 (1H, *dd*, *J* = 9.2 and 8.0 Hz, H-2′), 4.43 (1H, *d*, *J* = 8.0 Hz, H-1′), 4.16 (1H, *dd*, *J* = 12.3 and 4.7 Hz, H-6′a), 4.02 (1H, *dd*, *J* = 12.3 and 1.5 Hz, H-6′b), 3.59 (1H, *ddd*, *J* = 9.2, 4.7 and 1.5 Hz, H-5′), 3.11 (1H, *dd*, *J* = 11.2 and 4.1 Hz, H-1), 1.97 (3H, *s*, Ac), 1.93 (6H, *s*, 2Ac), 1.91 (3H, *s*, Ac), 1.33 (6H, *s*, 2Me-11), 1.19 (3H, *s*, Me-4), 1.08 (3H, *s*, Me-10); ^{13}C NMR: Table 1.

Hydrolysis of **1** to give *aglucone* **3**. β-Glucosidase (10 mg) was added to a soln of **1** (200 mg) in acetate buffer, pH 5.5 (20 ml). The soln was allowed to stand at 34° for 5 days and then extracted with a 1:1 mixt. of EtOAc and *n*-BuOH, and the residue of the organic phase purified by CCD with H_2O–EtOAc–*n*-BuOH (10:9:1), to give pure **3** (K_r = 0.60). Mp 177–179° from EtOAc and *n*-hexane. $[\alpha]_D^{20}$ = + 45.4 (MeOH; *c* 0.6); EI-MS, *m/z* (rel. int.): 239 $[M-17]^+$ ($C_{15}H_{28}O_3$) (1), 222 (16), 221 $[M-17-18]^+$ (100), 204 (12), 203 $[M-17-18-18]^+$ (70); ^{1}H NMR ($CDCl_3$): δ3.30 (1H, *dd*, 11.2 and 4.1 Hz, H-1), 2.00 (2H, *bm*, H_2-3), 1.68 and 1.50 (1H each, *m*, H_2-2), 1.25 and 1.24 (3H each, 2*s*, 2Me-11), 1.10 (3H, *s*, Me-4), 0.90 (3H, *s*, Me-10); ^{13}C NMR: Table 1. The aq. soln was extracted with *n*-BuOH and then percolated through a column of Dowex 50W (H^+). In the residue, D-glucose was identified by TLC and through its β-pentaacetate.

1-p-Bromobenzoyl ester and 1,11-bis (p-*bromobenzoyl-ester*) *of* **3**. *p*-Bromobenzoyl chloride (300 mg) was added to a soln of **3** (50 mg) in dry pyridine (3 ml) and kept overnight at 60°. The reaction mixt., after quenching with MeOH, was evapd to dryness, and the residue was submitted to CCD with the biphase system H_2O–EtOH–Me_2CO–cyclohexane (4:6:3:10). The more mobile derivative was the di-ester **5** (K_r = 0.3), mp 84–87° from *n*-hexane, $[\alpha]_D^{20}$ = + 61.5 ($CHCl_3$; *c* 0.9). ^{1}H NMR ($CDCl_3$): δ7.86 (4H, *d*, *J* = 8.0 Hz, 2H-2″ and 2H-6″), 7.57 (4H, *d*, *J* = 8.0 Hz, 2H-3″ and 2H-5″), 4.90 (1H, *dd*, *J* = 11.2 and 4.1 Hz, H-1), 1.71 (6H, *s*, 2 Me-11), 1.21 (3H, *s*, Me-4), 1.15 (3H, *s*, Me-10); ^{13}C NMR: Table 1.

Compound **4** (K_r = 0.4), mp 97–100° from *n*-hexane, $[\alpha]_D^{20}$ = + 81.8 ($CHCl_3$; *c* 0.7). ^{1}H NMR ($CDCl_3$): δ7.86 (2H, *d*, *J* = 8.0 Hz, H-2″ and H-6″), 7.57 (2H, *d*, *J* = 8.0 Hz, H-3″ and H-5″), 4.83 (1H, *dd*, *J* = 11.2 and 4.1 Hz, H-1), 2.55 (1H, *s*, exchangeable with D_2O, OH), 1.27 and 1.26 (3H each, 2*s*, 2Me-11), 1.19 (3H, *s*, Me-4), 1.15 (3H, *s*, Me-10); ^{13}C NMR: Table 1.

Oxidation of **3** to give *ketone* **6**. Aglucone **3** (20 mg) dissolved in CH_2Cl_2 (20 ml) was stirred with freshly prepd MnO_2 (200 mg) for 5 days. After filtration, the residue of the organic phase was submitted to CCD with H_2O–EtOH–EtOAc–cyclohexane (5:2:4:3). Ketone **6** was obtained as an oil. $[\alpha]_D^{20}$ = + 31.8 ($CHCl_3$; *c* 0.3); CD (MeOH; *c* 1.7×10^{-2}): Cotton effect at 298 nm ($[\Theta]$ = + 560). EI-MS, *m/z* (rel. int.): 253 $[M-1]^+$ (14), 237 $[M-17]^+$ (100), 219 $[M-17-18]^+$ (84); ^{1}H NMR ($CDCl_3$): δ2.55 (1H, *ddd*, *J* = 15.0, 10.5 and 4.5 Hz, H-2a), 2.38 (1H, *ddd*, *J* = 15.0, 6.5 and 4.5 Hz, H-2b), 2.17 (1H, *dd*, *J* = 9.0 and 4.0 Hz, H-5), 2.03 (1H, *m*, *J* = 12.0 Hz, H-6a), 1.98 (1H, *ddd*, *J* = 15.0, 6.5 and 4.5 Hz, H-3a), 1.89 (1H, *ddd*, *J* = 15.0, 11.0 and 4.5 Hz, H-8a), 1.83 (1H, *ddd*, *J* = 15.0, 10.5 and 4.5 Hz, H-3b), 1.72 (1H, *m*, H-7), 1.60–1.55 (3H, H-6b, H-8b and H-9a), 1.43 (1H, *dt*, *J* = 13.5 and 5.3 Hz, H-9b), 1.31 (3H, *s*, Me-10), 1.26 and 1.25 (3H each, 2*s*, 2Me-11), 1.13 (3H, *s*, Me-4); ^{13}C NMR: Table 1.

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