New Bioactive Steroids from *Melia volkensii*

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Melia volkensii Gurke belongs to the family Meliaceae. Plants in this family are rich sources of limonoids and have attracted considerable attention, particularly because of their insect antifeedant and growth inhibitory activities.[1] *M. volkensii* is a tree widely distributed in the dry areas of Eastern Africa. A tea prepared from the bark has been used in local folk medicine to alleviate pain and is reported to be poisonous in overdoses.[2] The crude extracts of both the dried fruit and the leaves have been shown to be toxic, and, when assayed with yellow fever mosquito larvae (*Aedes aegypti*), showed antifeedant and growth inhibiting activities more potent than azadirachtin, the natural pesticide obtained from the related neem seed kernel.[3] In our continuing search for new potential anticancer and pesticidal compounds, we have investigated the root bark of *M. volkensii*, collected in Kenya. Several bioactive limonoids were isolated previously in our laboratory, and, herein, we report the isolation of four new bioactive steroidal compounds: (*E*)-volkendousin (**1**), (*Z*)-volkendousin (**2**), meliavosin (**3**), and 2,19-oxymeliavosin (**4**). Compound **1** showed significant activity in the brine shrimp lethality test (BST),[4,5] the yellow fever mosquito larvae test (YFM),[6] as well as among six human tumor cell lines; its acetonide derivative **1b** showed selectivity for the PC-3 cell line (prostate) at a potency equal to that of adriamycin; **2**−**4** showed weaker activities with marginally significant selectivities for the MCF-7 (breast) cell line.

(*E*)-Volkendousin (**1**) was isolated as white needles. Its molecular formula, $C_{21}H_{30}O_3$, was established by the HRMS of the $[M + H]^+$ at *m/z* 331.2273 (Δ−0.01 mmu of calcd). The UV spectrum of **1** showed a maximum absorption at 242 nm, which is characteristic for α,*β*-unsaturated ketones. Strong absorptions at 1716 and 1644 cm^{-1} in the IR spectrum further specified the existence of an α,*β*-unsaturated cyclopentanone.[7]

In the ^1H and ^{13}C NMR spectra of **1**, signals were seen due to three methyls, in which one is secondary and two are tertiaries, six methylenes, seven methines, two of which are oxygenated and two are from trisubstituted double bonds, and one carbonyl group. These moieties accounted for three of the seven degrees of unsaturation, and the other four unsaturation units were concluded to originate from the four rings of a steroidal system. Data from COSY, relayed COSY, and HMBC established the tetracyclic framework of **1**, with the D ring being an unusual α,*β*-unsaturated cyclopentanone. The placement of the two hydroxyl groups on C-3 and C-4 was supported directly by a correlation observed between H-4 and C-6, and indirectly by the correlation observed between C-1 and H-19 in the HMBC spectrum. HMBC data also suggested the sites for the attachment of the two tertiary methyls: the methyl signal at *δ* 1.22, which showed correlations with C-1, C-5, and C-9, was placed on C-10; the other methyl at *δ* 1.03, which showed correlations with C-12, C-13, C-14, and C-17, was placed on C-13.

Two oxymethines in **1** could be identified as two carbinol protons by an IR band at 3346 cm^{-1}, as well as by two significant peaks at *m/z* 313 and 295 formed by consecutive losses of water (18 mmu) from the $[M + H]^+$ in the CIMS spectrum. Treatment of **1** with acetic anhydride in pyridine afforded a mixture of diacetate derivatives, **1a** and **2a** (Figure 1), which confirmed this conclusion. The relative stereochemistry of these two hydroxyl groups was determined to be *cis* according to the coupling constants of the two carbinol protons in the ^1H NMR spectrum. The proton at *δ* 3.48 (H-3) appeared as a double triplet with *J* couplings of 4.0 and 12.0 Hz, indicating an axial orientation; the proton at *δ* 4.06 (H-4) appeared as a broad doublet (possibly due to the *W*-type long-range coupling with 2α-H and the allylic coupling with H-6) with a *J* coupling of 3.0 Hz and, therefore, was concluded to be equatorial. Further support for this conclusion came from the ^1H NMR spectrum of **1b**, the acetonide of **1**, which was obtained by treatment of **1** with *p*-toluenesulfonic acid in dry acetone. The ^1H NMR spectrum of **1b** showed two distinct signals at *δ* 1.34 (H-3′) and 1.52 (H-2′) (Table 1) for the two acetonyl methyls; distinct signals are characteristic for a *cis*-diol,[8−10] since *trans*-diols generally give only one overlapped signal for the two methyls.[8,11] The orientation of the methyls on C-10, C-13 and the conformation of **1** were determined through the use of the NOESY data. The important correlations are shown in Figure 2.

(*Z*)-Volkendousin (**2**) was also isolated as white needles. The structure elucidation of **2** proceeded rapidly by comparing its spectral data with those of **1**. The molecular formula of **2**, $C_{21}H_{30}O_3$, as indicated by the molecular ion at *m/z* 331.2273 (Δ−0.014 mmu of calcd), was the same as that of **1**. The ^1H NMR spectrum of **2** resembled that of **1** except for the chemical shifts for H-20 and H-21 (Table 2). These observations suggested that **2** was (*Z*)-volkendousin, a geometric isomer of **1**. The chemical shift differences for H-20 and H-21 between **1** and **2,** as observed in their ^1H NMR spectra, were due to the

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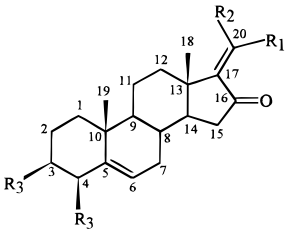
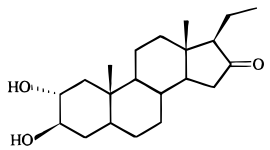


1	R_1 = H	R_2 = CH_3	R_3 = OH
1a	R_1 = H	R_2 = CH_3	R_3 = OAc
1b	R_1 = H	R_2 = CH_3	R_3 = acetonide
2	R_1 = CH_3	R_2 = H	R_3 = OH
2a	R_1 = CH_3	R_2 = H	R_3 = OAc

Figure 1. Structures of **1**, **2**, and their derivatives (**1a**, **1b**, and **2a**).

anisotropic effect of the carbonyl group at C-16. The vinyl proton or the methyl group syn to the carbonyl oxygen would experience a deshielding effect and appear with a higher chemical shift compared with the same group in its geometric isomer. Therefore, **2** was concluded to be (*Z*)-volkendousin.

The third new steroidal compound, meliavosin (**3**), was isolated as white prisms. Its molecular formula, $C_{21}H_{34}O_3$, was indicated by the molecular ion at *m/z* 334.2586 (Δ −0.004 mmu of calcd) in the HRMS. The central framework of **3** was substantiated by COSY, HMQC, and HMBC correlations, and by comparing the ^{1}H and ^{13}C NMR data with those of **1**.

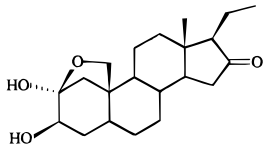


3

The ^{1}H and ^{13}C NMR spectra of **3**, besides other signals, showed resonances due to one primary methyl, two tertiary methyls, two oxymethines, and one carbonyl group. By examining the ^{1}H NMR and the HMBC data of **3**, the two tertiary methyls at δ 0.66 and δ 0.86 were assigned to H-18 and H-19, respectively. The secondary methyl signal (H-21) as shown in **1** was not seen in the ^{1}H NMR spectrum of **3**; instead, a triplet due to a primary methyl was observed, suggesting that the double bond between C-20 and C-21 in **1** was reduced.

The two oxymethines in **3** were indicated by an IR band at 3360 cm^{-1} and by the two significant peaks at *m/z* 317 and 299 formed by consecutive losses of water from the molecular ion in the CIMS spectrum. These two hydroxyl groups were concluded to be adjacent to each other, since a correlation between the two carbinol protons at δ 3.39 and δ 3.58 was observed in the COSY spectrum. Moreover, each carbinol proton showed correlation with a different methylene group. The only possible positions for these two hydroxyls on the tetracyclic skeleton were, then, on C-2 and C-3. The signals of both H-2 and H-3 appeared as a doublet of doublet of doublets with *J* couplings of 5.0, 9.0, and 11.0 Hz in the ^{1}H NMR spectrum. The large coupling constants of 9.0 and 11.0 Hz indicated that both carbinol protons take axial orientations.

The fourth steroidal compound, isolated as white needles, was 2,19-oxymeliavosin (**4**). The molecular formula of **4** was established to be $C_{21}H_{32}O_4$, based on the HRMS of the molecular ion peak at *m/z* 348.2379 (Δ 0.013 mmu of calcd). Compared with **3**, **4** contains one more unit of unsaturation and one more oxygen atom.



4

Parts of the ^{1}H and ^{13}C NMR data of **4** were very similar to those of **3**, suggesting that the two compounds are closely related. However, **4** contained only one tertiary methyl instead of two. The methyl signal at δ 0.86 (H-19) in the ^{1}H NMR spectrum of **3** was not seen in that of **4**; instead, an oxymethylene group with two proton signals at δ 3.73 and δ 4.00 were observed. Moreover, one of the two oxymethine signals in the ^{13}C NMR of **3** was replaced by a quaternary carbon at δ 104.31 in that of **4**. These observations suggested that an oxy linkage between C-2 and C-19 or between C-3 and C-19 was formed in **4**. The COSY spectrum of **4** revealed that the carbinol at δ 3.62 (H-3) was coupled with two methylene protons at δ 1.15 (H-4) and 2.12 (H-4), which were further coupled with a methine proton at δ 1.50 (H-5). Therefore, the oxy linkage was placed between C-2 and C-19. The HMBC data (Table 3) agreed well with this conclusion. Thus, **4** was concluded to be 2,19-oxymeliavosin. The conformation of **4** and the orientation of the two hydroxyl groups were examined with the NOESY spectrum, and some of the important correlations are shown in Figure 3. The correlations between H-3 and H-1,4,5 suggested that ring A has a chair conformation, and, consequently, a 2β,10β-oxide linkage will be much more favorable energetically than a 2α,10β-oxide linkage. Therefore, we assigned an α orientation for the hydroxyl group on C-2.

(*E*)-Volknedousin (**1**) was active in the BST and YFM tests and showed significant cytotoxicities among the six human tumor cell lines tested. On the other hand, the *Z* isomer, **2**, showed much less activity. However, **1** and **1b** showed activities for the prostate cell line (PC-3) at potencies equivalent to that of adriamycin, with **1b** showing good selectivity. Meliavosin (**3**) and 2,19-oxymeliavosin (**4**) showed only weak activities in all of the tests with marginally significant selectivity for the breast cell line (MCF-7).

Experimental Section

General Experimental Procedures. Mps were determined on a Fisher-Johns melting point apparatus, and the thermometer was used without correction. The optical rotations were determined on a Perkin-Elmer 241 polarimeter. UV spectra were taken in MeOH on a

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Table 1. ^{1}H and ^{13}C NMR Data of 1 and 1b

	1				1b			
no.	δ C (mult)	δ H (mult)	coupling(s) (Hz)	HMBC	δ C (mult)	δ H (mult)	coupling(s) (Hz)	HMBC
1	36.56 (t)	1.06 m		19	32.30 (t)	1.14 m		19
		1.83 m				1.74 m		
2	25.16 (t)	1.64 m			25.75 (t)	1.64 m		4
		1.90 m						
3	72.31 (d)	3.48 dt	4.0, 12.0		75.51 (d)	4.10 dt	6.0, 6.5	
4	77.06 (d)	4.06 bd	3.0	6	80.44 (d)	4.40 d	6.0	6
5	142.9 (s)			7, 19	138.6 (s)			19
6	127.9 (d)	5.62 dd	2.5, 5.0	4, 7	130.0 (d)	5.79 dd	2.5, 4.5	4, 7
7	31.70 (t)	1.65 m			31.57 (t)	1.70 m		
		2.09 dt	5.0, 18.0			2.13 dt	5.0, 18.0	
8	30.48 (d)	1.75 m		6, 15	30.41(d)	1.80 m		6
9	49.79 (d)	1.04 m		7, 19,	48.13 (d)	1.10 m		7, 19
10	36.10 (s)			6	36.25 (s)			4, 6, 19
11	20.15 (t)	1.62 m			32.30 (t)	1.64 m		
12	35.97 (t)	1.65 m		18	36.09 (t)	1.65 m		18
		2.32 m				2.33 m		
13	42.96 (s)			18, 20	43.07 (s)			5, 18, 20
14	50.42 (d)	1.42 ddd	7.0, 11.0, 14.5	15, 18	50.46 (d)	1.45 ddd	7.0, 14.0, 17.5	15, 18
15	37.86 (t)	1.99 dd	14.5, 17.0		37.85 (t)	2.02 dd	7.0, 17.0	
		2.20 dd	7.0, 17.0			2.19 dd	14.5, 17.0	
16	206.3 (s)			15, 20, 21	206.2 (s)			15, 20, 21
17	147.6 (s)			18, 20, 21	147.6 (s)			18, 20, 21
18	17.33 (q)	1.03 s			17.48 (q)	1.04 s		
19	20.92 (q)	1.22 s			21.44 (q)	1.20 s		
20	129.9 (d)	6.50 q	7.5	21	129.4 (d)	6.49 q	7.5	21
21	13.18 (q)	1.82	7.5		13.18 (q)	1.84 d	7.5	
1′					108.1 (s)			3, 2′, 3′
2′β					28.00 (q)	1.52		3′
3′α					25.65 (q)	1.34		2′

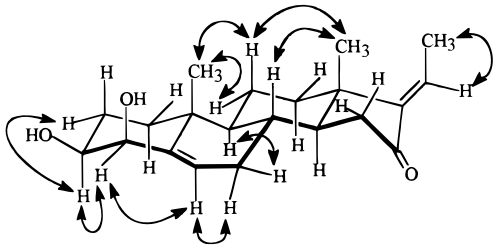

Figure 2. Selective NOESY correlations for **1**.

Beckman DU-640 spectrophotometer. IR spectra were taken on a Perkin-Elmer 1600 FTIR spectrophotometer. The NMR spectra were recorded at 500 MHz for ^{1}H and 125 MHz for ^{13}C on a Varian VXR-500S spectrometer. Standard pulse sequences were employed for the DEPT, HMQC, and HMBC experiments. NOESY spectra were measured with mixing times of 600 ms. Low-resolution MS were recorded on a Finnigan 4000 mass spectrometer. The exact masses were obtained on a Kratos 50 mass spectrometer. HPLC was performed on Dynamax-60A 8 μm silica gel columns.

Plant Material. The root bark of *M. volkensii* (B-644035, BRS-2-193) was collected in October, 1971, in Kenya for the National Cancer Institute, National Institutes of Health, under the auspices of Dr. Robert E. Perdue, Medicinal Plant Laboratory, U.S.D.A., Beltsville, MD, where voucher specimens are maintained.

Biological Evaluations. The extracts, fractions, and compounds isolated from the title plant were routinely evaluated for lethality to brine shrimp larvae (BST). Crude extracts resulting in LC_{50} values of less than 200 ppm were considered significantly active. The isolated compounds were also evaluated by the yellow fever mosquito larvae (YFM) test with rotenone as the positive control; pure compounds with LC_{50} values < 1 ppm are considered worthy of development as pesticides. The cytotoxicity test against six human solid tumor cell lines were performed in 7-day MTT tests at the Cell Culture Laboratory, Purdue Cancer Center, using adriamycin as a positive control in each run.

Extraction and Isolation. Powdered root bark of *M. volkensii* was extracted by ethanol (100 L) for 7 days using a continuous extractor at 22 °C. The ethanol residue (F001, 502 g) was partitioned four times between CH_2Cl_2 and water (1:1) to give water soluble (F002, 307 g), CH_2Cl_2 soluble (F003, 190 g), and the interfacial (F004, 4.8 g) portions. The F003 fraction was further partitioned four times between hexane and 90% methanol in water (1:1) to give 90% methanol (F005, 160 g) and hexane portions (F006, 30 g). The partitioning steps were monitored by the BST test. The bioactive F005 fraction (LC_{50} 0.18 ppm) was subjected to column chromatography (silica gel, 1350 g), eluted in a gradient fashion with hexanes−EtOAc−MeOH; 61 fractions were collected, and the residues of each fraction were tested by the BST. Active fractions were pooled and subjected to repeated chromatography over silica gel columns and further purified by HPLC to give white needles of **1** (45.6 mg), white needles of **2** (3 mg), white prisms of **3** (5 mg), and white needles of **4** (1.8 mg).

(*E*)-Volkendousin (1): white needles; mp 193−196 °C; $[\alpha]^{25}_D$ −163.5° (*c* 0.34, MeOH); UV (MeOH) λ_{max} 242 nm; log ϵ 3.88; IR (film) cm^{-1}, 3346, 2932, 1716, 1644, 1066; ^{1}H and ^{13}C NMR data are given in Table 1; CIMS *m/z* 331 ([M + H]$^+$, 37.3), 313 ([M − H_2O + H]$^+$, 100), 295 ([M − 2H_2O + H]$^+$, 16.4); HRCIMS *m/z* 331.2283 (calcd 331.2273).

Formation of the Acetonide of 1 (1b). A mixture of **1** (14.1 mg), *p*-toluenesulfonic acid (5.9 mg), dry acetone (10 mL), and molecular sieves (1 g) (Davison, type 5A, grade 522, 8−12 mesh beads) was stirred at room temperature for 9 h. Sodium bicarbonate 3.2 mg was then added, and the mixture was allowed to stir for

Table 2. ^{1}H and ^{13}C NMR Data of 2

no.	δ C (mult)	δ H mult	coupling(s) (Hz)	HMBC (C to H)	no.	δ C (mult)	δ H mult	coupling(s) (Hz)	HMBC (C to H)
1	36.56 (t)	1.06 m		19	11	20.15 (t)	1.62m		
		1.83 m			12	35.97 (t)	1.65 m		18
2	25.16 (t)	1.64 m					2.32 m		
		1.90 m			13	42.96 (s)			18, 20
3	72.31 (d)	3.48 dt	4.0, 12.0		14	50.42 (d)	1.42 ddd	7.0, 11.0, 14.5	15, 18
4	77.06 (d)	4.06 bd	3.0	6	15	37.86 (t)	1.99 dd	14.5, 17.0	
5	142.9 (s)			7,19			2.20 dd	7.0, 17.0	
6	127.9 (d)	5.62 dd	2.5, 5.0	7	16	206.3 (s)			15, 20, 21
7	31.70 (t)	1.65 m			17	147.6 (s)			18, 20, 21
		2.09 dt	5.0, 18.0		18	17.33 (q)	1.03 s		
8	30.48 (d)	1.75 m		6, 15	19	20.92 (q)	1.22 s		
9	49.79 (d)	1.04 m		7, 19	20	129.9 (d)	6.50 q	7.5	21
10	36.10 (s)			6	21	13.18 (q)	1.82	7.5	

Table 3. ^{1}H and ^{13}C NMR Data of 3 and 4

	3				**4**			
no.	δ C (mult)	δ H mult	coupling (Hz)	HMBC (C to H)	δ C (mult)	δ Hmult	coupling (Hz)	HMBC (C to H)
1	44.67 (t)	0.98 m		19	41.97 (t)	1.22 d	11.5	19
		1.98 dd	5.0, 17.5	1		2.35 d	11.5	
2	72.92 (d)	3.58 ddd	5.0, 9.0, 11.0	1, 4	104.3 (s)			1, 19
3	76.31 (d)	3.39 dt	5.0, 9.0, 11.0	1, 4	73.68 (d)	3.62 bt	6.5	1, 4
4	35.47 (t)	1.35 m			38.06 (t)	1.15 dt	10.5, 12.5	
		1.61 m				2.12 dt	6.0, 13.0	
5	44.78 (d)	1.23 m			42.79 (d)	1.50 m		1, 4
6	27.62 (t)	1.24 m			29.02 (t)	1.25 m		
		1.35 m				1.64 m		
7	32.03 (t)	1.60 m			31.50 (t)	0.94 dq	4.5, 12.0	
						1.61 m		
8	33.76 (d)	1.49 m		14, 15	36.09 (d)	1.23 m		
9	54.25 (d)	0.88 m		1, 12	45.96 (d)	1.04 m		12
10	37.58 (s)			1, 19	47.46 (s)			1
11	20.82 (t)	1.63 m			20.89 (t)	1.48 dq	3.0, 13.5	
						1.78 dq	4.0, 13.5	
12	38.10 (t)	1.34 m		18	37.76 (t)	1.36 m		
		1.88 dd	3.0, 9.0			1.93 dt	3.5, 12.5	
13	42.11 (s)			15, 18	41.77 (s)			15, 18
14	50.33 (d)	1.40 dd	7.5, 13.0	12, 18	50.38 (d)	1.35 m		12, 18
15	38.44 (t)	1.73 dd	13.0, 18.0 17.0		38.33 (t)	1.70 dd	13.0, 18.5	
		2.19 dd	7.5, 18.0			2.20 dd	8.0, 18.5	
16	219.7 (s)			15	209.0 (s)			
17	65.27 (d)	1.65 m		18, 21	65.19 (d)	1.64 m		18, 21
18	13.43 (q)	0.66 s			13.21 (q)	0.63 s		
19	13.48 (q)	0.86 s			67.39 (t)	3.73 d	8.5	
						4.00 d	8.5	
20	17.58 (t)	1.25 m		21	17.55 (t)	1.25 m	7.5	21
		1.64 m				1.62 m		
21	13.40 (q)	0.99 t	7.5		13.38 (q)	1.00 t	7.5	20

Table 4. Bioactivities of Compounds 1−4 and 1b

	LC_{50} (μg/mL)		IC_{50} (μg/mL)					
no.	BST[a]	YFM[b]	A-549[c]	MCF-7[d]	HT-29[e]	A-498[f]	PC-3[g]	PACA-2[h]
1	29.21	6.90	8.95×10^{-1}	3.87	3.44×10^{-1}	3.91×10^{-1}	1.99×10^{-1}	2.80×10^{-1}
1b	−	>100	1.51	32.63	14.07	2.55	2.66×10^{-1}	5.25
2	−	>100	22.51	3.19	12.44	13.36	3.68	24.28
3	−	>100	27.65	3.79	26.80	31.71	6.00	31.80
4	−	>100	18.63	3.33	12.44	16.56	4.47	12.43
adr[i]	−	−	7.42×10^{-3}	2.11×10^{-1}	2.91×10^{-2}	3.71×10^{-2}	2.66×10^{-1}	7.09×10^{-3}
rotanone[j]	4.9×10^{-2}	0.80	−	−	−	−	−	−

[a] Brine shrimp lethality test.[4,5] [b] Yellow fever mosquito larva test.[6] [c] Human lung carcinoma.[12] [d] Human breast carcinoma.[13] [e] Human colon adenocarcinoma.[14] [f] Human kidney carcinoma.[12] [g] Human prostate adenocarconoma.[15] [h] Human pancreatic carcinoma.[16] [i] Adriamycin was used as a positive control standard. [j] Rotanone was used as a positive YFM control.

another 10 min. After removal of the molecular sieves by filtration, the products were purified over a small pipet silica gel column, eluted by hexane−CH_2Cl_2 (2:8) to give **1b** (8.2 mg). Compound **1b**: white needles; mp 171−173 °C; $[\alpha]^{25}_D$ −16.7° (*c* 0.006, MeOH); UV (MeOH) λ_{max} 242 nm; log ϵ 3.59; IR (film) cm^{-1}, 2395, 1719, 1648, 1172, 1056; ^{1}H and ^{13}C NMR data are given in Table 1; CIMS *m*/*z* 371 ([M + H]$^+$, 100), 313 ([M − Me_2CO + H]$^+$, 100); HRCIMS *m*/*z* 371.2598 (calcd 371.2586).

(*Z*)-Volkendousin (2): white needles; mp 194−197 °C; $[\alpha]^{25}_D$ −812.5° (*c* 0.008, MeOH); UV (MeOH) λ_{max} 242 nm; log ϵ 4.16; IR (film) cm^{-1}, 3397, 2945, 1713, 1642, 1068; ^{1}H and ^{13}C NMR data are given in Table 2; CIMS *m*/*z* 331 ([M + H]$^+$, 91.8), 313 ([M − H_2O + H]$^+$, 100), 295 ([M − $2H_2O$ + H]$^+$, 5.5); HRCIMS *m*/*z* 331.2287 (calcd 331.2273).

Meliavosin (3): white prisms; mp 224−226 °C; $[\alpha]^{25}_D$ −171.4° (c 0.07, MeOH); UV (MeOH) λ_{max} 248 nm; log ϵ

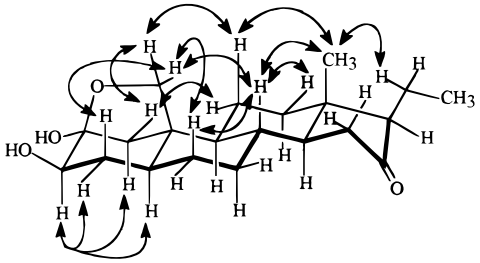

Figure 3. Selective NOESY correlations for **4**.

4.64; IR (film) cm^{-1}, 3360, 2930, 2849, 1738, 1648, 1055; ^1H and ^{13}C NMR data are given in Table 3; CIMS *m/z* 335 ($[M + H]^+$, 100), 317 ($[M - H_2O + H]^+$, 90.9), 317 ($[M - 2H_2O + H]^+$, 32.7); HRCIMS *m/z* 335.2590 (calcd 335.2586).

2,19-Oxymeliavosin (4): white needles; mp 162−164 °C; $[\alpha]^{25}_D$ −61.1° (*c* 0.18, MeOH); UV (MeOH) λ_{max} 243 nm; log ϵ 2.41; IR (film) cm^{-1}, 3398, 2931, 2871, 1737; ^1H and ^{13}C NMR data are given in Table 3; CIMS *m/z* 349 ($[M + H]^+$, 100), 331 ($[M - H_2O + H]^+$, 63.6); HRCIMS *m/z* 349.2366 (calcd 349.2379).

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Supporting Information Available: ^1H and ^{13}C NMR spectra of (*E*)-volkendousin (**1**), (*Z*)-volkendousin (**2**), meliavosin (**3**), and 2,19-oxymeliavosin (**4**) (8 pages). This material is contained in libraries on microfiche, immediately follows this article in the microfilm version of the journal, and can be ordered from the ACS; see any current masthead page for ordering information.

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