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SESQUITERPENE LACTONES FROM *SCHKUHRIA PINNATA*

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Key Word Index—*Schkuhria pinnata* var. *abrotanoides*; Compositae; sesquiterpene lactones; heliangolides; germacranolides; schkuhripinnatolide C; flavonoid.

Abstract—Whole plants of *Schkuhria pinnata* var. *abrotanoides* yielded, in addition to known sesquiterpene lactones, five new heliangolides, a germacranolide, schkuhripinnatolide C and pectolarigenin.

INTRODUCTION

Schkuhria Roth is a small genus with *ca* six species [1, 2], three of which are almost exclusively limited to Mexico; two species with some varieties grow in North and South America and only one is endemic to South America.

The taxonomy of the Argentinian species was clarified by Cabrera [3], who recognized two species with three varieties each: *S. pinnata* (Lam.) Kuntze and *S. multiflora* H. et. A., Heiser [2] in a monograph of the genus, accepted this classification as correct. Since the only reliable difference between the varieties is said to be the nature of the pappus, it was of interest to obtain chemical information that may support or not this delimitation.

Schkuhria pinnata and its varieties have some use in popular medicine as insect repellents or insecticides, particularly to kill fleas [2].

Previous chemical investigations on the members of this genus yielded several acetylenic compounds [4, 5], hydrocarbons [6], sterols and triterpenes [7], germacranolides [5, 8–14], elemanolides [15–17], labdanes [18] and the so-called schkuhripinnatolides [14].

RESULTS AND DISCUSSION

Pectolinarigenin, the known heliangolide eucannabinolide (**1a**) [8, 10], schkuhrin II (**1b**) [8], chromolaenolide (**1c**) [19], santhemoidin A (**1d**) [13], the heliangolide **1e** previously isolated as a diacetate [11], the new heliangolides **1f**, **1g**, **2a** and **2b**, and schkuhripinnatolide C (**3**) [14] were isolated from *S. pinnata* var. *abrotanoides* (Roth) CaBr.

The sesquiterpene lactone **2a** was assigned the molecular formula $C_{20}H_{26}O_8$ (high resolution MS). The IR spectrum showed hydroxyl (3427 *br* cm^{-1}), α-methylene-γ-lactone (1740 cm^{-1}) and ester (1723 cm^{-1}) absorption bands. The ^1H NMR spectrum of **2a** exhibited typical signals of a heliangolide with a 3-β-OH substitution similar to those of other heliangolides described in the literature [20]. The presence of a 4(5) *cis* double bond, a 6, 12 *trans*-lactone as well as an 8β-acyloxy residue vicinal to H-9 and H-9′ were determined by spin decoupling experiments (Table 1). The ^1H NMR pattern resembled that of leptocarpin [20], except for the absence of signals of an 8-β-acyloxy residue. Instead, it showed the typical signals of the 4,5-dihydroxy tiglate moiety (Table 1) which was corroborated by both the peak at *m/z* 105 (produced by the loss of 26 amu from the side chain) in the mass spectrum and the ^{13}C NMR spectrum (Table 2).

The structure of **2b** was readily elucidated since its NMR spectra were similar to those of **2a**, the only difference being the presence of signals for a furoate moiety at C-8 (Tables 1 and 2).

The ^1H and ^{13}C NMR spectra (Tables 1 and 2) of **1g** were very close to those of eucannabinolide (**1a**), except for the signals for the side chain at C-8. These showed the presence in **1g** of the isomeric 2,3-dihydroxy-angeloyloxy residue found in **1a**.

The NMR spectra of **1f** clearly showed the same signal pattern as in **1g**, the 3-acetoxy group being replaced by a 2-OH-isovalerate moiety.

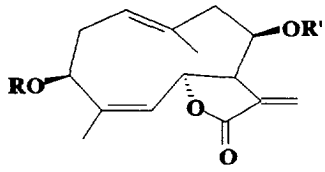
The chemistry of *S. pinnata* var. *abrotanoides* seems to be in line with the species studied so far.

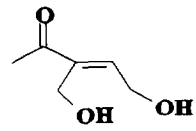
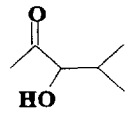
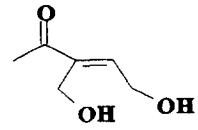
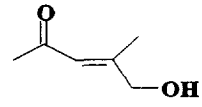
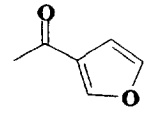
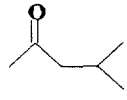
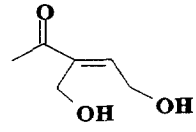
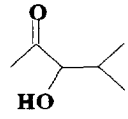
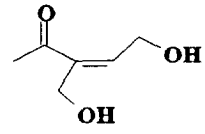
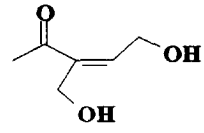
EXPERIMENTAL

HPLC: reverse phase mode Lichrosorb RP-18, MeOH–H_2O, detection by UV.

Plant material. Schkuhria pinnata var. *abrotanoides* was collected in January from the University Campus, Córdoba, Argentina and identified by Dr Luis Ariza Espinar. A voucher specimen (#232) is on deposit at the Museo Botánico Córdoba (CORD).

Extraction and isolation. Air-dried whole plant material (670 g) was exhaustively extracted with EtOH at room



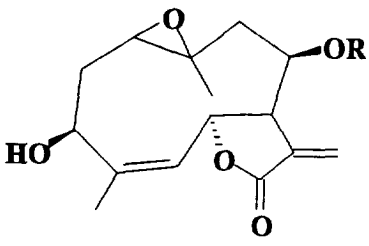
	R	R'
1a	Ac	
1b		
1c	Ac	
1d	Ac	
1e		
1f		
1g	Ac	

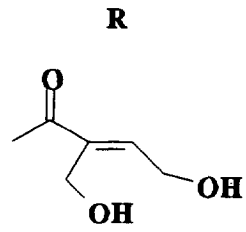
temp. The extract was partitioned with hexane–MeOH–H_2O (10:3:1). Extraction of the polar layer with $CHCl_3$, evapn and drying over Na_2SO_4, yielded 43.6 g of crude extract which was fractionated by CC on silica gel using hexane–EtOAc, EtOAc–MeOH mixts of increasing polarity.

Frs 22–33 provided pectolinarigenin; mp 206–207°, and UV, ^1H NMR and EIMS spectra coincident in all respects with lit. data [21]. The mother liquors (325 mg) were chromatographed by 'dry column' CC over silica gel using hexane–EtOAc mixts yielding 23 mg of pure **1c**. Frs 47–49 (550 mg) were purified by 'dry column' CC (as above) and by further radial chromatography providing 20 mg of **1a**. Purification of fr. 50 by 'dry column' CC followed by prep. HPLC yielded 30 mg **1a**, 5 mg **1b**, 30 mg **1d**, 22 mg **1f**, 20 mg **1g**, 7 mg **2a**, 6 mg **1e** and 22 mg **2b** and 17 mg **3**.

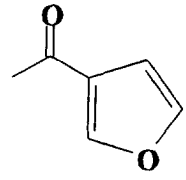
Compound **1e**. Amorphous solid. UV (MeOH): 225 nm; IR ν_{max}^{KBr} cm^{-1}: 3454 (hydroxyl), 1765 (α-methylene-γ-lactone), 1703 (ester), 1663 (ester); EIMS, *m/z* (rel. abundance): 368 $[M - 26]^+$ (1.0), 262 $[M - C_5H_8O_4]^+$ (2.1), 244 $[M - C_5H_8O_4 - H_2O]^+$ (1.8), 94 $(C_5H_3O_2]^+$ (19.4), 43 (100); ^1H and ^{13}C NMR: Tables 1 and 2.

Compound **1f**. Amorphous solid. UV (MeOH): 225 nm; IR ν_{max}^{KBr} cm^{-1}: 3440 (hydroxyl), 1749 (α-methylene-γ-lactone), 1723 (ester), 1664 (ester); EIMS, *m/z* (rel. abund-





2a



2b

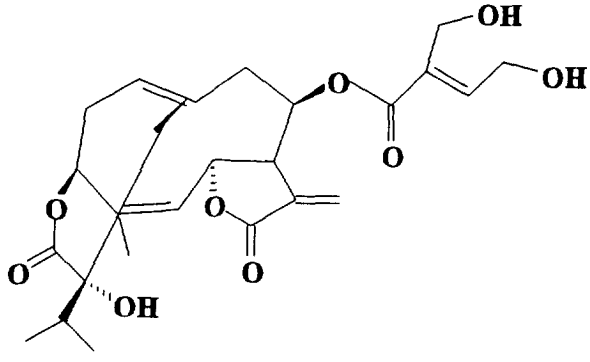


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Table 1. ^{1}H NMR spectra of **1e–1g**, **2a** and **2b**

H	1e	1f	1g	2a	2b
1	5.20 *m*	5.20 *m*	5.25 *m*	2.88 *dd* (10,4)	2.90 *dd* (10,4)
2	2.70 *m*	2.73 *m*	2.71 *m*		in 2.90
2′	2.30 *m*	2.45 *m*	2.45 *br d*		
3	5.20 *m*	5.25 *m*	5.25 *m*		
5	5.16 *dd* (10.5, 1.5)	5.18 *dd*	5.17 *dd*	5.29 *dd* (10,1)	5.26 *dd* (10,1)
6	5.91 *dd* (10.5, 2.5)	5.92 *dd* (10,2.1)	5.92 *dd* (10,2)	6.20 *dd* (12,3)	6.31 *dd* (12,3)
7	3.00 *m*	2.97 *m*	2.98 *m*	2.91 *m*	2.92 *m*
8	5.20 *m*	5.25 *m*	5.25 *m*	5.22 *m*	5.25 *m*
9	2.70 *m*	2.82 *m*	2.80 *dd*		in2.90
9′	2.41 *dd* (14,2)	2.50 *m*	2.40 *m*		
13a	6.35 *d* (2.1)	6.39 *d* (2.2)	6.39 *d* (2)	6.39 *d* (2.1)	6.36 *d* (2.1)

(*Contd.*)

Table 1. *Continued*

H	1e	1f	1g	2a	2b
13b	5.80 *d* (2.0)	5.80 *d* (2.0)	5.80 *d* (2.0)	5.81 *d* (2.0)	5.80 *d* (2.0)
14	1.80 *br**	1.81 *br**	1.81 *br**	1.50 *s**	1.50 *s**
15	1.85 *d** (1.5)	1.83 *d** (1.5)	1.83 *d** (1.4)	1.91 *d** (1)	1.94 *d** (1)
3′	6.93 *t* (6.7)	6.95 *t* (6.5)	6.95 *t* (6.5)	6.95 *t* (6.7)	6.78 *dd* (1.7,1)
4′	4.40 *d*† (6.7)	4.41 *d*† (6.5)	4.41 *d*† (6.5)	4.40 *d*† (6.7)	7.42 *t* (1.7)
5′	4.30 *br*†	4.31 *d*† (6.5)	4.31 *d*† (6.5)	4.32 *br*†	7.96 *dd* (1.7,1)
2″		4.05 *d* (4.5)			
3″	1.00 *d** (7.2)	1.05 *d** (6.9)			
4″	0.90 *d** (7.2)	0.95 *d** (6.9)			

*Intensity three protons.
†Intensity two protons.
(200.13 MHz,. in $CDCl_3$, TMS as int. standard).

Table 2. ^{13}C NMR spectra of **1e–1g**, **2a** and **2b**

C	1e	1f	1g	2a	2b
1	126.4 *d*	126.1 *d*	125.2 *d*	60.1 *d*	60.2 *d*
2	29.5 *t*	29.5 *t*	29.4 *t*	30.5 *t*	30.5 *t*
3	77.6 *d*	79.6 *d*	77.9 *d*	77.0 *d*	72.9 *d*
4	137.1 *s*	137.3 *s*	137.2 *s*	139.0 *s*	138.1 *s*
5	126.4 *d*	126.3 *d*	126.5 *d*	125.4 *d*	125.8 *d*
6	78.9 *d*	75.8 *d*	76.0 *d*	74.9 *d*	76.6 *d*
7	48.5 *d*	48.5 *d*	48.5 *d*	48.4 *d*	48.3 *d*
8	75.9 *d*	77.9 *d*	76.4 *d*	76.4 *d*	74.6 *d*
9	43.4 *t*	43.4 *t*	43.4 *t*	43.4 *t*	43.4 *t*
10	136.1 *s*	136.9 *s*	137.1 *s*	58.2 *s*	58.2 *s*
11	135.1 *s*	135.4 *s*	135.5 *s*	134.1 *s*	134.1 *s*
12	165.6 *s*	165.5 *s*	165.6 *s*	165.4 *s*	165.4 *s*
13	125.3 *t*	126.2 *t*	125.2 *t*	125.8 *t*	125.3 *t*
14	19.5 *q*	21.2 *q*	19.4 *q*	19.5 *q*	19.4 *q*
15	23.0 *q*	23.1 *q*	23.1 *q*	23.0 *q*	23.1 *q*
1′	170.1 *s*	169.8 *s*	169.8 *s*	169.5 *s*	169.5 *s*
2′	135.9 *s*	135.9 *s*	131.2 *s*	136.6 *s*	136.3 *s*
3′	145.5 *d*	145.4 *d*	145.6 *d*	145.5 *d*	109.4 *d*
4′	56.6 *t*	57.2 *t*	56.7 *t*	56.9 *t*	144.3 *d*
5′	59.0 *t*	59.3 *t*	59.0 *t*	59.2 *t*	147.9 *d*
1″	172.5 *s*	172.5 *s*	172.5 *s*		
2″	32.3 *d*	76.1 *s*	21.2 *q*		
3″	18.8 *q*	18.8 *q*			
4″	16.5 *q*	16.3 *q*			

(50.03 MHz, in $CDCl_3$, TMS as int. standard).

ance): 479 $[M + 1]^+$ (0.65), 361 $[M - C_5H_9O_3]$ (1.97), 229 $[M - C_5H_8O_4 - C_5H_8O_3]^+$ (100); ^1H and ^{13}C NMR: Tables 1 and 2.

Compound **1g**. Amorphous solid. UV (MeOH): 229 nm; IR ν_{max}^{KBr} cm^{-1}: 3447 (hydroxyl), 1749 (α-methylene-γ-lactone), 1722 (ester), 1689 (ester); EIMS, *m/z* (rel. abundance): 421 $[M + 1]^+$ (5.51), 361 $[M - C_2H_3O_2]^+$ (50.24), 343 $[M - C_2H_3O_2 - H_2O]^+$ (2.22), 229 $[M - C_5H_8O_4 - C_2H_3O_4]^+$ (100); ^1H and ^{13}C NMR: Tables 1 and 2.

Compound **2a**. Amorphous solid. UV (MeOH): 219 nm; IR ν_{max}^{KBr} cm^{-1}: 3427 (hydroxyl), 1749 (α-methylene-γ-lactone), 1723 (ester); EIMS, *m/z* (rel. abundance): 368 $[M - 26]^+$ (1.6), 262 $[M - C_5H_8O_4]^+$ (4.7), 244 $[M - C_5H_8O_4 - H_2O]^+$ (10.2), 43 (100); ^1H and ^{13}C NMR: Tables 1 and 2.

Compound **2b**. Amorphous solid. UV (MeOH): 222 nm; IR ν_{max}^{KBr} cm^{-1}: 3427 (hydroxyl groups), 1749 (α-methylene-γ-lactone), 1723 (ester): EIMS, *m/z* (rel. abundance): 341 $[M - HO - O]^+$ (2.14), 245 $[M - C_5H_3O_3]^+$ (17.64), 229 $[M - C_5H_3O_4]^+$ (100); ^1H and ^{13}C NMR: Tables 1 and 2.

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