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SESQUITERPENE LACTONES FROM *STEVIA VAGA*

LUIS R. HERNÁNDEZ, CÉSAR A. N. CATALÁN, CARLOS M. CERDA-GARCÍA-ROJAS* and PEDRO JOSEPH-NATHAN*†

Instituto de Química Orgánica, Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, Ayacucho 491, S.M. de Tucumán 4000, Argentina; *Departamento de Química, Centro de Investigación y de Estudios Avanzados, Instituto Politécnico Nacional, Apartado 14-740, México, D.F. 07000, México

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Key Word Index—*Stevia vaga*; Eupatorieae; Compositae; sesquiterpene lactones; guaianolides; germacranolides; heliangolides; melampolides; flavonoids.

Abstract—The aerial parts of *Stevia vaga* afforded four new guaianolides, four new germacranolides, one new melampolide and three new heliangolides as well as two known flavones. The structures were established mainly by NMR spectroscopy.

INTRODUCTION

In continuation of our work on the chemical constituents of Argentinean *Stevia* species [1–5] we report herein the isolation and structure elucidation of twelve new substances from a collection of *Stevia vaga* Griseb. whose distribution is limited to La Rioja and Catamarca provinces in northwestern Argentina [6]. The aerial parts of this plant yielded melampolide **1a**, germacradienolides **2–5** guaianolides **6–9**, heliangolides **10–12** and the known flavones eupatilin [7] and casticin [8].

RESULTS AND DISCUSSION

The structure of melampolide **1a** was readily assigned when its ^{1}H NMR spectrum (Table 1) was compared with the data reported for its positional isomer **1b**, previously isolated from *S. amambayensis* [9], *S. aristata* [10] and *S. breviaristata* [4]. An AB system centered at δ 4.83 and a quartet at δ 7.13 coupled to a methyl doublet at δ 1.97 indicated the replacement of the 4-acetyloxytiglate in **1b** by a 5-acetyloxytiglate in **1a**. Its ^{13}C NMR spectrum (Table 2) as well as its EIMS data (see Experimental) were also in agreement with the proposed structure.

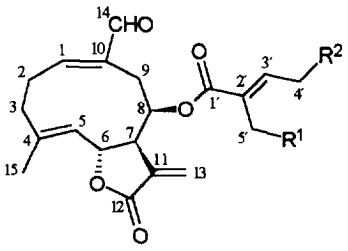
Although compounds **2** and **12** were isolated as a mixture in a 1.3:1 ratio, respectively, the ^{1}H NMR data for each compound could be obtained from the spectrum by a careful analysis of the integrals as well as by extensive decoupling experiments. The ^{1}H NMR data of **2** (Table 1) closely resembled those of 3β-acetoxy-8β-(4′-hydroxytigloyloxy)-14-hydroxycostunolide, a compound previously isolated from *Stevia breviaristata* [4], excepting the signals for the ester group at C-8 which is now a 5-hydroxytiglate (sarracenate) residue. The structure of lactone **12** was assigned from its ^{1}H NMR data since they were in close agreement with those of heliangolides bearing 3α,8β-oxygen functions [11]. The most diagnostic data were the signal of H-7, which appears as a broadened signlet at δ 2.98, the signal of H-3 which appears at δ 4.60 as a double doublet with $J_{2a,3}$ = 5 and $J_{2b,3}$ = 11 Hz, and the small coupling constant values $J_{7,13a}$ (2.5 Hz), $J_{7,13b}$ (2.0 Hz) and $J_{6,7}$ (2.0 Hz).

Since compounds **10** and **11** are closely related to **12**, their structures were easily deduced from their ^{1}H NMR spectra. The main differences were found in the coupling constants of H-3 ($J_{2a,3} = J_{2b,3} = 3$ Hz in **10** and **11** vs. $J_{2a,3} = 5$ and $J_{2b,3} = 11$ Hz in **12**) indicating the change in the C-3 stereochemistry. On the other hand, heliangolide **10** corresponded to the 14-hydroxy derivative of a previously reported substance, 3β-hydroxy-8β-tigloyloxyheliangolide [12], which gave us additional comparative ^{1}H NMR data to support the structure of **10**.

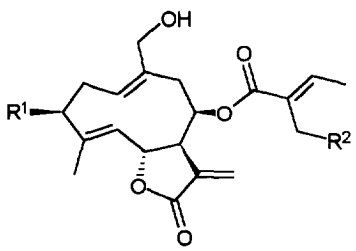
The structures of **3–5** were determined from their ^{1}H NMR data and from comparison with related analogs [4, 10] which differ only in the nature of the ester side chain at C-8. In the same way, the structure of guaianolide **7** and the corresponding C-10 epimer **9** could be deduced by comparison with the NMR data of breviarolide [13] and 10-*epi*-breviarolide [4]. Location of the acetate group in both **6** and **8** was evident from the downfield shift of the CH_2-5′ signals of the sarracenate ester residue.

Finally, the ^{1}H NMR data of guaianolides **6–9** revealed that, as in the case of 10-*epi*-breviarolide with respect to breviarolide, the stereochemical change at

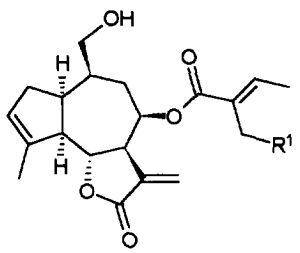
†Author to whom correspondence should be addressed.



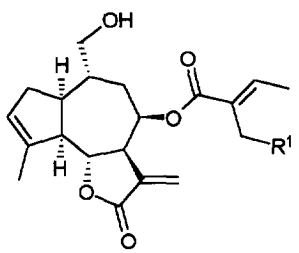
1a : R^1 = OAc; R^2 = H
1b : R^1 = H; R^2 = OAc



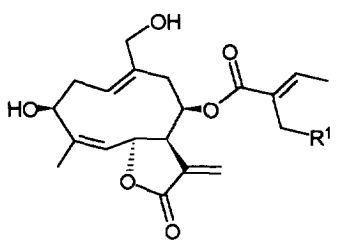
2 : R^1 = OAc; R^2 = OH
3 : R^1 = OAc; R^2 = H
4 : R^1 = H; R^2 = OH
5 : R^1 = H; R^2 = OAc



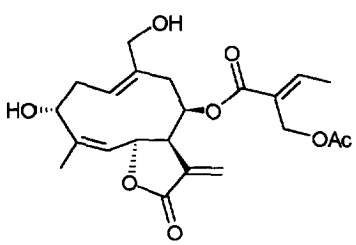
6 : R^1 = OAc
7 : R^1 = OH



8 : R^1 = OAc
9 : R^1 = OH



10 : R^1 = H
11 : R^1 = OAc



12

C-10 produced a significant conformational change in the seven-membered ring of this kind of substances [4].

EXPERIMENTAL

General. HPLC columns employed were: (A) a Beckmann C-18 (5μ, 10 × 250 mm) and (B) a Maxsil Phenomenex 10 C-8 (10 × 500 mm). R_fs were measured from the solvent peak. ^{1}H NMR: see Tables 1 and 3. ^{13}C NMR: see Table 2.

Plant material. Aerial parts of *Stevia vaga* Griseb. were collected at the flowering stage on 1st March, 1992 in Dique Las Pirquitas, Catamarca province, Argentina. A voucher specimen (Hernández No. 321) is deposited in the Herbarium of the Miguel Lillo Institute, Tucumán, Argentina.

Extraction and isolation. Aerial parts (200 g) were extracted (2×) with $CHCl_3$ (2.5 l) at room temp. for 4 days to give 18.65 g of crude extract (9.3% yield) which was suspended in EtOH (160 ml) at 60°C, diluted with H_2O (120 ml) and extracted (3×) with hexane (250 ml) and then 3× with $CHCl_3$ (250 ml). Evapn under vacuum of the $CHCl_3$ extracts gave a residue (10.5 g) which was chromatographed over silica gel (300 g) using hexane with increasing amounts of EtOAc (33–100%); 246 frs were collected and monitored by TLC and IR. Frs 101–117 were combined (206 mg). Trituration of the residue in the presence of MeOH followed by filtration afforded 117 mg of eupatilin [7] mp 234.5–236.5° (from MeOH). The filtrate was processed by HPLC (Column A; MeOH–H_2O 2:1; 2 ml min^{-1}) to give 4.6 mg of eupatilin (R_t 20 min); 3.6 mg of casticin [8] (R_t 24 min) and 11 mg of an impure lactone (R_t 10 min) which was rechromatographed on column B (MeOH–H_2O 4:3; 2 ml min^{-1}) to yield 6.6 mg **1a**. Frs 141–157 were

Table 1. ^{1}H NMR spectral data of compounds **1a** and **2–9** (300 MHz, $CDCl_3$, TMS as int. standard)

H	1a	2	3	4	5	6	7	8	9
1	6.62 *dddd*	5.10 *br dd*	5.10 *br dd*	5.05 *br dd*	5.06 *br dd*	2.90 *br qd*	2.88 *br qd*	2.50 *dddd*	2.45 *dddd*
2a	2.29 *br dddd*	2.59 *ddd*	2.63 *ddd*	}	}	2.05–2.40 *m*	2.18–2.26 *m*	2.57 *m*	2.54 *m*
2b	2.54 *m*	2.36 *ddd*	2.46 *ddd*	} 2.1–2.5 *m*	} 2.1–2.5 *m*	2.05–2.40 *m*	2.00–2.12 *m*	2.20 *m*	2.20 *m*
3a	2.41 *ddd*	5.23 *dd*	5.28 *dd*	}	}	5.54 *br s*	5.52 *br s*	5.52 *br s*	5.52 *br s*
3b	2.12 *ddd*	—	—	}	}	—	—	—	—
5	5.08 *d*	4.96 *br d*	5.01 *br d*	4.80 *dq*	4.82 *dq*	2.56 *br t*	2.61 *br t*	2.75 *br dd*	2.75 *br dd*
6	5.10 *t*	5.12 *dd*	5.13 *dd*	5.10 *dd*	5.11 *dd*	4.49 *dd*	4.52 *dd*	4.51 *dd*	4.53 *dd*
7	2.50 *dddd*	2.98 *dddd*	2.94 *dddd*	2.97 *br dddd*	2.95 *br dddd*	3.24 *dddd*	3.25 *dddd*	2.97 *dddd*	2.98 *dddd*
8	6.50 *ddd*	5.86 *br d*	5.80 *br d*	5.87 *br d*	5.84 *br d*	5.72 *td*	5.71 *td*	5.76 *br ddd*	5.75 *br ddd*
9a	2.80 *ddd*	3.38 *dd*	3.30 *dd*	3.42 *dd*	3.39 *br dd*	2.12 *dd*	2.11 *dd*	2.48 *ddd*	2.48 *dd*
9b	1.95*	2.14 *dd*	2.19 *dd*	2.15 *dd*	2.19 *br dd*	1.70†	2.08 *ddd*	1.61 *ddd*	1.58 *ddd*
10	—	—	—	—	—	2.25 *m*	2.22 *m*	1.97*	1.97 *dddd*
13a	6.22 *d*	6.31 *d*	6.33 *d*	6.30 *d*	6.30 *d*	6.28 *d*	6.29 *d*	6.22 *d*	6.22 *d*
13b	5.58 *d*	5.66 *d*	5.66 *d*	5.63 *d*	5.61 *d*	5.51 *d*	5.51 *d*	5.50 *d*	5.55 *d*
14a	9.45 *d*	4.24 *d*	4.25 *d*	4.24 *br d*	4.24 *br d*	3.49 *dd*	3.50 *dd*	3.66 *dd*	3.65 *dd*
14b	—	3.82 *d*	3.82 *d*	3.80 *br d*	3.78 *br d*	3.46 *dd*	3.46 *dd*	3.36 *dd*	3.28 *dd*
15‡	1.95 *br s*	1.71 *br d*	1.71 *br d*	1.70 *br d*	1.70 *br d*	1.93 *br s*	1.91 *br d*	1.91 *br s*	1.92 *br s*
3′	7.13 *q*	6.93 *q*	6.80 *qq*	6.92 *q*	7.10 *q*	7.03 *q*	6.84 *q*	7.07 *q*	6.87 *q*
4′‡	1.97 *d*	1.93 *d*	1.82 *dq*	1.93 *d*	1.98 *d*	1.93 *d*	1.88 *d*	1.94 *d*	1.89 *d*
5′a	4.86 *d*	4.39 *d*	1.83 *br s*‡	4.39 *d*	4.87 *d*	4.78 *s*	4.32 *d*	4.81 *s*	4.35 *d*
5′b	4.79 *d*	4.28 *d*	—	4.29 *d*	4.79 *d*	4.78 *s*	4.29 *d*	4.81 *s*	4.29 *d*
OAc‡	2.00 *s*	2.12 *s*	2.12 *s*	—	2.02 *s*	2.02 *s*	—	2.00 *s*	—

J (Hz) Compound **1**: 1,2a = 5,6 = 6,7 = 10; 1,2b = 8,9a = 3′,4′ = 7; 1,9a = 2a,3a = 2b,3b = 7,8 = 2; 1,14 ~ 1; 2a,2b = 13; 2a,3b = 3a,3b = 5′a,5′b = 12; 2b,3a = 6; 7,13a = 3.5; 7,13b = 3; 8,9b = 9; 9a,9b = 14. Compound **2**: 1,2a = 8,9a = 5; 1,2b = 14a,14b = 5′a,5′b = 12; 2a,2b = 13; 2a,3 = 6; 2b,3 = 5,6 = 10; 5,15 = 7,8 = 1; 6,7 = 8; 7,13a = 3.5; 7,13b = 3; 8,9b = 2; 9a,9b = 15; 3′,4′ = 7. Compound **3**: couplings as **2** and 3′,5′ = 2; 4′,5′ = 1. Compounds **4–5**: 1,2a = 8,9a = 5; 1,2b = 11; 5,6 = 10; 5,15 = 7,8 = 1; 6,7 = 8.5; 7,13a = 3.5; 7,13b = 3; 8,9b = 2; 9a,9b = 15; 14a,14b = 5′a,5′b = 12; 3′,4′ = 7. Compounds **6–7**: 1,2a = 1,2b = 6,7 = 9; 1,5 = 5,6 = 9b,10 = 14a,14b = 10; 1,10 = 7,13a = 3.5; 2a,2b = 9a,9b = 15; 3,15 = 9a,10 = 1; 7,8 = 4; 7,13b = 3; 8,9a = 8,9b = 10,14b = 8; 10,14a = 3′,4′ = 7; 5′a,5′b = 12. Compounds **8–9**: 1,2a = 9; 1,2b = 7,8 = 7,13b = 10,14a = 3; 1,10 = 5,6 = 9b,10 = 11; 1,5 = 6,7 = 14a,14b = 10; 2a,2b = 9a,9b = 15; 3,15 = 1; 7,13a = 3.5; 8,9a = 5; 8,9b = 2; 10,14b = 8; 3′,4′ = 7; 5′a,5′b = 12.

*Obscured by intense methyl signals.

†Overlapped with H_2O signal.

‡Intensity three protons.

Table 2. ^{13}C NMR spectral data of compounds **1a** and **2–12** (75.4 MHz, $CDCl_3$, TMS as int. standard)

C	1a	2	3	4	5	6	7	8	9	10	11*	12
1	153.9	129.4	130.5	133.0	133.6	43.7	43.5	43.2	43.4	127.0	127.3	128.8
2	26.2	31.9	31.8	26.0	25.9	31.5	32.5	38.5	38.5	31.2	31.3	33.6
3	37.2	78.6	78.6	38.2	38.6	125.7	125.8	126.6	126.6	74.6	74.3	69.7
4	142.9	139.6	139.7	142.2	142.4	142.9	142.6	141.3	141.3	139.4	139.6	140.1
5	126.4	125.7	125.7	127.7	127.5	56.5	56.4	56.4	56.3	126.9	126.6	123.8
6	75.4	74.5	74.5	75.4	75.4	80.4	80.3	78.7	78.7	75.2	75.1	74.1
7	49.6	52.2	52.4	52.8	52.8	47.1	47.2	54.2	54.2	48.4	48.2	48.5
8	66.4	71.2	71.1	71.4	71.9	68.6	68.7	66.3	66.4	77.9	78.4	79.2
9	29.0	38.3	39.1	39.3	39.3	29.1	29.6	34.3	34.2	39.9	39.7	38.4
10	135.0	135.8	136.0	136.3	136.5	38.4	39.0	38.0	38.2	138.3	138.1	136.8
11	137.7	139.6	139.0	138.0	137.7	134.4	134.4	135.2	135.0	137.7	137.6	137.2
12	169.4	169.3	169.2	169.5	169.4	169.5	169.4	169.4	169.3	169.9	169.8	169.4
13	121.0	121.9	121.9	121.4	121.2	122.2	122.2	120.8	120.9	124.4	124.5	124.8
14	195.2	60.4	61.1	60.5	60.6	65.8	65.5	66.8	66.2	63.6	62.9	60.6
15	17.0	12.5	12.3	17.3	17.1	17.3	17.1	18.0	18.0	23.2	23.1	17.3
1′	165.0	166.1	166.4	166.2	165.2	165.5	166.6	165.4	166.5	167.0	165.4	165.3
2′	127.6	131.9	128.1	132.1	127.8	127.7	131.5	128.0	131.9	128.1	127.6	127.7
3′	145.6	142.6	138.5	142.2	145.6	145.4	141.7	145.4	141.5	138.7	146.2	145.9
4′	14.7	14.3	14.6†	14.4	14.8	14.6	14.3	14.7	14.2	14.6†	14.7	14.8
5′	57.4	56.1	12.2†	56.3	57.7	57.4	56.8	57.7	56.5	11.9†	57.7	57.8
OAc	170.6	170.1	170.0	—	170.8	170.7	—	170.8	—	—	171.5	171.4
	20.7	21.0	21.0	—	20.7	20.7	—	20.7	—	—	20.8	20.8

*HETCOR measurements allowed assignments of protonated carbons.

†Assignments as in ref. [14].

Table 3. ^{1}H NMR spectral data of compounds **10**–**12** (300 MHz, $CDCl_3$, TMS as int. standard)

H	**10**	**11**	**12**
1	5.30 *m*	5.30 *m*	5.24 *m*
2a	2.97*	2.90†	2.72 *m*
2b	2.26 *ddd*	2.27 *ddd*	2.27 *m*
3	4.48 *br t*	4.47 *br t*	4.60 *dd*
5	5.24 *br d*	5.25 *br d*	5.17 *br d*
6	6.32 *dd*	6.30 *dd*	5.35 *dd*
7	2.97 *br s*	2.99 *br s*	2.98 *br s*
8	5.22 *br s*	5.25 *br s*	5.31 *br s*
9a	2.86 *dd*	2.93 *dd*	3.13 *br d*
9b	2.37 *br d*	2.39 *dd*	2.15 *br d*
13a	6.34 *d*	6.35 *d*	6.36 *d*
13b	5.77 *d*	5.78 *d*	5.79 *d*
14a	4.30 *br d*	4.23 *br d*	4.39 *d*
14b	4.15 *br d*	4.16 *br d*	4.16 *d*
15‡	1.74 *br d*	1.74 *br d*	1.80 *br s*
3′	6.82 *qq*	7.14 *q*	7.06 *q*
4′‡	1.75 *br qd*	1.92 *d*	1.93 *d*
5′a	1.78 *br s*	4.90 *d*	4.89 *d*
5′b	—	4.71 *d*	4.71 *d*
OAc‡	—	2.08 *s*	2.07 *s*

J (Hz) Compound **10**: 1,2b = 7, 2a,2b = 14; 2a,3 = 2b,3 = 8,9a = 3; 5,6 = 11; 5,15 = 7,8 = 8,9b = 3′,5′ ~ 1.5; 6,7 = 7,13b = 2; 7,13a = 2.5; 9a,9b = 14.5; 14a,14b = 14; 3′,4′ = 7; 4′,5′ = 1. Compound **11**: 1,2b = 7; 2a,2b = 14; 2a,3 = 2b,3 = 8,9a = 3; 5,6 = 11; 5,15 = 7,8 = 8,9b ~ 1.5; 6,7 = 7,13b = 2; 7,13a = 2.5; 9a,9b = 14.5; 14a,14b = 14; 3′,4′ = 7; 5′a,5′b = 12. Compound **12**: 1,2b = 7; 2a,2b = 14; 2a,3 = 5; 2b,3 = 11; 5,6 = 11; 7,8 = 8,9b ~ 1.5; 6,7 = 7,13b = 2; 7,13a = 2.5; 8,9a = 3; 9a,9b = 14.5; 14a,14b = 12; 3′,4′ = 7; 5′a,5′b = 12.

*Overlapped with H-7 signal.

†Overlapped with H-7 and H-9 signals.

‡Intensity three protons.

combined (215 mg) and dissolved in MeOH (17 ml); addition of H_2O (11 ml) to this solution produced precipitation of **5** (21.5 mg) which was separated by filtration. The filtrate was processed by HPLC (Column A; MeOH–H_2O 4:3; 2 ml min^{-1}) affording 12 mg **5** (R_t 11.2 min); 20 mg **3** (R_t 14.2 min); 6.3 mg **8** (R_t 25 min) and 6.6 mg **6** (R_t 34.2 min). Frs 165–185 were combined (1.3 g) and a portion (200 mg) was processed by HPLC on column A as before to give 83 mg of an impure lactone which was rechromatographed (MeOH–H_2O 2:3, 1 ml min^{-1}) to yield 52 mg **10** (R_t 45 min). Frs 196–224 were combined (845 mg) and a portion (200 mg) was processed by HPLC (Column A; MeOH–H_2O 1:1; 1.5 ml min^{-1}) to give 49 mg of a mixture of **2** and **12** (R_t 10 min); 43 mg **11** (R_t 12.5 min); 25 mg **4** (R_t 17.2 min); 21 mg **9** (R_t 41.5 min) and 11 mg **7** (R_t 48.5 min).

8β-Acetylsarracenyloxy-14-oxoacanthospermolide (**1a**). Gum; UV λ_{max}^{EtOH} (log ε): 208 (3.77): IR ν_{max}^{film} cm^{-1}: 2730, 1684, 1628 (C=CCHO), 1762 (C=O, γ-lactone), 1724 (C=CCO_2R). EIMS *m/z* (rel. int.) 402 [M]$^+$ (0.2), 342 (2.5), 244 (29), 99 (100).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{-28 \quad -30 \quad -37 \quad -95 \quad -315^\circ} \quad (c = 0.6, CHCl_3)$$

Mixture of 3β-Acetyloxy-8β-sarracenyloxy-14-hydroxycostunolide (**2**) *and* (3R,6R,7R,8R)-*8-acetylsarracenyloxy-3,14-dihydroxyheliango-1(10),4,11(13)-trien-6,12-olide* (**12**). Gum; ^{1}H NMR data in Tables 1 and 3, respectively. ^{13}C NMR Table 2.

3β-Acetyloxy-14-hydroxy-8β-tigloyloxycostunolide (**3**). Gum; UV λ_{max}^{EtOH} (log ε): 212 (4.39); IR ν_{max}^{film} cm^{-1}: 3308 (OH), 1764 (C=O, γ-lactone), 1738 (C=O, acetate), 1714 (C=O, tiglate), 1650 (C=C). CIMS *m/z* (rel. int.) 405 [M + 1]$^+$ (9.3), 345 (100), 245 (59).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436}{+38 \quad +39 \quad +47 \quad +94^\circ} \quad (c = 1.9, CHCl_3)$$

14-Hydroxy-8β-sarracenyloxycostunolide (**4**). Gum; UV λ_{max}^{EtOH} (log ε): 209 (4.28); IR ν_{max}^{film} cm^{-1}: 3436 (OH), 1762 (C=O, γ-lactone), 1714 (C=O, sarracenate), 1650 (C=C). CIMS *m/z* (rel. int.) 363 [M + 1]$^+$ (37), 345 (23), 247 [M + 1 − $C_5H_8O_3$]$^+$ (100).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{+32 \quad +34 \quad +40 \quad +83 \quad +158^\circ} \quad (c = 2.3, CHCl_3)$$

8β-Acetylsarracenyloxy-14-hydroxycostunolide (**5**). Solid, mp 169–171°C, UV λ_{max}^{EtOH} (log ε): 210 (3.92); IR ν_{max}^{film} cm^{-1}: 3526 (OH), 1758 (C=O, γ-lactone), 1724 (C=O, esters), 1656 (C=C). CIMS *m/z* (rel. int.) 405 [M + 1]$^+$ (100).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{+15 \quad +15 \quad +19 \quad +47 \quad +101^\circ} \quad (c = 1.6, CHCl_3)$$

(1S,5R,6R,7R,8R,10S)-*8-Acetylsarracenyloxy-14-hydroxyguai-3,11(13)-dien-6,12-olide* (**6**). Gum; UV λ_{max}^{EtOH} (log ε): 211 (4.32); IR ν_{max}^{film} cm^{-1}: 3516 (OH), 1760 (C=O, γ-lactone), 1732 (C=O, esters), 1654 (C=C). CIMS *m/z* (rel. int.) 405 [M + 1]$^+$ (100), 247 (19).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436}{-14 \quad -16 \quad -18 \quad -25^\circ} \quad (c = 0.6, CHCl_3)$$

(1S,5R,6R,7R,8R,10S)-*14-Hydroxy-8-sarracenyloxyguai-3,11(13)-dien-6,12-olide* (**7**). Gum; UV λ_{max}^{EtOH} (log ε): 208 (4.51); IR ν_{max}^{film} cm^{-1}: 3488 (OH), 1760 (C=O, γ-lactone), 1702 (C=O, sarracenate), 1652 (C=C). CIMS *m/z* (rel. int.) 363 [M + 1]$^+$ (39), 345 (100), 247 (41).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{-21 \quad -22 \quad -23 \quad -35 \quad -51^\circ} \quad (c = 0.8, CHCl_3)$$

(1S,5R,6R,7R,8R,10R)-*8-Acetylsarracenyloxy-14-hydroxyguai-3,11(13)-dien-6,12-olide* (**8**). Gum; UV λ_{max}^{EtOH} (log ε): 209 (4.26); IR ν_{max}^{film} cm^{-1}: 3516 (OH), 1764 (C=O, γ-lactone), 1724 (C=O, esters), 1656 (C=C). CIMS *m/z* (rel. int.) 405 [M + 1]$^+$ (100), 247 (24).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{-6 \quad -6 \quad -10 \quad -10 \quad -13^\circ} \quad (c = 0.3, CHCl_3)$$

(1S,5R,6R,7R,8R,10R) - 14 - *Hydroxy* - 8 - *sarracenyloxyguai*-3,11(13)-*dien*-6,12-*olide* (**9**). Gum; UV λ_{max}^{EtOH} (log ε): 208 (4.48); IR ν_{max}^{film} cm^{-1}: 3478 (OH), 1764 (C=O, γ-lactone), 1710 (C=O, sarracenate), 1652 (C=C). CIMS *m/z* (rel. int.) 363 $[M+1]^+$ (22), 345 (100), 247 (32).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{+18 \quad +19 \quad +22 \quad +46 \quad +90^\circ}$$

($c = 1.3$, $CHCl_3$)

(3S,6R,7R,8R) - 3,14 - *Dihydroxy* - 8 - *tigloyloxyheliango*-1(10),4,11(13)-*trien*-6,12-*olide* (**10**). Solid, mp 180–182°C; UV λ_{max}^{EtOH} (log ε): 208 (4.45); IR ν_{max}^{film} cm^{-1}: 3420 (OH), 1754 (C=O, γ-lactone), 1708 (C=O, tiglate), 1652 (C=C). CIMS *m/z* (rel. int.) 363 $[M+1]^+$ (5), 345 (78), 263 (11), 229 (100).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{-183 \quad -191 \quad -219 \quad -389 \quad -656^\circ}$$

($c = 2.5$, $CHCl_3$)

(3S,6R,7R,8R) - 8 - *Acetylsarracenyloxy* - 3,14 - *dihydroxyheliango* - 1(10),4,11(13) - *trien* - 6,12 - *olide* (**11**). Gum; UV λ_{max}^{EtOH} (log ε): 206 (3.92); IR ν_{max}^{film} cm^{-1}: 3424 (OH), 1754 (C=O, γ-lactone), 1718 (C=O, esters), 1654 (C=C). CIMS *m/z* (rel. int.) 421 $(M+1]^+$ (37), 403 (100), 263 (13).

$$[\alpha]^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365}{-140 \quad -146 \quad -167 \quad -299 \quad -504^\circ}$$

($c = 5.0$, $CHCl_3$)

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REFERENCES

1. de Heluani, C. S., de Lampasona, M. P., Catalán, C. A. N., Goedeken, V. L., Gutiérrez, A. B. and Herz, W. (1989) *Phytochemistry* **28**, 1931.
2. Sigstad, E. E., Catalán, C. A. N., Gutiérrez, A. B., Díaz, J. G., Goedeken, V. L. and Herz, W. (1991) *Phytochemistry* **30**, 1933.
3. de Gutiérrez, A. N., Catalán, C. A. N., Díaz, J. G. and Herz, W. (1992) *Phytochemistry* **31**, 1818.
4. Hernández, L. R., Catalán, C. A. N., Cerda-Carcía-Rojas, C. M. and Joseph-Nathan, P. (1994) *Phytochemistry* **37**, 1331.
5. Hernández, L. R., Catalán, C. A. N., Cerda-García-Rojas, C. M. and Joseph-Nathan, P. (1995) *Nat. Prod. Letters* **6**, 215.
6. Ariza Espinar, L. and Cerana, M. M. (1986) *Bol. Acad. Nac. Cs. Córdoba, Argentina* **57**, p. 381.
7. Kupchan, S. M., Sigel, C. W., Hemingway, R. J., Knox, J. R. and Udayamurthy, M. S. (1969) *Tetrahedron* **25**, 1603.
8. Raffauf, R. F., Menachery, M. D., Le Quesne, P. W., Arnold, E. V. and Clardy, J. (1981) *J. Org. Chem.* **46**, 1094.
9. Schmeda-Hirschmann, G., Zdero, C. and Bohlmann, F. (1986) *Phytochemistry* **25**, 1755.
10. Zdero, C., Bohlmann, F. and Schmeda-Hirschmann, G. (1987) *Phytochemistry* **26**, 463.
11. Boeker, R., Jakupovic, J., Bohlmann, F., King, R. M. and Robinson, H. (1986) *Phytochemistry* **25**, 1669.
12. Castro, V., Tamayo-Castillo, G. and Jakupovic, J. (1989) *Phytochemistry* **28**, 2415.
13. Oberti, J. C., Gil, R. R., Sosa, V. E. and Herz, W. (1986) *Phytochemistry* **25**, 1479.
14. Joseph-Nathan, P., Wesener, J. R. and Günther, H. (1984) *Org. Magn. Reson.* **22**, 190.