Pergamon

0031-9422(94)00945-7

Phytochemistry, Vol. 39, No. 2, pp. 387–389, 1995

0031-9422/95 $9.50 + 0.00

EREMANTHOLIDES AND A GUAIANOLIDE FROM *LYCHNOPHORA RUPESTRIS*

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(*Received in revised form* 31 *October* 1994)

Key Word Index—*Lychnophora rupestris*; Compositae; Vernonieae; sesquiterpene lactones; guaianolide; eremantholides; flavonoids.

Abstract—The investigation of the aerial parts of *Lychnophora rupestris* afforded, in addition to known sesquiterpene lactones and triterpenes, a new guaianolide closely related to eremanthin and a new eremantholide. Structures were determined by spectrometric methods.

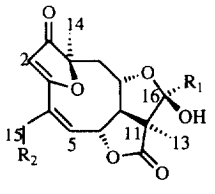
INTRODUCTION

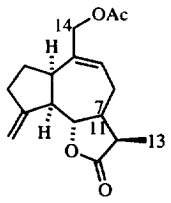
The genus *Lychnophora* Martius is endemic to the Brazilian Planalto and is placed in subtribe Lychnophorinae of Vernonieae [1]. Recent work in our laboratories led to the isolation of some sesquiterpene lactones with biological activities [2–4]. We have now investigated the aerial parts of *Lychnophora rupestris*, a new species described by Semir [5], which afforded two flavonoids and eight sesquiterpene lactones, two of which have not been reported previously.

RESULTS AND DISCUSSION

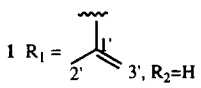
The hexane extract of leaves and inflorescences of *L. rupestris* afforded the triterpenes lupeol, β-amyrin, friedelanol, 30-oxolupeol [6] and 30-hydroxylupeol [7]. The ethyl acetate extract of the same parts afforded the heliangolide lychnopholide [8] and the eremantholides **1** [9], **2** [10], **3** [11], **4** [12] and **5**. The spectral data of **5** were similar to those of **4** and **6** [11] but when compared with **4** the ^{1}H NMR spectrum of **5** showed a downfield shift for the H-15 signal and an additional three-proton singlet for the acetate moiety (Table 1), while its ^{13}C NMR spectrum contained the signal of an acetate carbonyl at δ170.2 (Table 2). The previously unreported ^{13}C NMR spectra of **2** and **3** are also listed in Table 2. The ethanol extract of the same parts of the plant afforded the 3-*O*-glucoside of isorhamnethin and the flavone acacetin.

The ethyl acetate extract of the stems furnished eremanthin [13] and a new guaianolide **7**. A band at 1740 cm^{-1} in the IR spectrum and the signal of an acetate carbonyl at δ171 in the ^{13}C NMR spectrum (Table 2) suggested the presence of an acetate. The ^{1}H NMR data (Table 3) were generally similar to those of eremanthin; however, the C-10 methyl frequency was replaced by an AB system at δ4.56 and 4.43 allylically coupled to H-9 at

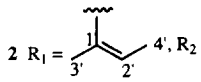




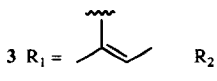
7



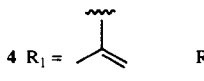
1 R_1 = 3', R_2=H



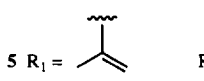
2 R_1 = 4', R_2



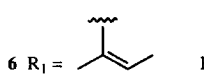
3 R_1 = R_2 =OH



4 R_1 = R_2 =OH



5 R_1 = R_2 =OAc



6 R_1 = R_2 =OAc

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Table 1. ^{1}H NMR spectrum of compound **5** (100 MHz, TMS as int. standard, $CDCl_3$)

H	5
2	5.70 *s*
5	6.30 *m*
6	5.00 *m*
7	2.80 *m*
8	4.20 *dt* (2.5, 10)
9α	2.40 *dd* (10, 14)
9β	*
13†	1.25 *s*
14†	1.50 *s*
15‡	4.81 *br s*
2'†	1.90 *s*
3'a	5.05 *m*
3'b	5.35 *m*
Ac†	2.10 *s*

*Obscured signal.
†Intensity three protons.
‡Intensity two protons.

Table 2. ^{13}C NMR spectra of compounds **2**, **3**, **5**, and **7** (50 MHz, $CDCl_3$)

C	2	3	5	7
1	205.3 *s*	205.2 *s*	205.3 *s*	41.8 *d*
2	106.6 *s*	106.2 *s*	106.5 *d*	29.1 *t*
3	186.9 *s*	184.5 *s*	183.9 *s*	29.3 *t*
4	130.0 *s*	129.5 *s*	129.5 *s*	137.4 *d*
5	134.7 *d*	135.0 *d*	138.2 *d*	43.4 *d*
6	81.4 *d*	81.7 *d*	81.1 *d*	51.3 *d*
7	62.4 *d*	62.8 *d*	62.1 *d*	48.2 *d*
8	78.2 *d*	78.0 *d*	78.1 *d*	30.5 *t*
9	43.7 *t*	43.9 *t*	43.6 *t*	127.0 *d*
10	90.0 *s*	90.1 *s*	90.3 *s*	149.6 *s*
11	60.0 *s*	57.0 *s*	59.7 *s*	82.8 *d*
12	175.0 *s*	174.4 *s*	175.3 *s*	177.0 *s*
13	21.9 *q*	21.6 *q*	21.7 *q*	21.1 *q*
14	20.5 *q*	20.6 *q*	20.5 *q*	70.5 *t*
15	20.3 *q*	63.2 *t*	62.5 *t*	110.9 *t*
16	104.5 *s*	106.3 *s*	106.7 *s*	—
1'	132.9 *s*	134.0 *s*	141.9 *s*	—
2'	124.6 *d*	126.0 *d*	18.9 *d*	—
3'	13.3 *q*	15.2 *q*	116.0 *t*	—
4'	12.3 *q*	13.1 *q*		—
Ac(CO)			170.2 *s*	171.0 *s*
Ac(Me)	—		29.7 *q*	29.7 *q*

Multiplicities by DEPT pulse sequence.

Table 3. ^{1}H NMR spectrum of compound **7** (500 MHz, $CDCl_3$)

H	7
1	2.65 *brddd* (12, 6, 6)
2a	1.7 *m*
2b	2.0–
3a	2.4 *m*
3b	
5	2.55 (10, 6)
6	3.97 *dd* (10.5, 10)
7	*
8a	2.48 *ddd* (17, 8.5, 3)
8b	*
9	5.88 *ddd* (8.5, 2, 1)
11	2.29 *dq* (7.5, 7, 7, 7)
13†	1.22 d (7)
14a	4.56 *ddd* (12, 2, 1.5)
14b	4.43 *ddd* (12, 1, 1)
15a	5.20 *br s*
15b	5.02 *br s*
Ac†	2.09 *s*

*Obscured signal.
†Intensity three protons.

δ5.88 and homo-allylically coupled to H-8. Consequently the acetate was attached to C-14. Furthermore, the vinylic H-13a and H-13b resonances of eremanthin were missing and replaced by a methyl doublet (J = 7 Hz). Spin decoupling confirmed most of the assignments although the configuration at C-11 remained questionable since the H-7 signal was obscured by an impurity. However, irradiation at the frequency of the H-13 signal converted the H-11 multiplet at δ2.29 to a doublet with J = 7.5 Hz. Consequently, the C-11 methyl group was β-oriented, differing in this respect from eregoyazidin [14, 15] and 11βH,13-dihydroeremanthin from *Lychnophora passerina* [6] and *L. columnaris* [16]. The ^{13}C NMR spectrum (Table 2) was fully in accord with the proposed structure. A somewhat similar 11,13-dehydro analogue with an angelate attached to C-14 has been isolated from *Zinnia linearis* [17].

EXPERIMENTAL

Plant material. Lychnophora rupestris was collected near Diamantina, State of Minas Gerais, Brazil, in July 1989. A voucher specimen is deposited at the Herbarium of the Instituto de Biologia, UNICAMP, Campinas. S.P.

Extraction and isolation. The aerial parts were sepd into inflorescences plus leaves (9.2 kg) and stems (15.8 kg). Both were pulverized and extracted with hexane, EtOAc and EtOH. The resulting extracts were chromatographed (VLC) over silica gel-D and further purified by repeated TLC (silica gel) or on a Chromatotron. Known compounds were identified by comparison with authentic substances (GC, TLC, ^{1}H NMR).

The hexane extract of the leaves and inflorescences afforded a mixt. of lupeol, β-amyrin and friedelanol, 30-oxolupeol (12 mg), 30-hydroxylupeol (10 mg), while the EtOAc extract of the leaves and inflorescences afforded lychnopholide (250 mg), **1** (30 mg), **2** (15 mg), **3** (60 mg), **4** (15 mg) and **5** (20 mg). The EtOH extract of the leaves and inflorescences afforded the flavonoids acacetin (10 mg) and the 3-glucoside of isorhamnetin (50 mg). The hexane extract of the stems afforded a mixture of friedelin and

friedelanol, and the EtOAc extract afforded eremanthin (30 mg) and **7** (20 mg).

15-*Acetoxyeremantholide C* (**5**). Gum; IR ν_{max} cm^{-1}: 3400 (OH), 1770 (C = O, γ-lactone), 1730 (C = O, acetate), 1700 and 1585 (furanone). GC-MS, *m/z* (rel. int.): 387 [M − OH]$^+$ (6), 181 (11), 135 (23), 95 (47), 83 (100), 69 (75), 60 (7), 55 (69). ^{1}H and ^{13}CNMR data in Tables 1 and 2.

14-*Acetoxy*-11αH, 13-*dihydroeremanthin* (**7**). Gum; IR ν_{max} cm^{-1}: 1770 (C=O γ-lactone), 1740 (C=O, acetate). GC-MS, *m/z* (rel. int.): 230 [M − AcOH]$^+$ (7), 151 (25), 123 (26), 91 (60), 55 (100), ^{1}H and ^{13}CNMR data in Tables 2 and 3.

Acknowledgements—Work in Ribeirão Preto was supported by CNPq, EEC (contract C 11* 0763) and FAPESP. The authors wish to thank Instituto de Quimica da UNESP, Araraquara, S.P., Departamento de Quimica da UFSCar for the NMR spectra, Departmento de Quimica da Faculdade de Filosofia Ciências e Letras de Ribeirão Preto, USP for the mass spectra and Profs Hermógenes de Freitas Leitão Filho and João Semir for plant classification.

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