PERGAMON

Phytochemistry 52 (1999) 1331–1334

PHYTOCHEMISTRY

Three ambrosanolides from *Parthenium hysterophorus*

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Received 4 December 1998; received in revised form 2 June 1999

Abstract

A chloroform extract of the aerial parts of *Parthenium hysterophorus* yielded three ambrosanolides 8α-epoxymethylacrylyloxyparthenin, its 11β,13-dihydro derivative and 8α-epoxymethylacrylyloxyambrosin by spectroscopic methods.

Keywords: Parthenium hysterophorus; Compositae; α-Methylene-γ-lactones; Ambrosanolides

1. Introduction

Parthenium hysterophorus L. (Compositae), a noxious weed, is a rich source of two pseudoguaianolides namely parthenin (**1**) and coronopilin (**2**) in addition to some minor constituents (Herz, Watanabe, Miyazaki & Kishida, 1962; Das & Das, 1977; Picman, Towers & Rao, 1980; Sethi, Kaul, Taneja & Dhar, 1987; Talwar & Kalsi, 1989; Kalsi, Mittal, Singh & Chhabra, 1995; Bhullar, Kalsi & Chhabra, 1997; de la Fuente, Novara, Alarcow, Diaz, Uriburu & Sosa, 1997). The plant has been reported to be responsible for allergic contact dermatitis in humans (Rodriguez, Dillon, Mabry, Towers & Mitchell, 1976), as well as being toxic for domestic animals (Narsimhan, Ananth, Swamy, Babu, Mangla & Rao, 1977; Das, Baruah, Sharma, Baruah, Kulanthaivel & Herz, 1983) and this is attributed to the presence of the α-methylene-γ-lactone moiety in these compounds. In the present paper we report the isolation and structure elucidation of three more hitherto unknown ambrosanolides.

2. Results and discussion

From the chloroform extract of the aerial parts of *Parthenium hysterophorus*, three ambrosanolides were isolated. A non-crystalline compound (**3**), showed IR bands characteristic of a γ-lactone (1765 cm^{-1}), a hydroxyl group (3600 and 3440 cm^{-1}, $CHCl_3$ solution), a cyclopentenone moiety (1722 cm^{-1}) and an ester grouping at 1740 cm^{-1}. The high resolution mass spectrum exhibited a $(M)^+$ at m/z 362.3816 consistent with the molecular formula $C_{19}H_{22}O_7$ with fragments at m/z = 278 and 260 which suggested the presence of C_4 ester side chain. The ^{1}H-NMR data (Table 1) established that the side chain was an epoxymethylacrylic acid residue as it showed a singlet at δ 1.36 and two doublets typical of AB system at δ 3.12 and 3.32 (J = 12 Hz). A pair of doublets due to one proton each at δ 5.62 and 6.26 (J = 2.7 Hz) was assigned to the exocyclic methylene conjugated with a carbonyl. A typical doublet due to one hydrogen at δ 5.08 (J = 8 Hz, lactonic C_6-H) and methyl singlet at 1.27 suggest the pseudoguaianolide structure for this compound. A secondary methyl (δ 1.11, d, J = 7.56 Hz) and a pair of doublets due to one hydrogen each at δ 6.27 and 7.51 (J = 6 Hz) hints towards the fact that this compound is closely related to parthenin. A close comparison of the ^{13}C-NMR spectrum (Table 2) of parthenin with that of this compound shows an appreciable difference in chemical shift of C-8 in both the compounds, thereby suggesting the substitution at C-8 by the epoxymethacryoxy grouping. The appearance of H-8 proton as doublet triplet at δ 5.5 (J = 8.5 and 4.0 Hz)

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0031-9422/99/$ - see front matter
PII: S0031-9422(99)00341-6

Table 1
^{1}H-NMR spectral data of compounds **3**, **4** and **5** (chemical shift in δ ppm)

Compound	C_2-H	C_3-H	C_6-H	C_8-H	C_{13}-H and C_{13}-H′	C_{14}-H′ S	C_{15}-H′ S	C_{18}-H	C_{18}-H′
3	7.51, 1H, *d* (J = 6.0 Hz)	6.27, 1H, *d* (J = 8.0 Hz)	5.08, 1H, *d* (J = 8.0 Hz)	5.5, 1H, *dt* (J = 4 and 9 Hz)	5.62, 1H, *d* (J = 2.7 Hz) 6.26, 1H, *d* (J = 2.7 hz)	1.11, 3H, *d* (J = 7.56 Hz)	1.27, 3H, *s*	3.12, 1H, *d* (J = 12.0 Hz) 3.32, 1H, *d* (J = 12.0 Hz)	1.36, 3H, *s*
4	7.60, 1H, *d* (J = 6.0 Hz)	6.22, 1H, *d* (J = 6.0 Hz)	5.16, 1H, *d* (J = 8.5 Hz)	5.45, 1H, *dt* (J = 4 and 9 Hz)	1.15, 3H, *d* (J = 7.0 Hz)	1.12, 3H, *d* (J = 7.0 Hz)	1.25, 3H, *s*	3.14, 1H, *d* (J = 12 Hz) 3.32, 1H, *d* (J = 12 Hz)	1.39, 3H, *s*
5	7.6, 1H, *dd* (J = 5 and 6.2 Hz)	6.2, 1H, *dd* (J = 1.8 and 6.2 Hz)	4.5, 1H, *d* (J = 8.0 Hz)	5.47, 1H, *m*	5.6, 1H, *d* (J = 3.0 Hz) 6.3, 1H, *d* (J = 3.0 Hz)	1.20, 3H, *d* (J = 7 Hz)	1.34, 3H, *s*	3.20, 1H, *d* (J = 11.5 Hz) 3.34, 1H, *d* (J = 11.5 Hz)	1.38, 3H, *s*

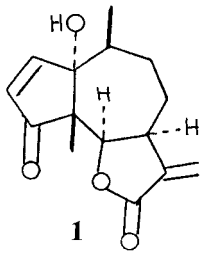
Table 2
^{13}C-NMR spectral data of compounds **1**, **3**, **4** and **5**

	1	**3**	**4**	**5**
C_1	84.3 (*s*)	83.9 (*s*)	51.6 (*d*)	84.5 (*s*)
C_2	163.8 (*d*)	162.7 (*d*)	162.3 (*d*)	163.3 (*d*)
C_3	131.4 (*d*)	132.1 (*d*)	128.4 (*d*)	115.0 (*d*)
C_4	211.1 (*s*)	210.7 (*s*)	214.8 (*s*)	211.2 (*s*)
C_5	59.0 (*s*)	60.3 (*s*)	56.9 (*s*)	58.4 (*s*)
C_6	79.1 (*d*)	77.6 (*d*)	78.4 (*d*)	79.3 (*d*)
C_7	40.5 (*d*)	39.7 (*d*)	40.4 (*d*)	39.2 (*d*)
C_8	29.8 (*t*)	73.5 (*d*)	72.3 (*d*)	72.4 (*d*)
C_9	28.4 (*t*)	29.1 (*t*)	30.7 (*t*)	29.6 (*t*)
C_{10}	44.2 (*d*)	43.8 (*d*)	45.3 (*d*)	40.8 (*d*)
C_{11}	140.5 (*s*)	140.3 (*s*)	139.6 (*s*)	49.6 (*d*)
C_{12}	171.2 (*s*)	170.8 (*s*)	171.2 (*s*)	169.0 (*s*)
C_{13}	121.9 (*t*)	122.1 (*t*)	123.4 (*s*)	19.2 (*q*)
C_{14}	18.3 (*q*)	19.5 (*q*)	19.8 (*q*)	18.1 (*q*)
C_{15}	17.4 (*q*)	17.6 (*q*)	17.3 (*q*)	18.1 (*q*)
C_{16}		174.8 (*s*)	174.5 (*s*)	174.6 (*s*)
C_{17}		77.0 (*s*)	77.2 (*s*)	77.2 (*s*)
C_{18}		68.4 (*t*)	68.4 (*t*)	68.3 (*t*)
C_{19}		22.3 (*q*)	22.1 (*q*)	21.9 (*q*)

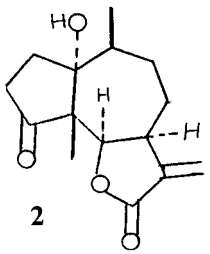
establishes the β-orientation for this proton (Fernandez, Garcia, Grancha & Pedro, 1987). Taking into account the rest of IR and ^{13}C-NMR spectral features structure (**3**) was assigned to this compound.

Compound (**4**) a non-crystalline solid, showed (M^+) 364.3963 corresponding to $C_{19}H_{24}O_7$. IR bands 3600, 3420 (hydroxyl group), 1760 (γ-lactone), 1740 (an ester) and 1720 cm^{-1} (cyclopentenone). As in (**3**), the presence of an epoxymethylacrylic ester was revealed by ions at m/z 280 and 262 in the mass spectrum and signals at δ 1.39 (*s*), 3.14 and 3.32 (AB system J = 12 Hz) in the ^{1}HNMR spectrum. The $(M)^+$ at 364 is two mass units greater than that of (**3**) and this difference is maintained in the fragment ions m/z 280 and 262. A comparison of ^{1}H- and ^{13}C-NMR (Tables 1 and 2) indicates the absence of conjugated exocyclic methylene instead of which there appears an additional secondary methyl at δ 1.15 (J = 7 Hz). By spin decoupling experiments the value of $J_{7,11}$ (10 Hz) (Bruno, Paternostro, Gedris & Herz, 1996) showed that H-11 is β-oriented which allowed us to assign structure (**4**) for this compound.

The third compound (**5**), a semisolid, showed (M^+) 346.3811 consistent with the molecular formula $C_{19}H_{22}O_6$. The IR spectrum showed the absence of hydroxyl group and the presence of three carbonyls (1760, 1740 and 1715 cm^{-1}). A detailed study of its $^{13}C-NMR$ showed the presence of all the chemical shifts as were exhibited by compound (**3**) with the only difference that C-1 appeared as a doublet at δ 51.6 instead of a singlet at δ 83.9 (as it appeared in **3**, Table 1) suggesting structure (**5**) for this compound. Further characterization of the pseudoguaianolide was obtained by ^{1}H- and ^{13}C-NMR spectroscopy (Tables 1 and 2).



1



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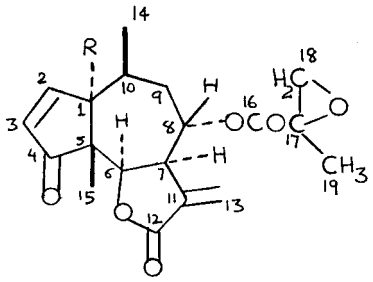
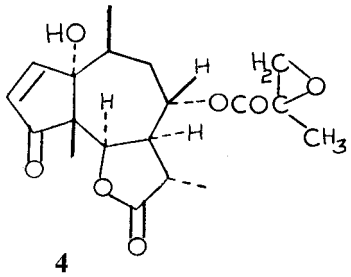


3, R = OH
5, R = H



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3. Experimental

3.1. Plant material

The plant *Parthenium hysterophorus* was collected from the Punjab Agricultural University Campus, Ludhiana (India) in August 1990 and the plant specimen was deposited in the herbarium of Department of Botany of this University (voucher No. 288).

MS were recorded at 70 eV. NMR (^1H and ^{13}C) spectra were measured at 270 and 67.8 MHz, respectively. $CDCl_3$ as solvent and TMS as int. standard. IR, $CHCl_3$ sol. powdered leaves (1.5 kg) of *Parthenium hysterophorus* were extracted with $CHCl_3$ (1 L, for 500 g of leaves, in batches) using a Soxhlet extractor for 24 h. The usual work up gave a semisolid mixture (20.0 g). It was chromatographed on SiO_2 (2 kg). Elution of the column with mixtures of increasing polarity ($CHCl_3$: Me_2CO) yielded parthenin (**1**) and coronopilin (**2**). Repeated CC of the fractions eluted with $CHCl_3$: Me_2CO (93 : 1) afforded (**3**, 260 mg), (**4**, 130 mg) and (**5**, 210 mg).

Compound (**3**) non-crystalline IR ($CHCl_3$): 3600, 3440, 3068, 1765, 1740, 1722, 1645, 1460, 1270, 1070, 990 and 890 cm^{-1}. MS *m/z* (rel. int.) 362.3816 ($C_{19}H_{22}O_7$) requires 362.3805, 278 (8), 260 (30), 242 (17).

Compound (**4**) non-crystalline IR ($CHCl_3$): 3600, 3420, 3080, 1760, 1740, 1720, 1620, 1455, 1260, 1070, 990 and 900 cm^{-1}. MS *m/z* (rel. int.) 364.3963 ($C_{19}H_{24}O_7$) requires 364.3976, 280 (9), 262 (35) and 244 (13).

Compound (**5**), semi-solid IR ($CHCl_3$): 1700, 1740, 1715, 1630, 1450, 1260, 1065, 985 and 890 cm^{-1}. MS *m/z* (rel. int.) 346.3811 ($C_{19}H_{22}O_6$) requires 346.3825, 262 (5) and 244 (13).

Acknowledgements

Financial support under the project 'Chemistry of some natural products and their significance in agriculture' by the Punjab Govt. (India) is highly acknowledged. We thank Prof. H. Etoh of Shizuoka University, Dept. of Applied and Agricultural Chemistry, Japan for supplying the spectral data. Thanks are also due to Dr G.S. Bains of Dept. of Agrometeorology of this University for identifying the plant.

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