Phytochemistry, Vol. 25, No. 10, pp. 2412–2414, 1986.
Printed in Great Britain.

0031–9422/86 \$3.00 + 0.00
Pergamon Journals Ltd.

AN EREMOPHILANOLIDE FROM *SENECIO ROSMARINUS*

GLAUCO MORALES B., JORGE BÓRQUEZ R., ARLETT MANCILLA P., SAMUEL PEDREROS T. and LUIS A. LOYOLA M.

Laboratorio de Productos Naturales, Departamento de Química, Facultad de Ciencias Básicas, Universidad de Antofagasta, Casilla 1240 Antofagasta, Chile

(*Revised received* 14 *February* 1986)

Key Word Index—*Senecio rosmarinus*; Compositae; 1-oxo-10βH-eremophila-7(11)-en-8α,12 olide; istanbulins A and B; acetovanillone.

Abstract—The aerial parts of *Senecio rosmarinus* afforded, in addition to the already known compounds, a new sesquiterpenic lactone, 1-oxo-10βH-eremophila-7(11)-en-8α,12 olide. The structure was established by spectral studies in which 2D-NMR spectroscopy played an essential role.

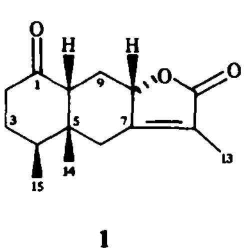
INTRODUCTION

In a continuation of a phytochemical investigation of the genus *Senecio* which grows on the western flank of the Andes in northern Chile (*ca* 4000 m), we wish to report the identification of a new sesquiterpenic lactone of the eremophilanolide type (**1**), isolated together with the known acetovanillone, istanbulin A (**2**) [1] and istanbulin B (**3**) [2, 3] from *Senecio rosmarinus*.

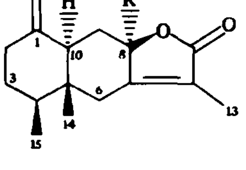
RESULTS AND DISCUSSION

The dried and powdered aerial parts of *S. rosmarinus* Phil. were extracted with ethanol. The HCl-insoluble portion of the ethanolic extract yielded four compounds (see Experimental).

Based on the spectral properties, compound **1** was deduced to be 1-oxo-10βH-eremophila-7(11)-en-8α,12 olide. The IR ($CHCl_3$) and UV (EtOH) spectra of **1** ($C_{15}H_{20}O_3$, M^+ 248.1385) supported the presence of the α,β-unsaturated-γ-lactone (1750, 1680 cm^{-1}, 218 nm, log ε 4.16), a six-membered ring ketone (1710 cm^{-1}, 283 nm, log ε 1.8) and the lack of hydroxyl groups. The ^{13}C NMR spectrum of **1** (Table 1) revealed the presence of three methyls (C-13, C-14, C-15), four methylenes (C-2, C-3, C-6, C-9), two methines (C-4, C-10), a closure-lactonic methine (C-8) and a quaternary carbon (C-5), a pair of olefinic carbons (C-7, C-11), a ketonic carbonyl (C-1) and a lactonic carbonyl (C-12). These spectral data of **1** are in agreement with those of istanbulin B (**3**) [2, 3] in almost all respects and suggested that both compounds possesed the same 1-oxo-eremophilanolide skeleton. The same base peak in the HRMS of both compounds at *m/z* 137.0975 $[C_9H_{13}O]^+$ also supported the above conclusion. The steric arrangement of **1** was derived on the basis of 400 MHz ^1H NMR (Table 2). The chemical shift of the C-5 methyl protons is considered direct evidence for the configuration at C-10. In a number of eremophilanolide derivatives it was found that the chemical shift of the C-5 methyl in the *cis*-annellation of the homobicylic system with the value δ0.9–1.2 is typical, while in the *trans*-annellation it is δ0.5–0.9 in $CDCl_3$ solutions [4, 5]. The resonance of the C-5 methyl group of **1** at δ0.93 is an indication of a *cis*-annellated decalone system. The careful spin-spin decoupling experiment can be explained assuming that the molecule (**1**) presents an optimum double-chair conformation in its *cis*-decalone moiety with the following relative configuration: C-4 methyl β-equatorial, C-5 methyl β-axial, C-10 H β-axial and C-8 H β-axial. The couplings of H-4 with the methylene hydrogens at C-3 have *J* values 13.0 and 6.5 Hz and of H-10 with the methylene hydrogens at C-9 values 12.7 and 6.6 Hz which are in agreement with the proposed stereochemistry for **1**. The assignment of all carbons and protons of **1**, as shown in Tables 1 and 2, was achieved by ^{13}C–^1H shift-correlated 2D and by ^1H shift-correlated 2D, COSY-45 experiments. The latter, a relatively new NMR pulse sequence, is particularly useful in order to assign a



1



2 R = OH
3 R = H

Table 1. ^{13}C NMR data of compounds 1, 2 and 3 (100.6 MHz, CDCl$_3$, TMS as internal standard)

C	1	2†	3†
1	211.72	211.18 *s*	211.40 *s*
2	37.00	41.12 *t*	41.32 *t*
3	30.35	31.12 *t*	31.18 *t*
4	29.18	42.07 *d*	42.63 *d*
5	42.57	44.81 *s*	44.38 *s*
6	36.03	33.77 *t*	38.61 *t*
7	158.91	157.90 *s*	159.01 *s*
8	78.48	108.69 *s*	79.96 *d*
9	33.57	37.00 *t*	29.34 *t*
10	56.80	54.29 *d*	54.42 *d*
11	121.94	123.90 *s*	122.83 *s*
12	174.10	171.88 *s*	176.60 *s*
13	8.37	8.09 *q*	8.28 *q*
14	20.91	11.51 *q*	12.07 *q*
15	14.87	14.74 *q*	14.89 *q*

*Assignment by CH-correlation 2D.

†Assignment by SFORD.

complicated pattern of ^{1}H NMR signals, while the 2D-^{13}C–^{1}H correlation allows, using only one experiment, connection between two types of nuclei (^{13}C and ^{1}H) to be established. The correlation character of the method allows an assignment made for one type of nucleus to be transferred immediately to another type [6]. Application of these techniques for **1** leads to unambiguous assignment of three methyls, four methylenes and two methine carbons, signals which are difficult to assign by other methods.

Compounds **2** and **3** were identified by comparison with authentic samples of istanbulin A and B which have been isolated only once before from *Smyrnium olusatrum* (Umbelliferae) [1–3]. The chemical transformation of **2** into **3** with hydrogen iodide, confirmed that both compounds had the same carbon skeleton, in accordance with the stereo structures recently proposed. The ^{13}C NMR and ^{1}H NMR spectra of **2** and **3** (Tables 1 and 2) were practically identical with the exception of the signals of the carbon atoms and protons affected by the presence of the hydroxyl group connected at C-8 in **2**.

The fourth isolated compound from *S. rosmarinus* was identified as 4-hydroxy-3-methoxyacetophenone (acetovanillone) by IR, ^{1}H NMR and mp, comparison with authentic sample.

EXPERIMENTAL

Plant material. Senecio rosmarinus was collected in the area of Toconce, 90 km east from the city of Calama in northern Chile, and identified by Professor C. Marticorena (University of Concepcion).

Voucher specimens are kept at the herbarium of the University of Concepcion, Chile.

Extraction and isolation. Air-dried aerial parts (3.70 kg) were powdered and extracted with EtOH (15 l.). The dry EtOH extract (400 g) was treated with 4% HCl (5 × 2.5 l.) and filtered. The HCl-insoluble part (350 g) was treated with CHCl$_3$ (3 × 1 l.), filtered and concd. The CHCl$_3$ concentrate (200 g) after standing for 2 weeks in Me$_2$CO yielded crystalline **2** (20.3 g). The supernatant (155.6 g) was subjected to silica gel CC (1.5 kg) and eluted with petrol, C$_6$H$_6$, CHCl$_3$ and EtOH in varying proportions of increasing polarity. The substance eluted with petrol was purified by repeated recrystallization from Me$_2$CO–Et$_2$O, whereby fine needles of **1** (1.8 g) were obtained. Further purification of the C$_6$H$_6$ eluates gave **3** (1.3 g); the C$_6$H$_6$–CHCl$_3$ (1:1) eluates yielded **4** (270 mg) and CHCl$_3$ eluates afforded **2** (2.5 g).

1-*Oxo*-10βH-*eremophila*-7(11)-*en*-8α,12 *olide* (**1**, 1.8 g). Colourless needles from Me$_2$CO–Et$_2$O, mp 157° (Found: C, 71.9; H, 8.1. C$_{15}$H$_{20}$O$_3$ requires: C, 72.5; H, 8.1%); $[\alpha]_D^{23}$ −11.2° (CHCl$_3$; *c* 0.83); UV λ_{max}^{EtOH} nm (log ε): 218 (4.16), 283 (1.8).

Table 2. ^{1}H NMR data of compounds 1, 2 and 3 (400 MHz, CDCl$_3$, TMS as internal standard)

	1	2	3
2α	2.47 *ddd* (15.2, 13.8, 7.5)*	2.38 *ddd* (16.5, 10, 3.5)	2.38 *ddd* (16.5, 10, 3.5)
2β	2.19 *ddd* (15.2, 5.5, 3)	2.47 *ddd* (16.5, 5, 3.5)	2.47 *ddd* (16.5, 5, 3.5)
3α	1.85 *dddd* (13.3, 7.5, 6.5, 3)	1.96 *dddd* (14.2, 3.8, 3.5, 3.5)	1.96 *dddd* (14.2, 3.8, 3.5, 3.5)
3β	1.58 *dddd* (13.8, 13.3, 13, 5.5)	1.65 *dddd* (14.2, 12.6, 10.5)	1.65 *dddd* (14.2, 12.6, 10, 5)
4α	1.88 *ddq* (13. 6.6, 6.5)	2.09 *ddq* (12.6, 6.6, 3.8)	2.00 *ddq* (12.6, 6.6, 3.8)
6α	2.92 *d* (14.3)	2.33 *dd* (13.5, 1.7)	2.10 *dd* (13.5, 1.7)
6β	1.92 *dd* (14.3, 1.5)	2.63 *d* (13.5)	2.75 *d* (13.5)
8α	—	—	4.62 *ddd* (12, 7, 1.7)
8β	4.59 *ddd* (10.9, 6.3, 1.5)	—	—
9α	1.78 *ddd* (16.3, 12.7, 10.9)	2.38 *dd* (13.8, 3.5)	2.47 *ddd* (13.8, 7, 3.5)
9β	2.38 *ddd* (16.4, 6.6 6.3)	1.75 *dd* (13.8, 13.1)	1.45 *ddd* (13.8, 13.1, 12)
10α	—	2.82 *dd* (13.1, 3.5)	2.47 *dd* (13.1, 3.5)
10β	2.32 *dd* (12.7, 6.6)	—	—
13	1.84 *t* (1.5)	1.80 *d* (1.7)	1.81 *t* (1.7)
14	0.93 *s*	0.55 *s*	0.55 *s*
15	0.90 *d* (6.6)	1.03 *d* (6.6)	1.02 *d* (6.6)
OH	—	4.13 *s*	—

*Coupling constants (Hz) in parentheses.

IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1750 (γ-lactone), 1710 (C=O). ^{13}C NMR: see Table 1. ^{1}H NMR: see Table 2.

EIMS (70 eV, direct inlet) *m/z* (rel. int.): 248 (52), 233 (7), 230 (8), 219 (10), 215 (12), 187 (13), 175 (18), 174 (17), 147 (10), 137 (100), 125 (22), 124 (22), 112 (43), 110 (22), 109 (48), 107 (13), 105 (13). HRMS *m/z*: 248.1385 ($C_{15}H_{20}O_3$; $[M]^+$), 230.1266 ($C_{15}H_{18}O_2$; $[M-H_2O]^+$), 215.1073 ($C_{14}H_{15}O_2$; $[230-Me]^+$), 137.0975 ($C_9H_{13}O$, 100%).

Transformation of istanbulin A to istanbulin B. To a soln of istanbulin A (68.7 mg) in $CHCl_3$ (15 ml) was added 57% HI (0.2 ml) and the soln was refluxed (1.5 hr). This reaction mixture was cooled, poured into 0.01 M $Na_2S_2O_3$ (50 ml), extracted with $CHCl_3$ (3 × 25 ml), dried and concd *in vacuo* yielding istanbulin B (45 mg) which was identified with authentic sample by mmp, TLC, IR, NMR spectral data.

4-hydroxy-3-methoxyacetophenone (*acetovanillone*). Identified by TLC, IR, ^{1}H NMR by comparison with an authentic sample.

Acknowledgements—We thank Professor C. Marticorena (University of Concepcion) for botanical classification, Dr. A. Ulubelen (University of Istanbul) for the authentic samples of istanbulins A and B, Dr. W. A. Ayer (Alberta University) for high resolution mass spectra measurements, Dr. F. Bohlmann (Berlin) for running 400 MHz ^{1}H NMR spectra and Dr. M. Spraul (Bruker, Silberstreifen, West Germany) for 2D-COSY-45 and CH-correlation-2D-spectra. Financial support from DIEXAT B-003 (Universidad de Antofagasta) and FONDECYT proyect N° 1053-84, are also gratefully acknowledged.

REFERENCES

1. Ulubelen, A., Oksuz, S., Samek, Z. and Holub, M. (1971) *Tetrahedron Letters* **46**, 4455.
2. Cox, P., Hall, F. and Sim, A. G. (1980) *Tetrahedron* **36**, 3437.
3. Budesinsky, M., Holub, M., Saman, D., Smitalova, Z., Ulubelen, A. and Oksuz, S. (1984) *Collect. Czech. Chem. Commun.* **49**, 1311.
4. Samek, Z., Harmantha, J., Novotny, L. and Sorm, F. (1969) *Collect. Czech. Chem. Commun.* **34**, 2792.
5. Bohlmann, F., Förster, H. J. and Fischer, C. H. (1976) *Justus Liebigs Ann. Chem.* 1487.
6. Benn, R. and Günther, H. (1983) *Angew. Chem. Int. Ed. Engl.* **22**, 350.

Phytochemistry, Vol. 25, No. 10, pp. 2414–2416, 1986.
Printed in Great Britain.

0031-9422/86 $3.00 + 0.00
Pergamon Journals Ltd.

CLERODANE DITERPENOIDS FROM *PORTULACA* CV JEWEL

AYUMI OHSAKI*, NORIKO OHNO, KOZO SHIBATA, TAKASHI TOKOROYAMA and TAKASHI KUBOTA*

* School of Medicine, Kinki University, Sayama-cho, Osaka, 589, Japan and Faculty of Science, Osaka City University, Sumiyoshi-Ku, Osaka, 558, Japan.

(*Received* 5 *February* 1986)

Key Word Index—*Portulaca* cultivar; Portulacaceae; diterpene; *trans*-clerodane; portulides A–D.

Abstract—Three *trans*-clerodane diterpenes were isolated from the aerial part of the *Portulaca* cv Jewel. Their structures were elucidated by spectroscopic methods and chemical correlations.

INTRODUCTION

Among the known constituents of *Portulaca* plants are portulal **1**, a plant growth regulator [1–3] and the minor diterpenoid congeners of *Portulaca grandiflora* Hook. [4, 5]. In this paper we report on the constituents of the *Portulaca* cv Jewel, the flower of which is similar to that of *Portulaca grandiflora* Hook. except that it is single-petalled. The two plants also differ in chromosome number [6].

RESULTS AND DISCUSSION

An ethyl acetate extract of *Portulaca* cv Jewel was separated by extensive chromatography. Portulide A **2**, previously reported as 'portulide' [4], was isolated as a major constituent. In addition, three new apparently closely related constituents, portulide B **3**, portulide C **4** and portulide D **5**, of which **3** represented the other major compound, were obtained and characterized on the basis of spectroscopic analyses and chemical correlations.

The new compounds **3**–**5** have the molecular formulae $C_{20}H_{28}O_3$, $C_{20}H_{28}O_4$ and $C_{20}H_{26}O_4$, respectively, deduced from the $[M-H_2O]^+$ peaks in high resolution mass spectra. The molecular ion peaks were ascertained by FAB mass spectroscopy in glycerol. The IR spectra indicated the presence of hydroxyl groups and $\Delta^{2,3}$-butenolide rings in every compound.

In the ^{1}H NMR spectrum portulide B **3** exhibited