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DITERPENOIDS FROM *BACCHARIS LINEARIS*

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Key Word Index—*Baccharis linearis*; Asteraceae; Astereae; diterpenes; neo-clerodanes; perhydroazulene.

Abstract—Investigation of *Baccharis linearis* has led to the isolation of 14 compounds. In addition to a number of known compounds, such as oleanolic acid, maslinic acid, stigmasta-7,22-dien-3β-ol, stigmasta-7,22-dien-3β-ol-β-D-glucopyranoside, nepetin, quercetin 3-methyl ether, lachnophyllum ester, werneria chromene, jewenol A and portulide B, three new neo-clerodane type diterpenes and one new perhydroazulene derivative have been identified. Structures were elucidated mainly by NMR spectroscopic techniques.

INTRODUCTION

Baccharis linearis (R. et P.) Pers (Asteraceae), commonly known in Chile as 'romerillo' occurs as evergreen shrubs very abundant in the sclerophyllous scrub community in the central zone of Chile. This species is widely used by local people as folk medicine for the treatment of rheumatism, headaches, and spasmodic, urinary and respiratory ailments [1,2]. A number of triterpenoids, flavonoids, chromenes, acetylenes, organic acids [3,4] and alkaloids [5] have been previously reported. As part of our continuing phytochemical investigation of arid-adapted plants in the New World, we have examined the acidic and methanolic extracts of *B. linearis* from Chile. Three novel neo-clerodane-type diterpenoids and one new perhydroazulene diterpenoid have been identified. The details of separation and structure determination for these new compounds are presented below.

RESULTS AND DISCUSSION

The molecular formula of compound **1** was determined as $C_{20}H_{28}O_3$ from its high resolution mass spectrum (*m/z* 316.2035 $[M]^+$, calc. 316.2031). The IR spectrum of **1** indicated the presence of a lactone group (1768 and 1038 cm^{-1}). The ^1H NMR data for **1** exhibited typical signals for a diterpene with a clerodane-type skeleton (Table 1): one tertiary methyl group at δ 0.58 ppm, two secondary methyl groups at δ 0.89 and 1.99 ppm, one aldehyde proton at δ 9.37 ppm, one β-unsaturated proton at δ 6.79 ppm, and an AB coupling system for an oxymethylene at δ 3.90 and 4.30 ppm. The presence of a γ-lactone with an α,β-unsaturated double bond was confirmed by a downfield doublet of doublets at δ 6.79 ppm for the β-proton on a double bond (H-3). Spin decouplings allowed the assignment of H-2, H-1 and H-10. The AB system with a chemical shift characteristic of the oxymethylene at δ 3.90 ppm (H-19) showed a long-range coupling with the axial H-6 at δ 1.25 ppm (W-type). Further spin decouplings from H-6 confirmed H-7, H-8 and H-17. The ^{13}C NMR spectral data showed 20 carbon signals discriminated into three methyls, seven methylenes, five methines and five quaternary carbons. Close similarities of the chemical shifts from C-1 to C-10 and C-17 to C-20 for **1** with reported values for the same carbons [6] indicated that **1** is a diterpene with a neo-clerodane-type skeleton (Table 2). The presence of an aldehyde conjugated with a double bond was indicated by a downfield signal at δ 6.57 ppm for a β-proton (H-14) and a carbonyl signal of the aldehyde at δ 194.5 ppm positioned in the side chain of **1**. That the third methyl group (Me-15) was directly connected to a double bond was supported by the coupling between the methyl protons and H-14. This methyl group was assigned to be in a *trans* configuration in relation to the aldehyde group by NOE spectra. Irradiation of the β-unsaturated proton at δ 6.57 ppm (H-14) resulted in an enhancement of 7.51% in the intensity of the aldehyde proton (H-16). When an aldehyde proton was irradiated at δ 9.37 ppm, a 4.34% increment in intensity of the β-unsaturated proton was observed while only a small increment (0.72%) was found when the methyl group was irradiated at δ 1.99 ppm. The relative stereochemistry of C-10, C-5, C-8 and C-9 was deduced from the coupling constants and NOE difference spectrum of **1**. According to the molecular model, when H-10 is axial (β-type), it is positioned at a 90° dihedral angle with respect to the equatorial proton H-1; no coupling was observed between them. C-19 occupied

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Table 1. ^{1}H NMR data for baclinal (**1**), baclinepoxide (**2**),*13-epi-baclinepoxide (**3**),*baclinic acid (**4**) and triacetyl baclinic acid (**4a**)*

H	1	2	3	H	4‡	4a
1	1.05 *qd* (11.5, 4.0)	1.02 *qd* (11.5, 5.4) 1.64†	1.01 *qd* (11.4, 4.1) 1.63†	1		1.63† 1.77†
2	2.27 *dddd* (18.2, 11.5, 4.2, 2.3) 2.45 *dddd* (18.2, 7.4, 4.0, 2.3)	2.11 *dddd* (18.0, 11.9, 5.4, 2.1) 2.36 *dddd* (18.0, 7.5, 5.4, 2.1)	2.18 *dddd* (18.0, 11.8, 5.4, 2.0) 2.37 *dddd* (18.0, 7.5, 5.3, 2.0)	2		2.21† 2.40†
3	6.79 *dd* (7.3, 2.3)	6.74 *dd* (7.5, 2.1)	6.75 *dd* (7.4, 2.1)	3	6.27 *br s*	7.04 *t* (4.5)
				5		1.22† 2.56 *br d* (8.1)
6	1.25 *tdd* (13.2, 3.6, 2.1) 1.93 *dt* (13.2, 3.6)	1.21 *tdd* (12.0, 3.1, 1.9) 1.89 *dt* (12.0, 2.9)	1.20 *m* 1.90 *dt* (12.6, 2.9)			
7	1.46 *dtd* (14.4, 13.2, 3.6) 1.64 *dq* (14.4, 2.9)	1.44 *m* 1.59 *m*	1.44 *m* 1.58 *m*	7		1.42† 1.78†
8	1.78 *m*	1.61†	1.62†	8		1.51†
10	1.81 *br d* (12.1)	1.65 *d* (12.4)	1.64†	10		1.45†
11	1.32 *m*	1.24 *m* 1.43 *m*	1.24 *m* 1.43 *m*	11		1.48† (2H)
12	2.04 *m* 2.37 *m*	1.26 *m* 1.45 *m*	1.26 *m* 1.45 *m*	12		1.81† 2.00†
14	6.57 *q* (7.0)	5.77 *dd* (17.4, 10.7)	5.78 *dd* (17.3, 10.7)	14	5.26 *t* (7.5)	5.55 *t* (7.4)
15	1.99 *d* (7.0)	5.28 *dd* (10.7, 1.3) 5.36 *dd* (17.4, 1.3)	5.31 *dd* (10.7, 1.2) 5.38 *dd* (17.3, 1.2)	15	3.94 (2H) *d* (7.5)	4.65 (2H) *d* (7.4)
16	9.37	3.50 (2H) *d* (3.0)	3.48 *d* (10.9) 3.55 *d* (10.9)	16	3.90 (2H) *s*	4.64 (2H) *s*
17	0.89 (3H) *d* (6.6)	0.82 (3H) *d* (6.3)	0.82 (3H) *d* (6.2)	17	0.79 (3H) *d* (8.8)	0.81 (3H) *d* (6.3)
19	3.90 *dd* (8.1, 2.1) 4.30 *d* (8.1)	3.90 *dd* (8.0, 1.9) 4.29 *d* (8.0)	3.90 *dd* (8.2, 2.0) 4.28 *d* (8.2)	19	0.67 (3H) *s*	0.79 (3H) *s*
20	0.58 (3H) *s*	0.56 (3H) *s*	0.59 (3H) *s*	20	3.87 *br d*	4.33 *d* (12.1) 4.59 *d* (12.1)
				CH_3CO		1.99 (3H) *s* 2.01 (6H) *s*

*Assignments were confirmed by ^{1}H–^{1}H COSY.

†Overlapped signal.

‡Spectrum was measured in DMSO.

an axial position (α-type) in the bridgehead of the bicyclic ring, which favours an unusual long range coupling with the axial H-6 (W-type). The equatorial conformation of Me-17 (α-type) was deduced by observing the couplings of the axial proton at the 7-position, which coupled with the axials H-6 and H-8. That the Me-20 has an axial configuration (α-type) was confirmed by irradiating this methyl at δ 0.58 ppm; 1.5 and 2.2% enhancements were observed for H-19 at δ 3.90 and 4.30 ppm, respectively. The main fragments in the mass spectrum of **1** corresponded to the characteristic neo-clerodane-type peaks [7]. The base peak of *m/z* 219 was obtained by losing the side chain. A proton migration followed by the loss of CH_2O is a characteristic fragment of neo-clerodanes with a γ-lactone ring. According to the described spectral data, the structure of **1** was, therefore, elucidated as the novel neo-clerodane diterpene, baclinal.

The molecular formula of $C_{20}H_{28}O_3$ for compound **2** was deduced from its high resolution mass spectrum (316.2035, calc. 316.2031). The IR band at 1762 and 1025 cm^{-1} indicated the presence of a γ-lactone group. The ^{13}C NMR of **2** exhibited 20 carbon signals and 14 of them (C1–C10 and C17–C20) showed chemical shifts similar to those of **1**. The ^{1}H NMR spectrum of **2** displayed an additional terminal double bond at δ 5.28, 5.36 and 5.77 ppm and an oxymethylene group at δ 3.50 ppm (2H,*d*). Full proton assignments were completed by ^{1}H–^{1}H COSY, and the assignments of the protonated carbons in **2** were established on the basis of the ^{1}H–^{13}C HETCOR spectrum. With the establishment of a neo-clerodane-type skeleton for **2** by the above spectral data, the remaining six carbons for the side chain were included in one terminal olefinic bond, one ethylene unit, one oxymethylene and one quaternary carbon attached to an oxygen atom. From the observed degrees of unsaturation, a cyclic ring unit should be present in this side chain. Since the oxymethylene displayed no cross peaks with others in the ^{1}H–^{1}H COSY spectrum and since the other oxycarbon was quaternary as indicated in the ^{13}C NMR spectrum, an epoxy substituent was the only possibility that could satisfy all NMR data and the degrees of unsaturation. The confirmation of this partial structure and completed carbon assignments were achieved by selective INEPT experiment: irradiation of

Table 2. ^{13}C NMR chemical shifts of baclinal (**1**), baclinepoxide (**2**),* 13-epi-baclinepoxide (**3**), baclinic acid (**4**) and triacetyl baclinic acid (**4a**)

C	1	2	3	4†	4a‡
1	19.5	19.5	19.4	16.8	17.2
2	27.7	27.6	27.6	26.0	27.1
3	136.2	135.7	135.9	142.9	142.9
4	138.5	138.6	138.6	136.2	136.2
5	45.6	45.6	45.6	37.0	33.5
6	34.4	34.4	34.5	38.2	38.7
7	27.8	27.7	27.8	26.9	27.3
8	36.5	36.4	36.5	36.0	36.2
9	38.9	38.4	38.4	46.1	40.6
10	47.9	47.9	47.9	41.8	46.6
11	35.9	29.7	29.5	37.0	36.8
12	17.1	30.3	30.3	27.3	28.2
13	144.7	75.7	75.9	148.1	140.1
14	149.4	140.4	140.5	126.1	123.8
15	14.6	115.5	115.8	57.0	60.4
16	194.5	68.7	69.0	58.5	61.7
17	15.6	15.5	15.5	18.9	18.2
18	169.9	169.5	169.5	175.9	171.8
19	71.8	71.9	71.9	15.9	15.8
20	17.4	17.8	17.9	64.4	67.6
CH_3CO					20.9, 170.6 20.9, 170.7 21.0, 170.8

*Assignments were confirmed by ^{1}H–^{13}C HETCOR.

†Spectrum was measured in DMSO.

‡Assignments were confirmed by HMQC.

Me-20 at δ 0.56 ppm ($^3J_{CH} = 8$ Hz and $^3J_{CH} = 3$ Hz) with a soft pulse led to the enhancements of C-9 (δ 38.4 ppm), C-10 (δ 47.9 ppm) and C-12 (δ 30.3 ppm). Irradiation of Me-17 at δ 0.82 ppm ($^3J_{CH} = 8$ Hz and $^3J_{CH} = 3$ Hz) enhanced C-9 (δ 38.4 ppm), C-8 (δ 36.4 ppm) and C-11 (δ 29.7 ppm). These correlation data clearly showed that C-9 was connected with C-10 and C-11. Analogous irradiation of the double bond at δ 5.77 ppm ($^3J_{CH} = 8$ Hz and $^3J_{CH} = 3$ Hz) resulted in the enhancements of C-13 (δ 75.7 ppm) and C-16 (δ 68.7 ppm). Enhancement at C-14 (δ 140.4 ppm) was observed when irradiating the oxymethylene (H-16) at δ 3.50 ppm ($^3J_{CH} = 3$ Hz). These experiments suggested that the terminal double bond was directly attached to the epoxy group. By analysis of its spectroscopic properties, **2** was determined to be the novel neo-clerodane diterpene, baclinepoxide.

The molecular formula of compound **3** was deduced as $C_{20}H_{28}O_3$ from its mass spectrum and ^{13}C NMR spectrum, which exhibited 20 carbon signals. Compound **3** displayed almost identical IR, ^{1}H and ^{13}C NMR spectra as those obtained for baclinepoxide (Tables 1 and 2). The only significant difference between the ^{1}H NMR spectra for the two compounds lay in the coupling pattern observed for H-16 at δ 3.50 ppm. The ^{1}H NMR of **3** exhibited an AB coupling system for H-16 at δ 3.48 and 3.55 ppm. No cross peak was observed for H-16 with others in the ^{1}H–^{1}H COSY spectrum. Since **3** displayed a different R_f value by TLC and different retention time on HPLC when compared to those of **2**, compound **3** was assigned as 13-epi-baclinepoxide.

The molecular formula of $C_{20}H_{32}O_5$ (*m/z* 352) for compound **4** was derived from the ^{13}C NMR and mass spectral data. The ^{13}C NMR spectrum exhibited 20 carbons including two methyls, nine methylenes, four methines and five quaternary carbon atoms. The mass spectrum of **4** gave a maximum molecular weight at *m/z* 316 corresponding to $[M^+ - 2H_2O]$. The ^{1}H and ^{13}C NMR spectra of **4** as well as its triacetyl derivative **4a** displayed a pattern characteristic for diterpenoid absorptions with two methyl groups and a side chain of 5-hydroxy-3-hydroxymethyl-3-pentenyl. This pattern was also observed for jewenol A (**5**) and portulide B (**6**). Compound **4a**, a triacetyl derivative prepared because of the poor solubility of **4**, showed a maximum molecular weight at *m/z* 478, and the molecular formula $C_{26}H_{38}O_8$ was derived from the high resolution mass spectrum at *m/z* 460.2795 (calc.460.2802 $[M\text{-}18]^+$). A strong fragment at *m/z* 460 $[M^+ - H_2O]$ and a weak *m/z* 433 peak $[M^+ - COOH]$ indicated a carboxylic acid, which was further confirmed by IR by the presence of a broad band at 3350–3000 cm^{-1}. The carboxylic acid group was conjugated with a double bond as indicated by the presence of a downfield shift at δ 7.04 ppm for a β olefinic proton (H-3) in **4a**. The sequences of $HO_2C\text{–}C{=}CHCH_2CH_2CH\text{–}$, $CH_3CHCH_2\text{–}$, and the side chain were confirmed by ^{1}H–^{1}H COSY and HMQC NMR techniques.

The connection of these partial sequences and the complete assignment of carbon atoms for **4a** were established by HMBC NMR technique. The methyl signal at δ 0.79 ppm (H_3-19) showed long-range correlations with the carbons at δ 38.7 (C-6, *s*) and 46.6 (C-10, *d*), indicating that C-6 was connected with C-10. Similarly, the methyl signal at δ 0.81 ppm (H_3-17) showed long-range correlations with the carbons at δ 36.2 (C-8, *d*) and 27.3 ppm (C-7, *t*), indicating that C-8 was connected with both C-7 and C-17. The methylene at δ 4.64 ppm (H_2-16) displayed long-range correlations with δ 28.2 (C-12, *t*), 140.1 (C-13, *s*) and 123.8 (C-14, *d*), indicating that C-13 was connected not only with C-16, C-14, but also with C-12. The relative stereochemistry of **4a** was solved by a NOESY (0.4 and 0.8 sec mixing times were tried) and one-dimensional (1D) NOE difference spectrum. Based on biogenetic considerations, as well as a previous knowledge of other diterpenoids with a similar type of structure, Me-17 always takes an equatorial position corresponding to an α-configuration. Since clear correlations were observed between H_2-20 at δ 4.33 and 4.59 ppm and H_3-17 at δ 0.81 ppm in NOESY, C-20 was determined to have an axial position (α-type). This was further supported by a molecular model. The absence of correlations among H_3-19 at δ 0.79 ppm, H_3-17 and H_2-20 suggested the possibility of C-19 taking a β-configuration. Absence of correlations were observed between H-10 at δ 1.45 ppm and H_2-20, indicating that H-10 had a β-configuration. The observed correlations between H_3-19 at δ 0.79 and H-7 at δ 1.78 ppm, as well as H_2-20 and

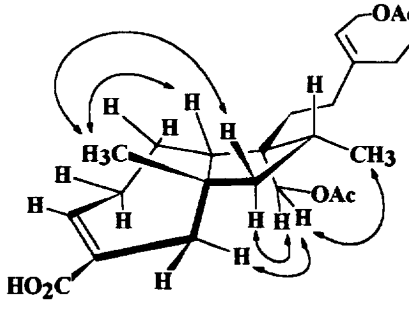
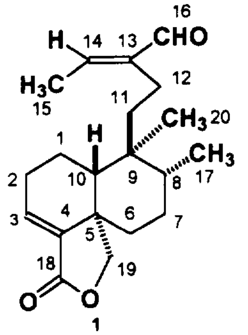


Fig. 1. NOE effects of 4a.



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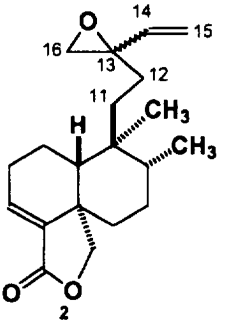
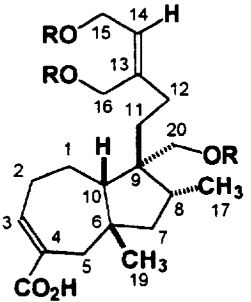
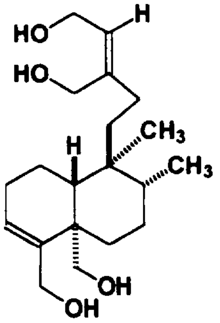


2
3 13-*epi*



4 R = H
4a R = Ac



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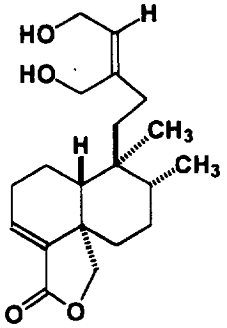

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H-7 at δ 1.42 ppm, supported the above deduction (Fig. 1). An enhancement of 7.9% was observed for H-10 in the 1D NOE difference spectrum when H-19 was irradiated at δ0.79 ppm. These data indicated that both H-19 and H-10 took a β-configuration. According to the described spectral data, the structure of 4 was elucidated as a novel diterpene baclinic acid with a perhydroazulene skeleton. Perhydroazulenes, although with different chemical substituents, were reported for *Portulaca grandiflora* [8–10].

Compounds **5** and **6**, previously isolated from *Portulaca* cv. Jewel, were elucidated as jewenol A and portulide B [11]. The other known compounds obtained in the present investigation, oleanolic acid, maslinic acid, stigmasta-7,22-dien-3β-ol, stigmasta-7,22-dien-3β-ol-β-D-glucopyranoside, nepetin, quercetin 3-methyl ether, lachnophyllum ester and werneria chromene, were identified by comparison of their spectroscopic data with corresponding literature values [3]. The diterpenoids with a γ-lactone ring reported here elicit a positive Dragendorff test, which formed the basis for a previous claim that this plant produces alkaloids. This study suggests that *B. linearis*, in fact, does not synthesize alkaloids as was previously reported [5].

EXPERIMENTAL

General. NMR spectra: 300 MHz for ^{1}H and 75 MHz for ^{13}C in $CDCl_3$ (unless otherwise stated) with TMS as int. standard. IR: KBr pellets. MS: direct inlet, 70 eV. HPLC: Alltech Model 425 High Pressure Pump with Vydac, ODS, 5 μm, 4.6 × 250 mm, Econosil C18, 10μm, 10 × 250 mm, and Econosil Silica, 10 μm, 10 × 250 mm; detection: 254 nm; flow rate: 0.8–1.0 ml min^{-1} for analyt. and 3.0–4.0 ml min^{-1} for prep. purposes.

Plant material. Baccharis linearis was collected on 11 October 1991 in San Carlos de Apoquindo, Chile, by Luis Gonzalez. The voucher specimen (No. 910010) is deposited in the Herbarium, at the Pontificia Universidad Catolica de Chile, Santiago, Chile.

Extraction and isolation. For diterpenoids: air-dried ground biomass (200 g) was extracted with CH_2Cl_2 and the CH_2Cl_2 was evapd under red. pres. to give a crude extract (20 g) which was further extracted with 2% HCl. Conc. NH_3 was added to the HCl soln and adjusted to pH 8–9. The alkaline soln was extracted with CH_2Cl_2 and the organic layers were evapd *in vacuo* to yield a residue (8 g). This residue was sepd on a silica gel (200 g) column eluted with a gradient CH_2Cl_2–MeOH solvent system and by prep. HPLC to yield **1** (22 mg), **2** (11 mg), **3** (5 mg), **5** (12 mg) and **6** (7 mg). Isolation of other compounds: pulverized material of above-ground parts of *B. linearis* (920 g) was extracted with MeOH, and the MeOH was evapd *in vacuo* to give a crude extract (320 g). The crude extract was partitioned between MeOH and hexane and then the MeOH layers were evapd *in vacuo* to yield a residue (210 g) which was subjected to CC on silica gel (2.5 kg). Frs were eluted with a gradient CH_2Cl_2–MeOH system on repeated columns to give **4** (119 mg), oleanolic acid (3.1 g), stigmasta-7,22-dien-3β-ol (44 mg), stigmasta-7,22-dien-3β-ol-β-D-glucopyranoside (49 mg), maslinic acid (42 mg), lachnophyllum ester (450 mg), nepetin (96 mg), quercetin 3-methyl ether (51 mg) and werneria chromene (220 mg).

Baclinal (**1**). Oily solid, HRMS: *m/z* 316.2035 $[M]^+$ $C_{20}H_{28}O_3$ calc. 316.2031. $[\alpha]_D$ − 179° ($CHCl_3$; *c* 0.7). IR ν^{KBr} cm^{-1}: 2928, 2870, 1768, 1645, 1462, 1363, 1143, 1038, 763. ^{1}H NMR: Table 1; ^{13}C NMR: Table 2. EIMS: *m/z* (rel. int.): 316 $[M]^+$ (12), 286 (29), 285 (14), 271 (5), 258 (17), 219 (100), 202 (14), 189 (61), 188 (15), 187 (55), 173 (13), 165 (9), 161 (17), 159 (20), 149 (24), 133 (16), 121 (15), 119 (21), 105 (35), 91 (62), 81 (22), 77 (28), 67 (25), 55 (22).

Baclinepoxide (**2**). Oil, HR-MS: *m/z* 316.2035 $[M]^+$ $C_{20}H_{28}O_3$ calc. 316.2031. $[\alpha]_D - 95°$ ($CHCl_3$, *c* 0.7). IR ν^{KBr} cm^{-1}: 2958, 2925, 2885, 1762, 1663, 1600, 1449, 1364, 1297, 1182, 1025, 998, 760. ^1H NMR: Table 1; ^{13}C NMR: Table 2. EIMS: *m/z* (rel. int.): 316 $[M]^+$ (7), 286 (28), 271 (5), 258 (12), 219 (71), 202 (8), 189 (57), 187 (50), 173 (26), 161 (37), 149 (43), 133 (34), 121 (39), 105 (66), 91 (100), 77 (58), 55 (80).

13-epi-*Baclinepoxide* (**3**). Oil, $[\alpha]_D - 78°$ ($CHCl_3$; *c* 0.3). IR ν^{KBr} cm^{-1}: 2924, 2885, 1763, 1665, 1445, 1361, 1290, 1181, 1031, 998, 768. ^1H NMR: Table 1; ^{13}C NMR: Table 2. EIMS *m/z* (rel. int.): 316 $[M]^+$ (5), 286 (21), 285 (37), 271 (5), 258 (4), 219 (50), 202 (14), 189 (53), 187 (27), 173 (26), 161 (42), 149 (73), 133 (39), 121 (50), 105 (70), 91 (100), 87 (85), 77 (55), 55 (92).

Baclinic acid (**4**). Amorphous powder. ^1H NMR: Table 1; ^{13}C NMR: Table 2. IR ν^{KBr} cm^{-1}: 3450–3000, 2951, 2922, 1700, 1384, 1366, 1183, 1034, 781. EIMS: *m/z* (rel. int.): 316 $[M - 2H_2O]$ (0.4), 287 (0.5), 258 (0.7), 217 (12), 193 (4), 173 (4), 161 (7), 159 (11), 149 (14), 117 (30), 95 (68), 91 (100), 79 (34), 67 (20).

Triacetyl baclinic acid (**4a**). HR-MS: *m/z* 460.2795 $[M - 18]^+$ $C_{26}H_{36}O_7$ calc. 460.2802. $[\alpha]_D - 68°$ (*c* 0.7). IR ν^{KBr} cm^{-1}: 3350–3000, 2950, 2928, 1742, 1454, 1383, 1233, 1033, 968, 781. EIMS: *m/z* (rel. int.): 478 $[M]^+$ (1.5), 460 (25), 418 (35), 400 (7), 387 (9), 374 (6), 358 (12), 340 (15), 327 (87), 301 (33), 285 (42), 241 (72), 219 (40), 187 (34), 175 (60), 173 (71), 161 (70), 147 (53), 119 (63), 105 (81), 91 (100), 79 (65).

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REFERENCES

1. Montes, M. and Wilkomirsky, T. (1985) *Medicina Tradicional Chilena* Ed. de la Universidad de Concepcion. p. 203, Concepcion, Chile.
2. Murillo, A. (1889) *Plantes Medicinales du Chili, Exposition Universelle de Paris*, Section Chilienne, p. 234.
3. Labbe, C., Rovirosa, J., Faini, F., Mahu, M., San-Martin, A. and Castillo, M. (1986) *J. Nat. Prod.* **49**, 517.
4. Brown, G. D. (1994) *Phytochemistry* **35**, 1037.
5. Montes, G. M., Wilkomirsky, T., Valenzuela, R. L. and Neira, M. R. (1971) *Rev. Real. Acad. Cienc. Exactas, Fis. Nat., Madrid* **65**, 499.
6. Kuroyanagi, M., Uchida, K., Ueno, A., Satake, M. and Shimomura, K. (1993) *Phytochemistry* **34**, 1377.
7. Stapel, G., Menßen, H. G. and Snatzke, G. (1980) *Planta Med.* **38**, 366.
8. Yamazaki, S., Tamura, S., Marumo, F. and Saito, Y. (1969) *Tetrahedron Letters* 359.
9. Ohsaki, A., Matsumoto, K., Shibata, K., Kubota, T. and Tokoroyama, T. (1985) *Chem. Pharm. Bull.* **33**, 2171.
10. Ohsaki, A., Shibata, K., Tokoroyama, T., Kubota, T. and Naoki, H. (1986) *Chem. Letters* **27**, 1585.
11. Ohsaki, A., Ohno, N., Shibata, K., Tokoroyama, T. and Kubota, T. (1986) *Phytochemistry* **25**, 2414.