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A *SECO*-GUAIANOLIDE AND OTHER SESQUITERPENE LACTONES FROM *POSTIA BOMBYCINA*

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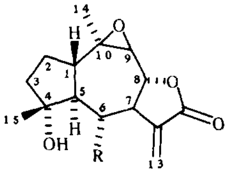
Key Word Index—*Postia bombycina*; Compositae; sesquiterpene lactones; pseudoguaianolide; guaianolides; *seco*-quaianolide.

Abstract—The aerial parts of *P. bombycina* afforded three pseudoguaianolides, four guaianolides, a *seco*-guaianolide, the known eudesmanolide granilin and the xanthanolide tomentosin. The structures were elucidated by high field ^{1}H NMR spectroscopy.

INTRODUCTION

The small genus *Postia*, (tribe Inuleae) with four species, distributed over Syria and Iran, was previously placed in the subtribe Buphthalminae next to *Anisopappus* [1, 2]. Recently, however, both were transferred to the subtribe Inulinae *sensu amplo* in the Inula group [3]. While the chemistry of many genera of this group has been studied nothing is known about that of *Postia*. We now present the results of a study of a species from the latter genus.



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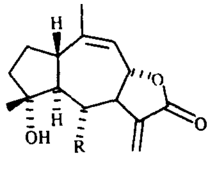
2 R = OAc



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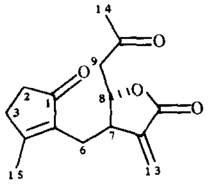

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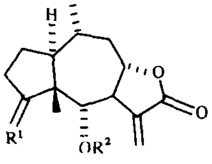

	R¹	R²
6	β-OH, H	Ac
7	β-OAc, H	H
8	=O	Ac

RESULTS AND DISCUSSION

The aerial parts of *Postia bombycina* Boiss. et Haussk. afforded, in addition to tomentosin [4] and granilin [5], the guaianolides **1**–**4**, the *seco*-guaianolide **5** and the pseudoguaianolides **6**–**8**, the latter already being reported from an *Erigeron* species [6]. As the ^{1}H NMR data of this lactone are incomplete, we have included them in Table 1.

The structure of **1** followed from its ^{1}H NMR spectrum (Table 2). Though some signals were overlapping, and not first order (H-2 and H-3), the sequences could be assigned by spin decoupling. Thus irradiation of the signal at $\delta 2.81$ showed that it was due to H-7 as the double doublet at $\delta 4.03$ collapsed to a doublet and the doublets at $\delta 6.26$ and 5.57 (H-13) to singlets. Furthermore, as the signals of H-6 were affected and were themselves coupled with the threefold doublet at $\delta 1.79$ (H-5) the presence of a guaia-12.8α-olide was very likely. A doublet at $\delta 3.13$ was coupled with H-8. The chemical shift, the observed coupling and the observed NOE indicated the presence of a 9β,10β-epoxide. Saturation of H-14 ($\delta 1.39s$) gave clear effects with H-9 (7%) and H-5 (5%). The ^{1}H NMR spectrum of **2** (Table 2) was in part very similar to that of **1**. The presence of the 6α-acetoxy derivative followed from the replacement of the H-6 signals in the spectrum of **1** by a triplet at $\delta 4.64$ ($J = 10$), which was coupled with a further triplet at $\delta 1.94$ (H-5).

The ^{1}H NMR spectra of **3** and **4** (Table 2) indicated that these lactones were the corresponding Δ^9-derivatives. Accordingly, the H-9 doublet was replaced by low-field signal at $\delta 5.85$ and 5.64 respectively. Spin decoupling showed that the observed splitting was due to allylic couplings with H-1 and H-14 and to a vicinal coupling with H-8. As followed from the signals of H-6 in the case of lactone **4**, again a 6α-acetoxy derivative was present. An interesting fact was that the spectrum of **4** was partly broadened at room temperature; especially the signal of H-6. At elevated temperature in deuteriobenzene all signals were sharp. Probably this is due to hindered rotation of the acetoxy group.

The stereochemistry of **4** was determined by NOE-difference spectroscopy. Clear effects were observed between H-15, H-6 (10%), H-1 (4%) and H-3 (5%), between H-14 and H-9 (15%), between H-1, H-10 (10%), H-6 (3%) and H-15 (3%), between H-7 and H-5 (7%), between H-8, H-6 (3%) and H-1 (6%) as well as between H-6, H-8 (6%), H-1 (4%) and H-15 (8%). As the coupling of **1**–**3** were more or less the same as in the case of **4** all configurations were probably the same in these lactones. A glycoside of **4** has been reported from a *Helenium* species [7]. The ^{1}H NMR data are very similar.

The ^{1}H NMR spectra of **6** (Table 1) indicated the presence of a pseudoguaianolide, especially the chemical shifts of the methyl signals (δ1.00 *s*, 0.98 *d*). Spin decoupling further showed that again a *trans*-7,8-lactone was present. The chemical shifts indicated that an acetoxy group was at C-6 and a hydroxy group at C-4. The coupling allowed the assignment of the stereochemistry. The ^{1}H NMR spectrum of **7** was very similar to that of **6** (Table 1). As followed from the chemical shifts, only the position of the oxygen functions were exchanged. Thus a 4β-acetoxy-6α-hydroxy derivative was present. The proposed stereochemistry was further supported by comparing the couplings with those of **8** were all signals could be assigned by spin decoupling though those of H-2 and H-3 were not first order (Table 1). As mentioned previously, this ketone is almost certainly identical with ergolide [6], as the few signals in the literature agree with those observed here.

Table 1. ^{1}H NMR spectral data of compounds **6**–**8** (400 MHz, $CDCl_3$, δ-values)

H	**6**	**7**	**8**
1	1.68 *br ddd*	1.76 *br ddd*	2.27 *ddd*
2	1.90 *m*	1.90 *m*	2.40 *m*
2′		1.71 *m*	2.15 *m*
3	1.43 *m*	1.50 *m*	1.45 *m*
3′			
4	3.95 *t*	5.48 *t*	—
6	5.10 *d*	3.54 *dd*	5.49 *d*
7	3.02 *dddd*	2.79 *dddd*	3.03 *dddd*
8	4.54 *ddd*	4.47 *ddd*	4.48 *ddd*
9	2.42 *ddd*	2.37 *ddd*	2.50 *ddd*
9′	1.43 *q*	1.38 *q*	1.50 *q*
10	1.68 *m*	1.71 *m*	1.85 *dddq*
13	6.16 *d*	6.19 *d*	6.21 *d*
13′	5.37 *d*	5.98 *d*	5.85 *d*
14	0.98 *d*	0.98 *d*	1.11 *d*
15	1.00 *s*	0.87 *s*	1.02 *s*
OAc	2.20 *s*	2.13 *s*	1.97 *s*
OH	—	4.83 *d*	—

J[Hz]: compounds **6** and **7** 1,2 = 8; 1,2′ = 1,10 ~ 10; 3,4 = 3′,4 = 8; 6,7 = 8; 7,8 = 10; 7,13 = 3.5; 7,13′ = 3; 8,9 = 2.5; 8,9′ = 12; 9,10 = 4; 9′,10 = 12; compound **8**: 1,2 = 5; 1,2′ = 1,10 ~ 11; 6,7 = 8; 7,8 = 10; 7,13 = 3.5; 7,13′ = 3; 8,9 = 3; 8,9′ = 9,9′ = 9′,10 = 12; 9,10 = 4.

The ^{1}H NMR spectrum (Table 2) and the mass spectrum of **5** indicated the presence of a *seco*-guaianolide. Thus loss of MeCO and $MeCOCH_2$ in the mass spectrum required an acetonyl group and spin decoupling showed that H-8 was coupled with a pair of doublets (δ2.80 and 2.58). The chemical shifts required a neighbouring keto group and the couplings an open chain group as the vicinal couplings were nearly identical. Though some signals again were not first order only the proposed structure agreed with all data. Thus in the IR, in addition to the lactone carbonyl band, a band for a conjugated keto group and one for a non-conjugated keto group were observed (1770, 1720, 1680 cm^{-1}). Most likely the seco derivative **5**, which we have named postia secoguaianolide, is formed by oxidative enzymatic cleavage of the Δ^{9} double bond of the anhydro derivative of **3**.

The chemistry of this species supports the proposed relationship of *Postia* to *Anisopappus* where also pseudoguaianolides have been isolated [8]. Similar sesquiterpene lactones are also reported from other genera which

Table 2. ^{1}H NMR spectral data of compounds **1**–**5** (400 MHz, $CDCl_3$, δ-values)

H	**1**	**2** (C_6D_6)	**3**	**4**(C_6D_6, 77°)	**5**
1	1.63 *m*	1.24 *m*	2.50 *m*	2.08 *br ddd*	—
2			1.8–1.5 *m*	1.31 *dddd*	2.60 *m*
2β	1.72 *m*	1.35 *m*		1.60 *dddd*	
3α				1.46 *ddd*	2.48 *m*
3β	1.92 *m*	1.55 *m*		1.41 *ddd*	
5	1.79 *ddd*	1.94 *t*	1.94 *m*	1.71 *dd*	—
6α	2.41 *ddd*	4.64 *t*	2.47 *dt*	4.96 *t*	2.58 *m*
6β	1.19 *ddd*		1.40 *ddd*		2.41 *m*
7	2.81 *tq*	2.95 *tt*	2.54 *tq*	2.82 *tt*	3.10 *m*
8	4.03 *dd*	3.42 *dd*	4.72 *ddq*	4.20 *ddq*	4.58 *dt*
9	3.13 *d*	2.66 *d*	5.85 *ddq*	5.64 *ddq*	2.80 *dd*
13	6.26 *d*	6.25 *d*	6.19 *d*	6.25 *d*	6.27 *d*
15′	5.57 *d*	5.45 *d*	5.98 *d*	5.45 *d*	5.58 *d*
14	1.39 *s*	1.04 *s*	1.82 *br s*	1.49 *br s*	2.16 *s*
15	1.18 *s*	1.01 *s*	1.23 *s*	1.17 *s*	2.06 *br s*
OAc	—	1.79 *s*	—	1.81 *s*	—

J[Hz]: compounds **1** and **2**: 7,8 = 10; 7,13 = 3.5; 7,13′ = 3; 8,9 = 6 (compound **1**: 1,5 = 5,6β = 12; 5,6α = 6α,7 = 3; 6α,6β = 13; compound **2**: 1,5 = 5,6 = 10); compounds **3** and **4**: 7,8 = 9; 7,13 = 3.5; 7,13′ = 3 (compound **3**: 5,6α = 6α,7 = 3; 5,6β = 6α,6β = 6β,7 = 12; compound **4**: 1,2α = 6; 1,2β = 1,5 = 10; 1,9 = 1; 2α,2β = 3α,3β = 13; 2α,3α = 7; 2α,3β = 10; 2β,3α = 9; 2β,3β = 3.5; 5,6 = 6,7 = 10; 8,14 = 9,14 1); compound **5**: 7,8 = 3.5; 7,13 = 2.5; 7,13′ = 2; 8,9 = 6.5; 8,9′ = 6; 9,9′ = 17.

are now placed in the subtribe Inulinae *sensu amplo*, especially in the first group (Inula group) and in the second (Geigeria group).

EXPERIMENTAL

The air-dried aerial parts (500 g) were collected in August 1986 in the province of Khorrassan, 60 km W of Mashed, Iran (voucher number 324 deposited in the Herbarium of the Department of Botany, Shahid Beheshty University, Tehran). Extraction and separation was performed as reported previously [9]. The CC fraction obtained with Et_2O–petrol (1:1), Et_2O and Et_2O–MeOH (9:1) were further separated by TLC (silica gel, PF 254) and HPLC (RP8, always *ca* 100 bar, flow rate 3 ml/min). The less polar fractions gave by HPLC (MeOH–H_2O, 13:7) 90 mg **8** (R_t 6.8 min), 80 mg **4** (R_t 7.2 min), 20 mg tomentosin (R_t 8.4 min), 15 mg **3** (R_t 8.8 min), 40 mg **6** (R_t 10.2 min) and 35 mg **7** (R_t 12.8 min). The more polar fractions by HPLC (MeOH–H_2O, 1:1) gave 25 mg **5** (R_t 5.2 min), a mixture of **1** and **2** (R_t 6.5 min) and 120 mg granilin (R_t 8.8 min). Repeated HPLC of the mixture **1**/**2** (MeOH–H_2O, 2:3) gave 30 mg **2** (R_t 16.5 min) and 10 mg **1** (R_t 20.6 min). The structures of granilin and tomentosin were determined by comparison of the 400 ^{1}H NMR spectra with those of authentic material.

*4α-Hydroxy-9β,10β-epoxy-1β*H*-guaia*-11(13)-*en*-12.8*α-olide* (**1**). Colourless oil, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3580 (OH), 1770 (γ-lactone); MS *m/z* (rel. int): 264 $[M]^+$(0.5), 246.125 $[M-H_2O]^+$(6) (calc. for $C_{15}H_{18}O_3$ 246.125), 231 $[246-Me]^+$(8), 228 $[246-H_2O]^+$ (7), 55 (100), $[\alpha]_D^{24°}$ −36 ($CHCl_3$; *c* 0.15).

*6α-Acetoxy-4α-hydroxy-9β.10β-epoxy-1β*H*-guaia*-11(13)-*en*-12.8*α-olide* (**2**). Colourless crystals, mp 227°, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3598 (OH), 1770 [γ-lactone 1735 (OAc)]; MS *m/z* (rel. int): 322.141 $[M]^+$(3) (calc. for $C_{17}H_{22}O_6$ 322.141), 307 $[M-Me]^+$(5), 262 $[M-HOAc]^+$(10), 204 (81), 186 (100), 91 (88), 84 (98); $[\alpha]_D^{24°}$ −68 ($CHCl_3$; *c* 0.12).

*4α-Hydroxy-1β*H*-guaia*-9.11(13)-*dien*-12.8*α-olide* (**3**). Colourless crystals mp 140°; IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3570 (OH), 1770 (γ-lactone); MS *m/z* (rel. int): 248.141 $[M]^+$(36) (calc. for $C_{15}H_{20}O_3$ 248.141), 233 $[M-Me]^+$(8), 230 $[M-H_2O]^+$(12), 55 (100); $[\alpha]_D^{24°}$ −38 ($CHCl_3$; *c* 0.2).

*6α-Acetoxy-4α-hydroxy-1β*H*-guaia*-9.11(13)-*dien*-12.8*α-olide* (**4**). Colourless gum, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3580 (OH), 1770 (γ-lactone), 1740 (OAc); MS *m/z* (rel. int): 306.146 $[M]^+$ (8) (calc. for $C_{17}H_{22}O_5$ 306.146), 246 $[M-HOAc]^+$(40), 228 $[246-H_2O]^+$(42), 188 (100); $[\alpha]_D^{24°}$ −49 ($CHCl_3$, *c* 1.3).

*6α-Acetoxy-4β-hydroxy-*1α,10β*H-pseudoguaia*-11(13)-*en*-12.8 *α-olide* (**6**). Colourless oil, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3580 (OH), 1770 (γ-lactone), 1735 (OAc); MS *m/z* (rel. int): 308 $[M]^+$(0.5), 248.141 $[M-HOAc]^+$(6) (calc. for $C_{15}H_{20}O_3$ 248.141), 230 $[248-H_2O]^+$(5), 81 (100), $[\alpha]_D^{24°}$ −28 ($CHCl_3$; *c* 0.2).

*4β-Acetoxy-6α-hydroxy-*1α.10β*H-pseudoguaia*-11(13)-*en*-12.8 *α-olide* (**7**). Colourless oil, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3540 (OH), 1770 (ν-lactone), 1735 (OAc); MS *m/z* (rel. int): 308 $[M]^+$(0.2), 248.141 $[M-HOAc]^+$(7) (calc. for $C_{15}H_{20}O_3$ 248.141), 230 $[248-H_2O]^+$(6), 81 (100); $[\alpha]_D^{24°}$ −16 ($CHCl_3$; *c* 0.4).

Postia secoguaianolide (**5**). Colourless oil, IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1770 (γ-lactone), 1720 (C=O), 1680 (C=CC=O); MS *m/z* (rel. int): 262.120 $[M]^+$(38) (calc for $C_{15}H_{18}O_4$ 262.120), 219 $[M-COMe]^+$(26), 205 $[M-CH_2COMe]^+$(42); $[\alpha]_D^{24°}$ +24 ($CHCl_3$; *c* 0.15).

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