hydroxyl, a methoxyl and two prenyl groups. According to the fragment $[B]^+$, **1** has a hydroxyl (m/z 120) in the 4'-position, while **2** has two hydroxyl groups (m/z 136) in the 3',4'-position.

The substitution pattern of ring A was determined by the ^{13}C NMR chemical shifts (Table 1), by placing the methoxyl group at C-7 and the prenyl substituents at C-6 and C-8 in **1** (5,4'-dihydroxy-7-methoxy-6,8-di-*C*-prenylflavanone) and **2** (5,3',4'-trihydroxy-7-methoxy-6,8-di-*C*-prenylflavanone).

The ^1H NMR spectrum of **3** showed two methoxyl groups (δ3.91, 3.75) and a chelated hydroxyl group (δ12.02). Methylation gave a product which was identical to the dimethyl ether of **2**. Compounds **2** and **3** had identical UV spectra with diagnostic reagents, thus one of the methoxyl groups in **3** must be at C-7. On the basis of these data it could not be decided whether the second methoxyl is at the C-3' or at the C-4'-position. The structural investigations could not be extended because of scarcity of the isolated compound.

EXPERIMENTAL

Extraction and isolation. Dried, powdered root bark of *A. fruticosa* L. (14 kg) was percolated with MeOH (70 l.). The extract was evapd to 6 l., diluted with H_2O (6 l.) and extracted with C_6H_6. Evapn of the C_6H_6 fraction yielded a brown, oily residue (290 g), which was fractioned on a silica gel column with petrol and petrol–CH_2Cl_2 (19:1, 9:1, 4:1, 7:3, 1:1), then on a polyamide column (MeOH–H_2O, 2:3, 3:2, 7:3, 4:1). The flavanone-containing fractions were purified on silica gel prep. layers in *n*-hexane–Me_2CO (4:1), *n*-hexane–EtOAc (4:1) and C_6H_6–EtOAc (19:1). By this method, 10 mg of amoradin (**1**), 610 mg of amoradicin (**2**) and 1.5 mg of amoradinin (**3**) were obtained in crystalline form. R_f (C_6H_6–EtOAc, 19:1): **1** 0.28; **2** 0.09; **3** 0.42; (*n*-hexane–Me_2CO, 4:1): **1** 0.22; **2** 0.10; **3** 0.23.

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PHENOLIC DERIVATIVES FROM *ARTEMISIA CAMPESTRIS* SUBSP. *GLUTINOSA*

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Key Word Index—*Artemisia campestris*; Compositae; flavonoids; acetophenone derivatives.

Abstract—From the hexane extract of *Artemisia campestris* subsp. *glutinosa*, sakuranetin, dihydroquercetin-7,3'-dimethyl ether and three acetophenone derivatives identified as 3-[4-acetoxyisopent-2(*Z*)-enyl]-4-hydroxyacetophenone, 3-[4-acetoxyisopent-2(*E*)-enyl]-4-hydroxyacetophenone and 3-(3-acetoxymethyl-2-hydroxybut-3-enyl)-4-hydroxyacetophenone, have been isolated.

INTRODUCTION

Column chromatography of the weakly acidic fraction of the hexane extract of *Artemisia campestris* L., subsp. *glutinosa* (Gay ex Besser) Batt., afforded the previously reported acetophenone derivatives [1, 2], sakuranetin [3], dihydroquercetin-7,3'-dimethyl ether [4] and three acetophenone derivatives, **1–3**.

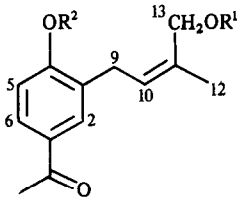
RESULTS AND DISCUSSION

Compounds **1** and **2** were chromatographically very similar and showed practically the same spectral properties: $[M]^+$ at m/z 262 ($C_{15}H_{18}O_4$); IR spectra with bands at ν_{max} 3300 (OH), 1680 (C=O), 1640 (C=C), 1600, 1500 (aromatic) and 1740, 1270 (OAc) cm^{-1}; the ^1H NMR spectra showed the presence of one 1,3,4-trisubstituted aromatic ring, the substituents being identified as COMe, OH and 4-acetoxyisopent-2-enyl groups (Table 1). The only significant difference was the signal due to the CH_2OAc groups, which appeared in both as singlets, but at δ 4.72 in **1**, and 4.45 in **2**. This difference suggested that **1** and **2** may be one pair of (*Z*) and (*E*) stereoisomers [2]. The stereochemistry (*Z*) for **1** and (*E*) for **2**, was confirmed by acetylation and saponification of **1** and **2**, which gave **1a** or **2a** and **1b** or **2b**, respectively. Compounds **1b** and **2b** were identical in all respects with those already isolated from *A. campestris* [2].

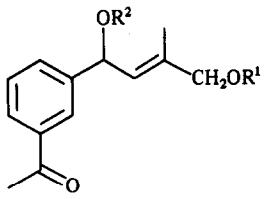
Table 1. ^{1}H NMR spectral data for 1–3 and 1a–3a (60 MHz, $CDCl_3$, TMS)

	1	1a	2	2a	3	3a
H-2	7.72 *d* (2)*	7.83 *d* (2)	7.64 *d* (2)	7.90 *d* (2)	7.68 *d* (2)	7.80 *d* (2)
H-5	6.89 *d* (8)	7.10 *d* (8)	6.76 *d* (8)	7.16 *d* (8)	6.83 *d* (8)	7.10 *d* (8)
H-6	7.64 *dd* (8, 2)	7.70 *dd* (8, 2)	7.58 *dd* (8, 2)	7.85 *dd* (8, 2)	7.58 *dd* (8, 2)	7.75 *dd* (8, 2)
H-8	2.56 *s*	2.58 *s*	2.52 *s*	2.54 *s*	2.51 *s*	2.55 *s*
H-9	3.44 *d* (8)	3.38 *d* (7)	3.37 *d* (8)	3.36 *d* (7)	3.06 *d* (7)	2.95 *d* (7)
H-10	5.54 *t* (8)	5.47 *t* (7)	5.50 *t* (8)	5.60 *t* (7)	4.13 *t* (7)	5.45 *t* (7)
H-12	1.81 *br s*	1.82 *s*	4.45 *br s*	4.52 *s*	5.18 *s* 5.25 *s*	5.10 *s* 5.20 *s*
H-13	4.72 *br s*	4.68 *s*	1.76 *s*	1.76 *s*	4.60 *br s*	4.60 *br s*
Ph–OH	8.84 *s*		9.67*s*		9.54 *s*	
Ph–OAc		2.33 *s*		2.37 *s*		2.36 *s*
R–OAc	2.11 *s*	2.10 *s*	2.04 *s*	2.08 *s*	2.19 *s*	2.10 *s* 1.98 *s*

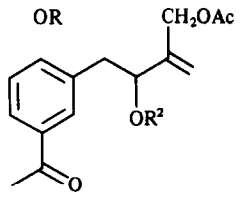
*Coupling constants in Hz are given in parentheses.



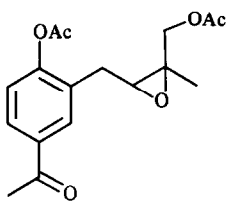
1 R^1=Ac R^2=H
1a R^1=R^2=Ac
1b R^1=R^2=H



2 R^1=Ac R^2=H
2a R^1=R^2=Ac
2b R^1=R^2=H



3 R^1=R^2=H
3a R^1=R^2=Ac



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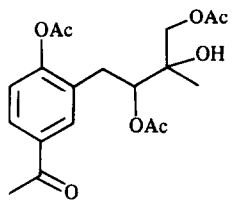

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Compound **3** had $[M]^+$ *m/z* 278 ($C_{15}H_{18}O_5$) and IR spectrum with ν_{max} cm^{-1}: 3300 (OH), 1690 (C=O), 1650 (C=C), 1600, 1500 (aromatic), 890 (C=CH_2) and 1740, 1270 (OAc). Its ^{1}H NMR spectrum suggested the presence of a 1,3,4-trisubstituted aromatic ring with the COMe, OH and 3-acetoxymethyl-2-hydroxybut-3-enyl groups as substituents (Table 1). Acetylation of **3** gave **3a**, $[\alpha]_D = -0.8°$ and IR spectrum ν cm^{-1}: 1760 and 1740 (Ar–OAc and R–OAc). Its ^{1}H NMR (Table 1) showed signals at δ 1.98, 2.10 and 2.36 (three OAc groups); the signal at δ 5.45 (1H, J = 7 Hz) confirmed that one of the acetoxyl groups was secondary. The proposed structure for **3**, was confirmed by transformation of **1a** in **3a**: epoxidation of **1a** with *m*-chloroperbenzoic acid gave the epoxide **4**, which by acetolysis with HOAc–NaOAc [5], gave **5**. Dehydration of **5** with $POCl_3$–pyridine [6] afforded (±)**3a**.

EXPERIMENTAL

Mps are uncorr. UV spectra were recorded in EtOH and ^{1}H NMR at 60 MHz using TMS as int. standard. Analytical TLC was performed on silica gel (Merck No 7731) and CC on silica gel 60 (Merck No 7734).

Extraction and isolation of compounds. Plant material collected near 'La Flecha' (Salamanca) was identified by Prof. B. Casaseca Mena. A voucher specimen (Herbarium No 7362) is kept at the Botany Department of Salamanca University. The aerial parts of the plant (2.6 kg) were finely ground and extracted with hexane. The extract, previously steam-distilled consisted of *ca* 65% of a neutral fraction and *ca* 35% of an acidic fraction. The alkaline aq. soln of the acidic fraction was satd with CO_2 (pH 7.5–8) and extracted with Et_2O, to give 24.0 g of weak acids (20% of extract), which were chromatographed on silica gel and eluted with C_6H_6–Et_2O mixtures and Et_2O, giving several acetophenone derivatives [1, 2], sakuranetin (50 mg), dihydroquercetin-7,3'-

dimethyl ether (62 mg), **1** (213 mg), **2** (97 mg) and **3** (30 mg).

3-[4-*Acetoxyisopent*-2(Z)-*enyl*]-4-*hydroxyacetophenone* (**1**). Viscous oil; UV λ_{max}^{EtOH} nm: 226 (ε15.438), 280 (ε12.652); IR ν cm^{-1}: 3300 (OH) 1740, 1270 (acetate), 1690 (C=O), 1600, 1500 (aromatic), 1350, 1130, 1020, 820; ^{1}H NMR (Table 1); MS *m/z* (%): 262 $[M]^+$ (7), 202 $[M-HOAc]^+$ (17), 187 $[202-Me]^+$ (29), 159 $[187-CO]^+$ (18), 144 (10), 131 (7), 85 (77), 83 $[C_5H_7O]^+$ (100). Acetylation of **1** (45 mg) gave **1a** (48 mg), oil; IR ν cm^{-1}: 1750, 1715, 1250, 1215 (two acetates), 1670 (C=O), 1590, 1500; ^{1}H NMR (Table 1); $[M]^+$ *m/z* 304 ($C_{17}H_{20}O_5$). Alkaline hydrolysis of **1** (27 mg) with KOH–MeOH (10%, 4 ml) gave the dihydroxy compound **1b** (20 mg), identical in all respects with the natural product [2].

3-[4-*Acetoxyisopent*-2(E)-*enyl*]-4-*hydroxyacetophenone* (**2**). Viscous oil; UV λ_{max}^{EtOH} nm: 228 (ε18 724), 282 (ε14 337); IR ν cm^{-1}: 3280 (OH), 1740, 1270 (acetate), 1680 (C=O), 1590, 1510 (aromatic), 1360, 1120, 1040, 820; ^{1}H NMR (Table 1); MS *m/z* (%): 262 $[M]^+$ (5), 202 (12), 187 (25), 159 (26), 144 (14), 131 (8), 85 (60), 83 (100). Acetylation of **2** (36 mg) gave **2a** (39 mg), oil; IR ν cm^{-1}: 1770, 1740, 1690, 1610, 1500, 1250, 1210; ^{1}H NMR (Table 1); $[M]^+$ *m/z* 304 ($C_{17}H_{20}O_5$). Alkaline hydrolysis of **2** (40 mg) with KOH–MeOH (10%, 5 ml) gave the dihydroxy compound **2b** (32 mg), identical with the natural product [2].

3-(3-*Acetoxymethyl*-2-*hydroxybut*-3-*enyl*)-4-*hydroxyacetophenone* (**3**). A semi-solid mass; IR ν cm^{-1}: 3300 (OH), 1730, 1270 (acetate), 1700 (C=O), 1640, 890 (C=CH_2), 1590, 1500 (aromatic), 1375, 1120, 1070, 920; ^{1}H NMR (Table 1); MS *m/z* (%): 278 $[M]^+$ (8), 218 $[M-HOAc]^+$ (6), 205 $[M-CH_2OCOMe]^+$ (14), 187 $[205-H_2O]^+$ (9), 149 (23), 117 (15), 60 (87), 43 $[MeCO]^+$ (100). Acetylation of **3** (24 mg) gave **3a** (29 mg); IR ν cm^{-1}: 1760, 1740, 1230 (acetates), 1680 (C=O), 1600, 1500 (aromatic), 1190, 1120, 910, 890; ^{1}H NMR (Table 1); $[M]^+$ *m/z* 362 ($C_{19}H_{22}O_7$).

Synthesis of (±) **3a**. To a stirred soln of **1a** (172 mg) in CH_2Cl_2 (3 ml) was added for 1 hr, a soln of *m*-chloroperbenzoic acid (130 mg) in CH_2Cl_2 (3 ml). A 10% aq. soln of Na_2SO_3 was then added dropwise and the organic layer washed × 3 with a 5% aq. $NaHCO_3$, dried and evapd. The residue was chromatographed on silica gel to afford **4** (170 mg), IR ν cm^{-1}: 1760, 1740, 1690, 1590, 1500, 1370, 1230, 1200, 1170, 1040; ^{1}H NMR ($CDCl_3$): δ1.37 (3H, *s*), 2.11 (3H, *s*), 2.34 (3H, *s*), 2.53 (3H, *s*), 2.93 (3H, *m*), 4.16 (2H, *s*), 7.10 (1H, *d*, *J* = 8 Hz), 7.77 (1H, *dd*, *J* = 8 and 2 Hz), 7.84 (1H, *d*, *J* = 2 Hz); $[M]^+$ *m/z* 320 ($C_{17}H_{20}O_6$). Treatment of **4** (150 mg) with dry NaOAc (230 mg) in HOAc (2 ml) at 60–65° for 7 hr, followed by extraction with Et_2O and washing with aq. $NaHCO_3$, afforded **5** (124 mg) after chromatographic purification; IR ν cm^{-1}: 3460, 1760, 1740, 1680, 1590, 1500, 1370, 1260, 1160, 1110, 1040, 920; ^{1}H NMR ($CDCl_3$): δ 1.28 (2H, *s*), 1.88 (3H, *s*), 2.08 (3H, *s*), 2.32 (3H, *s*), 2.54 (3H, *s*), 2.91 (2H, *m*), 3.99 (2H, *s*), 5.11 (1H, *dd*, *J* = 9 and 5 *Hz*), 7.00 (1H, *d*, *J* = 8 Hz), 7.67 (1H, *dd*, *J* = 8 and 2 Hz), 7.71 (1H, *d*, *J* = 2 Hz); $[M]^+$ *m/z* 380 ($C_{19}H_{24}O_8$).

Dehydration of **5**. To a stirred soln of **5** (40 mg) in dry pyridine (2 ml) at 0°, 0.15 ml of $POCl_3$ were added dropwise and the soln kept at room temp. for 12 hr. The soln was then poured over ice H_2O and extracted with CH_2Cl_2. The organic layer was washed with 2 N HCl, aq. $NaHCO_3$ soln and H_2O, dried (Na_2SO_4) and evapd to give a compound (32 mg) of $[\alpha]_D$ = (±) 0°, whose spectral data were identical to those above described for **3a**.

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