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FURANOSESQUITERPENES FROM THE FRUITS OF *SMYRNIUM CORDIFOLIUM*

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Key Word Index—*Smyrnium cordifolium*; Umbelliferae; furanogermacranes; furanoeremophilane.

Abstract—In addition to two known furanogermacranes, a new furanogermacrane and a new and highly unstable furanoeremophilane were obtained from the fruits of *Smyrnium cordifolium*. The latter compound could be the precursor of a number of eremophilanolides obtained from some other *Smyrnium* species.

INTRODUCTION

As a part of our continuing investigation of the genus *Smyrnium*, we have now isolated, in addition to known compounds, two new furanosesquiterpenes namely, 2-α-acetylfurodien and the highly unstable furanoeremophilane 1-oxo-10-hydroxyfurano-eremophila-3,7,11-trien from the fruits of *S. cordifolium* Boiss. The latter compound is probably the precursor of a number of eremophilanolides isolated from various *Smyrnium* species [1–4].

RESULTS AND DISCUSSION

The known compounds glechomafuran (**1**) [5] and furodien (**2**) [6] were identified by comparing their spectra to those of known compounds. The new furanogermacrene, 2-α-acetylfurodien (**3**), was assigned the composition $C_{17}H_{22}O_3$ on the basis of mass spectrometry (M^+, *m/z* 274, 63 %). Its IR spectrum contained an acetyl band at 1730 cm^{-1}, as well as furan bands at 1660, 1550 and 880 cm^{-1}. Its ^1H NMR spectrum confirmed the presence of an acetyl group (δ 2.08, 3H, *s*) and exhibited a furan proton signal at δ 7.06 (1H, *s* (*br*), H-12). Methyl signals were present at δ 1.40 (*s*, Me-15), 1.67 (*s*, Me-14) and 1.92 (*d*, $J = 1$ Hz, Me-13), whilst a three-fold doublet at δ 4.95 ($J = 4$, 11, 12 Hz) showed the C-2 proton was geminal to the acetyl group indicating its equatorial character which was corroborated by the study of Dreiding models. Vinylic proton signals were at δ 5.22 (*d* (*br*), H-5) and 5.07 (*d* (*br*), H-1), and the doublets at δ 3.55 (1H, *d*, $J = 16$ Hz, H-9) and 3.42 (1H, *d*, $J = 16$ Hz, H-9′) indicated the isolated methylene group. Other peaks were at δ 2.52 (1H, *dd*, H-3), 2.35 (1H, *t*, H-3′), 3.08 (1H, *dd* (*br*), H-6), 3.00 (1H, *d* (*br*), H-6′). There were four possible placements for the acetyl group in compound **3**, namely C-2, C-3, C-6 and C-9. The three-fold doublet at δ 4.95 indicated that the acetyl group was situated at C-2 rather than at C-3, since in the latter case there would be a double doublet instead of three-fold doublet. On the other hand if the acetyl group was at C-9 there would have been a one proton singlet at around δ 5.00 and the isolated methylene group would not be seen. If it was at C-6 there would only be a doublet present around 5.00 ppm. In the MS the presence of the acetyl group and the furan moiety was shown by peaks at *m/z* 214 $[M - 60]^+$ (base peak) and *m/z* 108 (45 %).

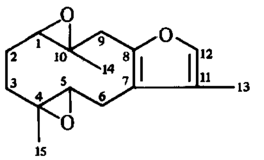
The new furanoeremophilane **4** had the composition $C_{15}H_{18}O_3$ on the basis of mass spectrometry (M^+, *m/z* 246, 48 %). Its IR spectrum showed a hydroxyl band at 3450 cm^{-1} and a keto group at 1725 cm^{-1} as well as furan bands at 1650 and 870 cm^{-1}. The peak at δ 7.04 (1H, *s*, *br*) in the ^1H NMR spectrum of **4** confirmed the presence of a furan ring. The chemical shifts of the methyl signals were present at δ 0.93 (*s*, Me-15), 1.71 (*s*, Me-14, vinylic methyl) and 1.98 (*d*, $J = 1$ Hz, Me-13, vinylic methyl) and indicated an eremophilane type compound. The vinylic proton signal at δ 5.55 (*t*, $J = 8$ Hz, H-3) was in agreement to that of H-3 in istanbulin E [3]. Since no conjugation was observed (λ_{max} 218; log ε 4.50) in its UV spectrum, the oxo group must be situated at C-1 as it is in istanbulins A–C, and E [1–3], other possible places for an oxo group were C-2, C-6 and C-9 which in each case would result in a conjugation. In the ^1H NMR spectrum of **4** there was no peak between δ 3.5–5.5 corresponding to a hydrogen geminal to a hydroxyl group, therefore the latter must be tertiary and could only be situated at C-10; the location of a hydroxyl group at this position is quite common among *Ligularia* species [7–11].

Although a furoeremophil-1-one (**5**) has been isolated from *S. olusatrum* by Bohlmann and Zdero [12] this is the first time we have isolated a furanoeremophilane from a *Smyrnium* species having structural resemblances to eremophilanolides obtained from other *Smyrnium* species. As all istanbulin type eremophilanolides have an oxygen function at C-1 (oxo group for istanbulins A and B [1], C [2] and E [3]. hydroxyl for istanbulin D [3] and acetyl for istanbulin F[4]), and an ethyl group at C-4 (vinylic methyl for istanbulin E, exocyclic methylene for istanbulins C, D and F) the new compound could be the precursor of all these eremophilanolides.

EXPERIMENTAL

The plant material was collected from southeastern Turkey (near Hakkari) in Sept. 1982 by M. Çoşkun (Faculty of Pharmacy, Ankara). A voucher specimen No. 10997 is deposited in the Herbarium of the Faculty of Pharmacy, University of Ankara.

Isolation and characterisation of compounds **1–4**. Air dried and



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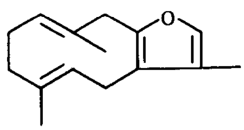

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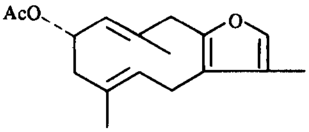

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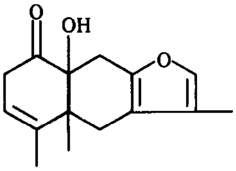

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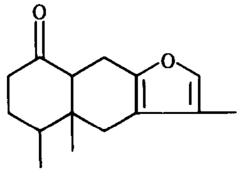

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powdered fruits of *S. cordifolium* Boiss. (100 g) were extracted with petrol (bp 40–70°)–Et$_2$O (1:2). After filtration, the extract was concd *in vacuo* at room temp. and subjected to CC over silica gel (2 x 30 cm) with rapid elution. The fractions were collected within 2 hr, and the spectra of the compounds obtained from these fractions were recorded on the same day. Compounds **1** and **2** were obtained from the column as single compounds and crystallized from Et$_2$O, whereas compounds **3** and **4** were separated on prep. TLC plates developed in petrol–Et$_2$O (4:1). As observed in our earlier studies [13, 14] and by other workers [15], the use of CHCl$_3$ as a solvent causes a rapid oxidation of furanosesquiterpenes to their corresponding lactones, therefore ^{1}H NMR and ^{13}C NMR spectra were recorded soon after the compounds were dissolved in CDCl$_3$.

1: Spectral data including X-ray data given in [16]. **2**: Yield 120 mg, mp 45°, spectral data given in [6, 12], except ^{13}C NMR: (22.6 MHz, CDCl$_3$): δ 128.9 (*d*) C-1, 39.5 (*t*) C-2, 40.9 (*t*) C-3, 121.9 (*s*) C-4, 127.8 (*d*) C-5, 24.3 (*t*) C-6, 119.0 (*s*) C-7, 149.9 (*s*) C-8, 27.3 (*t*) C-9, 134.5 (*s*) C-10, 121.9 (*s*) C-11, 136.1 (*d*) C-12, 8.9 (*q*) C-13, 16.2 (*q*) C-14, 16.5 (*q*) C-15. **3**: Yield 15 mg, amorphous. UV λ_{max}^{MeOH} nm: 218 (log ε 4.45); IR ν_{max}^{KBr} cm^{-1}: 3000, 2920, 2850, 1730, 1660, 1555, 1450, 1370, 1240, 1140, 1020, 880; ^{1}H NMR (NT-FT 200 MHz, CDCl$_3$): text; MS (probe) 70 eV, *m/z* (rel. int.): 274 $[M]^+$ (63), 232 $[M-Ac+H]^+$ (30), 214 $[M-AcOH]^+$ (100), 108 [furan moiety]$^+$ (45). **4**: Yield 18 mg, amorphous. UV λ_{max}^{MeOH} nm: 218 (log ε 4.50); IR ν_{max}^{KBr} cm^{-1}: 3450, 2970, 2910, 2840, 1725, 1445, 1365, 1150, 1080, 1035, 880, 830; ^{1}H NMR (NT-FT 200 MHz, CDCl$_3$): text; MS (probe) 70 eV, *m/z* (rel. int.): 246 $[M]^+$ (48), 228 $[M-H_2O]^+$ (13), 205 $[M-Me{-}CH{=}CH]^+$ (100), 109 [furan moiety + H]$^+$ (78), 108 [furan]$^+$ (74).

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