STRUCTURE AND CONFIGURATION OF TAVIMOLIDIN

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UDC 547.9:582.89

From the roots of *Peucedanum mogoltavicum* Korov. have been isolated tadzhiferin, farnesiferol B, 5-methoxy-3,4-methylenedioxypropiophenone, and a new terpenoid coumarin — tavimolidin. The structure and absolute configuration of tavimolidin have been established on the basis of a study of its chemical and spectral characteristics. The passage from tavimolidin to feselol has confirmed the structure proposed previously for mogoltavinin, mogoltavin, and mogoltin and has established their absolute configurations.

From an ethanolic extract of the roots of *Peucedanum mogoltavicum* Korov. collected in 1977 in the environs of the village of Babadarkhan (Kurama range, TadzhSSR) in the budding phase we have isolated 5-methoxy-3,4-methylenedioxypropiophenone [1, 2], tadzhiferin [3], farnesiferol B [4, 5], and new terpenoid coumarin with the composition $C_{29}H_{34}O_6$, M^+ 478, mp 144-146°C, $[\alpha]_D^{20}$ −110° (c 1.0; chloroform), which we have called tavimolidin (I).

Tavimolidin is readily soluble in ether, chloroform, ethanol, and ethyl acetate, sparingly soluble in benzene, and insoluble in water.

The UV spectrum of (I) showed the maxima [$\lambda_{max}^{C_2H_5OH}$ 216, 242, 253, 352 nm (log ε 4.29, 3.63, 3.37, 4.04)] that are characteristic for the 7-hydroxycoumarin chromophore, and the IR spectrum had absorption bands at 1738, 1730, and 1715 cm^{-1} (C=O of an α-pyrone, of an ester group, and of a ketone group in a six-membered ring) and 1617 and 1560 cm^{-1} (aromatic nucleus).

The mass spectrum of tavimolidin showed, in addition to the peak of the molecular ion with M^+ 478, peaks with m/e 316, 162, and 163 due to the terpenoid moiety of the molecule and to the molecular and protonated ions of umbelliferone. In addition, a peak was observed with m/e 395, probably corresponding to the fragment formed as the result of the ejection of acyl residue with m/e 83 ($C_4H_7C{=}O$) from the molecule. Tavimolidin was hydrolyzed by the action of a 5% ethanolic solution of KOH, and on reaction with 2,4-dinitrophenylhydrazine it formed the corresponding hydrazone with mp 169-170.5°C. These facts permit the assumption that (I) is an acylated coumarin containing an oxo group in its molecule.

In the PMR spectrum of (I), the strong-field region contained the following signals: singlets at 0.90 ppm (6 H) and 1.08 ppm (3 H) — methyl groups attached to quaternary carbon atoms; and a broadened singlet at 1.68 ppm (3 H) — a vinyl methyl group. The broadening of the last-mentioned signal was caused by the allyl interaction of the protons of a methyl group with an olefinic proton which appeared in the form of an unsplit signal at 5.57 ppm ($W_{1/2}$= 9 Hz). A broadened singlet at 1.95 ppm (3 H), a doublet at 1.99 ppm (3 H, J = 6 Hz), and a quartet signal at 6.05 ppm (1 H, J = 6 Hz) showed the presence of an angelicyl residue in the tavimolidin molecule. A multiplet in the 4.04 ppm region (2 H) was due to the methylene protons in a R—O—CH_2—CH grouping. A one-proton singlet at 5.00 ppm was caused by the presence of a hemiacyl proton. In the 6.20-7.59 ppm region signals due to the protons of a 7-oxy-substituted coumarin nucleus were observed.

The composition given and the results of a study of the PMR spectrum of (I) showed that it belonged to the terpenoid coumarins of the iresane group in which one of the hydroxy groups was acylated with an angelic acid and the second had been oxidized to a ketone.

The positions of the angelicyl residue and of the oxo group were determined from the nature of the signal of the hemiacyl proton. As already mentioned, the latter appeared in the form of a singlet (5.00 ppm), which indicates the absence of protons in the vicinal posi-

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR, Tashkent. Translated from Khimiya Prirodnykh Soedinenii, No. 4, pp. 480-483, July-August, 1979. Original article submitted February 23, 1979.

0009-3130/79/1504-0417$07.50

tions to the hemiacyl proton. This is possible only if the oxo group is present in the $C_{7'}$ position and the acyl residue is at $C_{6'}$ or $C_{8'}$.

If we take into account the presence of substituents at $C_{6'}$ in all iresane coumarins, the angelicyl residue is, in all probability, present in the same position (at $C_{6'}$).

In the IR spectrum of (I), the methylene protons at $C_{8'}$ appeared in the form of one-proton doublets at 2.45 and 2.70 ppm (J = 12.5 Hz), which shows the absence of vicinal coupling and thereby confirms the position of the keto group at $C_{7'}$.

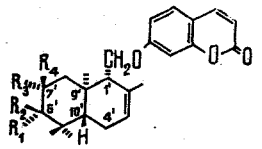
The facts given above permit structure (I) to be suggested for tavimolidin.

The orientation of the acid residue at $C_{6'}$ follows from the following considerations. When mogoltavinin [6, 7] was oxidized with chromium trioxide in pyridine, we isolated a compound identical with tavimolidin. These facts show the quasi-equatorial orientation of the angelicyl residue at $C_{6'}$ in (I).

The configurations of the asymmetric centers at $C_{1'}$, $C_{9'}$, and $C_{10'}$ were established in the following way. In view of the closeness of the structures of (I) and of feselol (II) (moschatol [8]), for which the configuration has been established [9-12], we effected a transition from tavimolidin to feselol (II) by the Huang-Minlon reduction of (I) [13, 14].

Consequently, the terpenoid part of tavimolidin has a trans-nonsteroid decalin ring with equatorial orientation of the $C_{1'}$–CH_2 group, and for it the absolute configuration (I) is proposed.

Taking into account the passage made (from mogoltavinin to tavimolidin), the corresponding absolute configurations are also put forward for mogoltavinin (III), mogoltavin (IV), and mogoltin (V) [15].



I. R_1=OAng, R_2=H, R_3=R_4=O
II. R_1=OH, R_2=R_3=R_4=H
III. R_1=OAng, R_2=R_3=H, R_4=OH
IV. R_1=OAc, R_2=R_3=H, R_4=OH
V. R_1=R_4=OH, R_2=R_3=H

In conclusion, it must be mentioned that the isolation from *Peucedanum mogoltavicum* Korov. of tadzhiferin, fernesiferol B, 5-methoxy-3,4-methylenedioxypropiophenone, which have been obtained previously from *Ferula tadshikorum, F. kopetdaghensis, F. ugamica,* and *F. karatavica*, respectively, shows the taxonomic closeness of the genera *Peucedanum* and *Ferula*.

EXPERIMENTAL

The conditions for recording the spectra have been described previously [16]. For chromatography we used type KSK silica gel. The homogeneity of the substances and the courses of the reactions were checked by the TLC method on Silufol plates in the chloroform–ethyl acetate (4:1) system.

Isolation of the Coumarins. The air-dry comminuted roots of *Peucedanum mogoltavicum* (1 kg) were extracted three times with ethanol (1 × 5), with steeping for 72 h each time. The combined and concentrated extract was diluted with water (1:2) and was treated with diethyl ether. The ethereal extract was shaken with a 1% solution of KOH and then with water to neutrality and was dried. The solvent was distilled off, giving 75 g (7.5%) of total neutral extractive substances, which were deposited on a column (6 × 105 cm) of silica gel and were eluted with hexane–chloroform (2:1), 200-ml fractions being collected. The fractions with the same properties were combined.

5-Methoxy-3,4-methylenedioxypropiophenone. When the solvent was evaporated off, fractions 9-14 yielded 0.54 g (0.054% on the dry plant) of a substance $C_{11}H_{12}O_4$, M^+ 208, mp 89-91°C, R_f 0.91.

Tavimolidin. When the eluate from fractions 27-32 was concentrated, 0.29 g (0.029%) of a crystalline compound was obtained with the composition $C_{29}H_{34}O_6$, M^+ 478, mp 144-146°C, $[\alpha]_D^{20}$ −110° (c 1.0; chloroform), R_f 0.82.

Tadzhiferin. Fractions 36-43 yielded 0.91 g (0.091%) of a compound $C_{24}H_{30}O_4$, M^+ 382, mp 67-69°C, $[\alpha]_D^{20}$ +9° (c 1.0; chloroform), R_f 0.64.

Farnesiferol B. The last fractions, 47-55, yielded 0.94 g (0.094%) of a coumarin with a composition $C_{24}H_{30}O_4$, M^+ 382, mp 117-119°C $[\alpha]_D^{20}$ +8° (c 1.0; chloroform), R_f 0.42, which proved to be pure farnesiferol B (uncontaminated by kopetdaghin [5]).

Tavimolidin 2,4-Dinitrophenylhydrazone. To 0.12 g of (I) in 5 ml of ethanol was added an ethanolic solution of the same amount of 2,4-dinitrophenylhydrazine. The dark orange precipitate that deposited was separated off, dissolved in 5 ml of chloroform, and chromatographed on a column of alumina. Evaporation of the chloroform eluate yielded a crystalline substance with mp 169-170.5°C.

Oxidation of Mogoltavinin. A mixture of 0.1 g of the substance and 0.12 g of chromium trioxide was dissolved in 10 ml of pyridine. After 4 h, the reaction mixture was poured into cold water and extracted with ether. The extract was shaken with a 2% solution of hydrochloric acid and then with water to neutrality. The solvent was distilled off, giving 0.07 g of a substance with mp 144-146°C, $[\alpha]_D^{20}$ −110° (c 1.0; chloroform), R_f 0.82.

Huang-Minlon Reduction of Tavimolidin. A mixture of 0.09 g of compound (I), 1.5 ml of hydrazine hydrate, and 0.4 g of caustic potash in 10 ml of diethyleneglycol was heated at 95-102°C. After 45 min, the low-boiling reaction products were distilled off, and then the temperature was raised to 190°C and was kept at that level for 3.5 h. The reaction mixture was acidified with a 5% solution of sulfuric acid and was treated with ether. The solvent was evaporated off, giving a compound $C_{24}H_{30}O_4$, M^+ 382, mp 116-117°C, $[\alpha]_D^{20}$ −101° (c 1.0; chloroform).

SUMMARY

From the roots of *Peucedanum mogoltavicum* Korov. have been isolated tadzhiferin, farnesiferol B, 5-methoxy-3,4-methylenedioxypropiophenone, and a new terpenoid coumarin — tavimolidin.

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