A NEW COMPONENT OF Artemisia fragrans

S. V. Serkerov and A. N. Aleskerova

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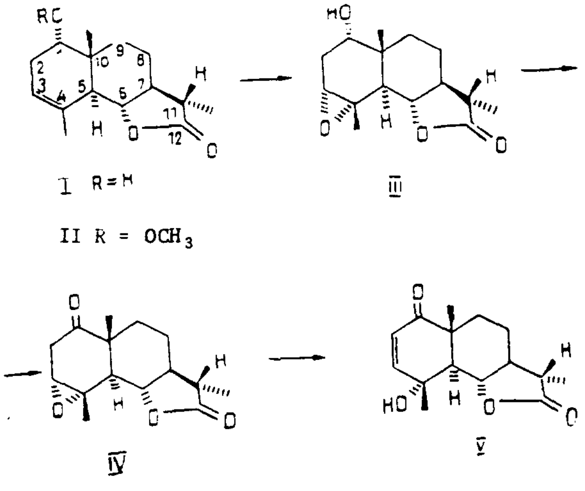
A new component $C_{15}H_{22}O_3$, has been isolated from the epigeal part of Artemisia fragrans. On the basis of chemical transformations and spectral characteristics it has been established that it has the structure of 1α-hydroxy-5,7αH,6,11βH-eudesm-3,4-en-6,12-olide (I).

The sesquiterpene lactones (alkhanol, alkhanin, and erivanin) isolated from the epigeal part of Artemisia fragrans Willd. have been reported previously [1, 2]. On continuing the study of the sesquiterpene lactones of this plant, by chromatography we isolated a minor component with the composition $C_{15}H_{22}O_3$, mp 167-168°C. On comparing the physicochemical properties of the lactone under investigation with those of known lactones we came to the conclusion that it was new, and we have proposed to call it alkhanene (I).

In the region of characteristic frequencies of the IR spectrum of alkhanene the maxima of an OH group (3520 cm^{-1}) and of a γ-lactone ring (1760 cm^{-1}) were observed. Acetylation of the compound under investigation led to a monoacetyl derivative (II) with the composition $C_{17}H_{24}O_4$, mp 132-133°C (from aqueous ethanol). The IR spectrum of the acetyl derivative had absorption bands at (cm^{-1}) 1785 (CO of a γ-lactone ring), and 1740 and 1260 (acetyl group). No OH group was present.

In the NMR spectrum of the substance were found the singlet of an angular methyl group at 0.85 ppm, the doublet of a secondary methyl group at 1.20 ppm (J = 7 Hz), and the doublet of a vinyl methyl group at 1.96 ppm (J = 1 Hz).

The hydroxy group in the molecule of the lactone under investigation had a secondary nature. This was shown by the one-proton doublet at 3.40 ppm (J = 4 Hz) belonging to the gem-hydroxylic proton. A one-proton quartet observed in the spectrum at 4.00 ppm (J_1 = 10, J_2 = 11.5 Hz) related to the lactone proton, which permitted the lactone ring to be assigned to the C_6—C_7 position.



I R=H

II R = OCH_3

III

IV

V

Scheme of the transformations of alkhanene

V. L. Komarov Institute of Botany, Academy of Sciences of the Azerbaidzhan SSR, Baku.
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A broadened, unresolved one-proton signal at 5.30 ppm ($W_{\frac{1}{2}}$ = 10 Hz) and the signal of a vinyl methyl group characterized the double bond as secondary-tertiary (at C_3–C_4).

The NMR spectrum of the acetyl derivative had the singlet of an angular methyl group at 0.90 ppm, the doublet of a secondary methyl group with its center at 1.20 ppm (J = 7 Hz), a weakly resolved doublet of a vinyl methyl group at 1.80 ppm (J = 1 Hz), and the singlet of an acetyl group at 2.00 ppm. The gem-acetyl proton appeared in the form of a quartet at 5.25 ppm (J_1 = 4, J_2 = 2 Hz, 1H). A one-proton triplet at 5.25 ppm (J = 3.5 Hz) related to an olefinic proton.

On the basis of the facts given above it is possible to assume that the compound under investigation was an unsaturated hydroxylactone based on a eudesmane carbon skeleton, with the probable structure (I).

The treatment of compound (I) with m-chlorobenzoic acid [sic] and the subsequent oxidation of the product obtained (III) with chromium trioxide led to the ketoepoxylactone (IV) with the composition $C_{15}H_{20}O_4$, mp 165-166°C (aqueous ethanol). The IR spectrum of (IV) had the absorption bands of the CO group of a γ-lactone-ring (1788 cm^{-1}) and of a keto group in a six-membered ring (1725 cm^{-1}).

The UV spectrum confirmed the presence of an isolated ketone group in the (IV) molecule (λ_{max} 283 nm; log ε 1.65).

The IR spectrum of (IV) coincided completely with that of the oxidized product of shonachalin B [3]. A compound with an identical structure has also been prepared from santamarin ($C_{15}H_{20}O_4$, mp 154-156°C) [4].

By using the method described in [4], from the ketoepoxylactone (IV) we prepared the hydroxyketolactone (V), with the composition $C_{14}H_{20}O_4$, mp 178-179°C (chloroform–hexane), in the IR spectrum of which were found the absorption bands of CO groups of a γ-lactone ring (1770 cm^{-1}) and of a conjugated ketone group in a six-membered ring (1670 cm^{-1}) and that of a hydroxy group (3500 cm^{-1}). A comparison of the IR spectra of the hydroxyketolactone (V) and of tauremisin showed their identity. A mixed melting point of the hydroxyketolactone and an authentic sample of tauremisin gave no depression of the melting point.

Thus, it was shown that the compound under investigation had the structure of 1α-hydroxy-5,7αH,6,11βH-eudesm-3,4-en-6,12-olide (11,13-dihydrodouglanin) (I) [5].

EXPERIMENTAL

IR spectra were recorded on a UR-20 spectrophotometer in paraffin oil, the NMR spectrum of compound (I) on a Varian HA-100D spectrometer in deuterated chloroform solution, and the NMR spectrum of the acetyl derivative on a Bruker WP-200, SY50, 32 MHz, spectrometer. The chemical shifts are given in the δ scale relative to TMS.

Isolation of Alkhanene. The dark green resin obtained by an extraction method [1] (20 g) was chromatographed on a column of silica gel (L 40/100, Chemapol, 3.5 × 80 cm). Elution was performed with hexane, with hexane–chloroform in ratios of 4:1, 3:2, 1:1, 1:2, 1:3, and 1:4, and with chloroform. The hexane–chloroform fractions yielded a crystalline substance with the composition $C_{15}H_{22}O_3$, which, after recrystallization from aqueous ethanol, had mp 167-168°C.

Acetylation of Alkhanene. A solution of 0.05 g of the substance in 2 ml of pyridine was treated with 2 ml of acetic anhydride, and the mixture was heated on the water bath for 20 min and was left at room temperature for 24 h. Then it was worked up by a known method [6]. This gave a crystalline substance with the composition $C_{17}H_{24}O_4$, mp 132-133°C (from aqueous ethanol).

Production of the Ketoepoxylactone (IV). a) The substance (0.35 g) in 20 ml of chloroform was boiled with 0.35 g of m-chlorobenzoic acid [sic] for 5 h. The solution was washed with aqueous $NaHCO_3$ and with water. The residue was dissolved in 10 ml of chloroform and the solution was filtered through a 5-cm layer of alumina (activity grade IV). Elution was performed with 20 ml of chloroform–ethanol (20:0.5). The fractions were combined and evaporated.

b) A solution of 0.17 g of residue (III) in 10 ml of acetone was treated with 0.09 g of CrO_3 in 6 ml of acetone, and the mixture was left for 3 h. Then it was worked up by the usual method. The reaction product was dissolved in 10 ml of chloroform and the solution was filtered through a 5-cm layer of alumina (activity grade IV). Elution was performed with 20 ml of chloroform—ethanol (20:0.5). The fractions were combined and evaporated. The residue was recrystallized from aqueous ethanol. This gave 0.16 g of the ketoepoxylactone (IV) with the composition $C_{15}H_{20}O_4$, mp 165-166°C (from aqueous ethanol).

Preparation of Tauremisin (V). The ketoepoxylactone (IV) (0.15 g) in 20 ml of methanol was boiled with 0.06 g of KOH in 2 ml of water. The reaction mixture was acidified with dilute HCl and was extracted with chloroform, and the extract was washed with water, dried, filtered, and evaporated. The residue was recrystallized from chloroform—hexane. This gave 0.07 g of acicular crystals with the composition $C_{15}H_{20}O_4$, mp 178-179°C (from aqueous ethanol).

LITERATURE CITED

1. S. V. Serkerov and A. N. Aleskerova, Khim. Prir. Soedin., 75 (1978).
2. S. V. Serkerov, Khim. Prir. Soedin., 326, 488 (1979).
3. S. V. Serkerov and A. N. Aleskerova, Khim. Prir. Soedin., 636 (1985).
4. A. Romo de Vivar and H. Jimenez, Tetrahedron, 21, 1741 (1965).
5. K. H. Lee and T. A. Geissman, Phytochem., 9, 403 (1970).
6. S. V. Serkerov and A. N. Aleskerova, Khim. Prir. Soedin., 196 (1985).

CONFORMATION OF δ-CADINOL IN SOLUTION

A. V. Tkachev and A. Yu. Denisov

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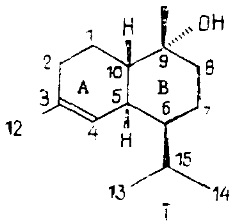
An assignment of the signals in the ^{13}C and ^1H NMR spectra of the natural sesquiterpene alcohol δ-cadinol has been made by the NMR method (INADEQUATE, 2D-INADEQUATE, two-dimensional C—H correlation on $^1J_{CH}$ constants, two-dimensional homonuclear J-spectroscopy) and the spin—spin coupling constants $^1J_{CC}$ and some J_{HH} constants have been determined. By comparing the experimental and calculated values of the spin—spin coupling constants J_{HH} it has been shown that the predominant conformation of the δ-cadinol molecule in solution is that in which ring A has the half-chair form and ring B the chair form with an equatorial arrangement of the hydroxy and isopropyl groups.

δ-Cadinol (I) is a sesquiterpenoid widely distributed in the vegetable kingdom, the structure and conformation of which have been the subject of prolonged discussion in the literature. In [1], on the basis of an analysis of the ^{13}C NMR spectra the δ-cadinol molecule (I) was assigned conformation (II), which, however, did not agree with the calculated figures obtained by the method of molecular mechanics [2]. In an analysis of the ^{13}C NMR spectrum of δ-cadinol (I) we found that an error had been admitted into [1] in the assignment of the signals of some of the carbon atoms, and since it was precisely the values of the chemical shifts that played a key role in the paper mentioned in determining the conformation of δ-cadinol (I) we undertook an additional investigation of this compound by the NMR method.



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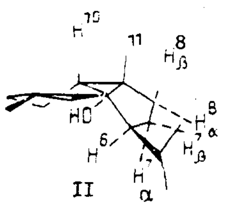

II

Analysis of the ^{13}C NMR spectra of δ-cadinol (I) recorded under the INADEQUATE and 2D-INADEQUATE regimes permitted an unambiguous assignment of the signals of the carbon atoms to be made (Table 1). A comparison of the assignment of the signals made in this way with

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