LITERATURE CITED

1. Z. Sh. Faizutdinova, I. A. Bessonova, and S. Yu. Yunusov, Khim. Prir. Soedin., 360 (1968); I. A. Bessonova, Z. Sh. Faizutdinova, Ya. V. Rashkes, and S. Yu. Yunusov, Khim. Prir. Soedin., 273 (1969).
2. I. A. Bessonova, M. R. Yagudaev, and S. Yu. Yunusov, Khim. Prir. Soedin., 597 (1978).
3. I. A. Bessonova, Kh. A. Abdullaeva, and S. Yu. Yunusov, Khim. Prir. Soedin., 682 (1974).
4. Tables of Interatomic Distances and Configuration in Molecules and Ions, Chemical Society, London (1955).
5. S.-M. Nasirov, V. G. Andrianov, Yu. T. Struchkov, and S. Yu. Yunusov, Khim. Prir. Soedin., 395 (1975).
6. S.-M. Nasirov, V. G. Andrianov, Yu. T. Struchkov, and S. Yu. Yunusov, Khim. Prir. Soedin., 197 (1976).
7. A. T. McPhail and G. A. Sim, J. Chem. Soc., B, 923 (1968).
8. V. I. Andrianov, Z. Sh. Safina, and B. L. Tarnopol'skii, Zh. Strukt. Khim., 15, 911 (1974).

ALKALOIDS OF Haplophyllum dubium

D. M. Razakova, I. A. Bessonova,
and S. Yu. Yunusov

UDC 547.944/945

From the epigeal part of Haplophyllum dubium we have isolated dubamine, γ-fagarine, skimmianine, graveoline, haplopine, the new alkaloid norgraveoline, and the steroid β-sitosterol. This is the first time that γ-fagarine has been found in this plant. On the basis of the results of a study of spectral characteristics and also passage to the known alkaloid graveoline, it has been established that norgraveoline has the structure of 2-piperonyl-4-quinolone.

The alkaloid composition of the plant Haplophyllum dubium Eug. Kor. (family Rutaceae) has been studied previously [1]. We have investigated this plant from a different growth site, since the qualitative and quantitative compositions of the alkaloids change according to the conditions of growth of the plant. The epigeal part, collected in the flowering phase by S. A. Khamidkhodzhaev in the southern part of the Babatag range in the region of Kara-Kuz, Tadzhik SSR, was extracted with methanol and the extract was separated into basic, acidic, and neutral fractions. Chromatography of the basic fraction led to the isolation of dubamine, γ-fagarine, skimmianine, graveoline, and base (I) with mp 288-290°C (decomp.), while the neutral fraction yielded β-sitosterol, and the acid fraction haplopine.

The known alkaloids and the β-sitosterol were identified by direct comparison in TLC and by mixed melting points with authentic samples.

The amount of alkaloids in the epigeal part of H. dubium in the flowering period was 0.3% (on the air-dry weight of the raw material). Base (I) had the composition $C_{16}H_{11}NO_3$, mol. wt. 265 (mass spectrometrically). $\lambda_{\max}^{C_2H_5OH}$ 213.5, 243.5, 276, 324 nm (log ε 4.46, 4.46, 4.13, 4.30). The long-wave absorption maximum in the UV spectrum of (I) underwent a hypsochromic shift on alkalinification and was observed at 301 nm, which is characteristic of 4-quinolones containing no alkyl group on the nitrogen atom [2]. The IR spectrum of (I) had absorption maxima in the 3260-2840 cm^{-1} region, which are characteristic for associated NH groups, and at 1635, 1600, 1555, and 1505 cm^{-1} (4-quinolone system). The NMR spectrum of (I) showed the signals of seven aromatic protons and singlets of the protons of a methylenedioxy group and of H_3 of a quinolone nucleus, indicating that (I) belongs to the class of 2-phenyl-4-quinolone alkaloids. Analysis of the splitting of the signals of the aromatic protons showed that the methylenedioxy group was present in the aryl part of the molecule.

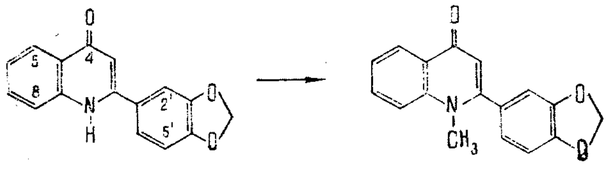
Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR, Tashkent. Translated from Khimiya Prirodnykh Soedinenii, No. 6, pp. 810-812, November-December, 1979. Original article submitted June 27, 1979.

0009-3130/79/1506-0716$07.50

In view of the presence in the plant of base (I) together with dubamine [1] and graveoline (II) [3], which have similar structures, we assumed that it was norgraveoline. This assumption was confirmed by the production of graveoline when base (I) was methylated with dimethyl sulfate.

This is the first time that norgraveoline has been isolated from a plant. However, a substance with the structure (I) has been obtained previously during the synthesis of the alkaloids graveoline and graveolinine [4, 5].

The results of the mass-spectrometric fragmentation of norgraveoline and its melting point correspond to those published for 2-piperonyl-4-quinolone [6].



I II

Norgraveoline is the first 2-phenyl-4-quinolone alkaloid having no methyl group attached to the nitrogen atom. It is interesting to note that, in contrast to the N-methyl-2-phenyl-4-quinolone alkaloids, the curve of the UV spectrum of norgraveoline undergoes a bathochromic shift on acidification.

EXPERIMENTAL

The UV spectra were taken on a Hitachi EPS-3T spectrophotometer, the IR spectra on a UR-20 instrument (KBr), the NMR spectra on a JNM-4H-100/100 MHz instrument (in CF_3COOH, τ scale), and the mass spectra on a MKh-1303 spectrometer.

For TLC (KSK silica gel with 5% of gypsum) we used the solvent system toluene–ethyl acetate–formic acid (5:4:1).

Isolation of the Alkaloids. The comminuted epigeal part (3.25 kg) of *H. dubium* was extracted with methanol until the alkaloids had been completely exhausted. The solvent was driven off by evaporation in vacuum. The extract was separated into basic (10 g), acidic (25 g), and neutral (49 g) fractions. The basic fraction was chromatographed on a column of Al_2O_3. Ethereal eluates yielded dubamine with mp 96°C, γ-fagarine with mp 140-141°C, and skimmianine with mp 175-176°C, and chloroform eluates yielded graveoline with mp 204-205°C and norgraveoline with mp 288-290°C (decomp.). Chromatography of the neutral fraction on Al_2O_3 and elution with ether gave β-sitosterol with mp 140-141°C. The acid fraction by treatment with acetone yielded haplopine with mp 202-203°C.

Norgraveoline (I) is insoluble in the usual organic solvents, water, dilute acids, and alkali, and it crystallizes from ethanol. With the Dragendorf reagent it gives a deep-blue spot with R_f 0.23, and in UV light it has a pale blue fluorescence.

$$\lambda_{max}^{C_2H_5OH+H^+}\ 244.5,\ 350\ \text{nm}\ (\lg\varepsilon\ 4.46,\ 4.21);$$

$$\lambda_{max}^{C_2H_5OH+OH^-}\ 274,\ 301\ \text{nm}\ (\lg\varepsilon\ 4.38,\ 4.21).$$

NMR spectrum of (I): 2.00 (H_5, doublet), 2.42 ($H_{6,7}$, doublet), 2.64 (H_8, multiplet), 3.13 (H_3, singlet), 2.95-3.05 and 3.30-3.50 (3 H, $H_{2',5',6'}$), 4.31 ppm ($-CH_2O_2$, singlet). Mass spectrum (m/e, %): 265 (M^+, 100), 264 (13), 237 (34), 207 (5), 178 (20).

Methylation of Norgraveoline. A mixture of 0.02 g of norgraveoline, 1 ml of 4% NaOH, and 2 ml of dimethyl sulfate was heated in the water bath for 2 h, cooled, made alkaline, and extracted with chloroform. The solvent was distilled off and the residue was chromatographed on a column of Al_2O_3. Chloroform eluates yielded a substance which was identical with an authentic sample of graveoline on TLC (R_f 0.37) and according to a mixed melting point.

SUMMARY

1. From the epigeal part of *Haplophyllum dubium* we have isolated dubamine, γ-fagarine, skimmianine, graveoline, haplopine, the new alkaloid norgraveoline, and the steroid β-sitosterol. This is the first time that γ-fagarine has been found in this plant.

2. It has been established that norgraveoline has the structure of 2-piperonyl-4-quinolone.

LITERATURE CITED

1. S. Yu. Yunusov and G. P. Sidyakin, Zh. Org. Khim., 25, 2009 (1955); S. A. Sultanov, V. I. Pastukhova, and S. Yu. Yunusov, Khim. Prir. Soedin., 355 (1967); S. A. Sultanov and S. Yu. Yunusov, Khim. Prir. Soedin., 131 (1969).
2. G. F. Tucker, Jr. and J. L. Irvin, J. Am. Chem. Soc., 73, 1923 (1951).
3. D. M. Razakova, I. A. Bessonova, and S. Yu. Yunusov, Khim. Prir. Soedin., 755 (1972).
4. H. R. Arthur and L. Y. S. Loh, J. Chem. Soc., 4360 (1961).
5. J. Reisch, I. Novak, K. Szendrei, and E. Minker, Naturwissenschaften, 54, No. 8, 200 (1967).
6. J. Reisch, R. Pagnucco, and N. Jantos, Phytochemistry, 7, 997 (1968).

STRUCTURE OF DICTYSINE

B. T. Salimov, M. S. Yunusov,
Ya. V. Rashkes, and S. Yu. Yunusov

UDC 547.944/945

The results are given of an investigation of the structure of the new diterpene alkaloid dictysine $C_{21}H_{33}NO_3$ isolated from the epigeal part of Delphinium dictyocarpum DC. On the basis of the results of a study of chemical and spectral characteristics, dictysine has been shown to have the sengorine skeleton, with hydroxy groups at C_{15}, C_{16}, and C_{20}.

We have previously reported the isolation from the epigeal part of Delphinium dictyocarpum DC collected in the upper reaches of the R. Koktal in the budding stage of a new alkaloid dictysine [dictyzine] [1].

Dictysine, $C_{21}H_{33}NO_3$ (I), has mp 184-186°C (methanol), $[\alpha]_D^{20}$ −120° (c 1.25; chloroform), mol. wt. 347.2404 [high-resolution mass spectrometry (HRMS)], and it is sparingly soluble in chloroform and readily soluble in acetone and methanol. In the IR spectrum of (I) at 3440 cm^{-1} there is a broad absorption band of hydroxy groups. In the NMR spectrum signals are observed which are due to a tertiary methyl group (0.62 ppm, singlet, 3 H) and an N-methyl group (2.23 ppm, singlet, 3 H). In the mass spectrum of the base there are the peaks of the ions with m/e 347 (M^+, 100%), 330, 316, 312, 304, 256, and 172. Deuteration showed the presence in (I) of three active hydrogen atoms. Consequently, the developed formula of dictysine can be represented as $C_{20}H_{27}(>N-CH_3)(OH)_3$.

When (I) was acetylated with acetyl chloride, in addition to the triacetate (II) the diacetates (III) and (IV) were obtained. The empirical and developed formulas of (I), and also the nature of the mass-spectrometric fragmentations of dictysine and the diacetate (III) permit us to assign the base to the diterpene alkaloids of the songorine type [2]. The subsequent investigations confirmed this hypothesis.

A comparison of the mass spectra of dictysine and its deutero analog show that on passing from (I) to its trideutero analog there was a displacement by two mass units of the peaks of the ions with m/e 330 and 316 (Fig. 1a, b), which is connected with the ejection from the molecular ion of OH and CH_2OH groups, respectively. The peak of the ion with m/e 312 did not change, and its appearance is due to the successive ejection of OH and H_2O, as was confirmed by a metastable peak. In addition to those mentioned above, the spectrum of (I) has peaks of ions with m/e 304 and 256. The shift by three mass units of the peak of the first ion in the spectrum of the deutero analog, and also the presence of a metastable peak, showed that this fragment arose through the ejection from the molecular ion of a propyl radical. This was also shown by the HRMS, according to which the ion with m/e 304 corresponded to

---

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR, Tashkent. Translated from Khimiya Prirodnykh Soedinenii, No. 6, pp. 812-817, November-December, 1979. Original article submitted June 29, 1979.

0009-3130/79/1506-0718$07.50