THE STRUCTURE OF DIPTOCARPILINE AND DIPTOCARPIDINE

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Continuing a study of the combined alkaloids of *Dipthychocarpus strictus* we have isolated two bases: the first has been isolated previously and has been called diptocarpidine [or dipthocarpidine] [1], while the second is new, and we have called diptocarpiline. In the present paper we give the results of a study of the structures of these bases.

Diptocarpiline is an optically active white crystalline substance with the composition $C_{15}H_{32}N_2O_2S_2$ (I), mp 95-97°C $[\alpha]_D^{28}$ −53.24° (MeOH). The IR spectrum of the alkaloid has absorption bands of N—H stretching vibrations (3340 cm^{-1}) of an amide carbonyl group (1590, 1620 cm^{-1}), and of an S→O bond (1030 cm^{-1}).

The mass spectrum of (I) contains the peaks of ions with m/e 336 (M^+), 320 $(M - 16)^+$, 289, 273 $(M - 63)^+$, 190, 173 (100%), 147, and 61. The NMR spectrum of diptocarpiline shows the signals of the following protons (δ, ppm): 1.10-1.70 (16H, m, methylene protons); 2.00 (3H, s, $S—CH_3$); 2.4 (2H, t, $S—CH_2$); 2.52 $\left(3H, s, \overset{O}{\overset{\nearrow}{S}}—CH_3\right)$; 2,63 $\left(\overset{O}{\overset{\nearrow}{S}}—CH_2\right)$; 3.05 ($2N—CH_2$) and 5.27 (2H, 2NH groups capable of undergoing exchange with deuterium). It can be seen from the IR, mass, and NMR spectras that the two sulfur atoms in the molecule of diptocarpiline form terminal $\overset{O}{\overset{\nearrow}{S}}—CH_3$ and $S—CH_3$ groups. The reduction of (I) with zinc in hydrochloric acid led to an optically inactive base with mp 57-59°C (II), M^+ 320 (mass spectrometrically). The mass spectra of (I) and (II) differed by the fact that the molecular ion of the former had m/e value 16 units greater than that of the latter, and the IR spectrum of the latter lacked the absorption band of an S→O bond that is present in the spectrum of (I). In a comparative study of the NMR spectra of (I) and (II) it was observed that the signal of the protons of a methyl group attached to sulfur had undergone a diamagnetic shift by 0.48 ppm. These facts show that (II) is formed from (I) by the reduction of a sulfide group.

The hydrogenation of diptocarpiline in order to desulfurize it in a current of hydrogen in the presence of Raney nickel catalyst led to a neutral substance with mp 73-74°C (III) in the IR spectrum of which there were the absorption bands of NH and amide carbonyl groups (3340 and 1615 cm^{-1}).

The mass spectrum of (III) showed, in addition to the peak of the molecular ion with m/e 228, the peaks of ions with m/e 213 $(M-15)^+$, 199, 185, 171, 158, 128, 115, 85, 69, 57, and 43 (100%), which are similar to the peaks in the spectrum of N-n-hexyl urea [2]. The difference in the molecular weight of diptocarpiline and its dethio product of 108 m/e shows that the sulfuration led to the splitting out of the $\overset{O}{\overset{\nearrow}{S}}—CH_3$ and $S—CH_3$ groups with reduction of the positions of cleavage of the C—S bonds. Consequently, we assumed that the desulfuration product (III) should be N,N'-di-n-hexylurea.

For a direct comparison, we synthesized N,N'-di-n-hexylurea from n-hexyl bromide and urea in the presence of triethylamine. The substance synthesized and the desulfuration product proved to be identical in a mixed melting point. Thus, diptocarpiline has the structure of 6-methylsulfinyl-6'-methylthio-N-N'-di-n-hexylurea.

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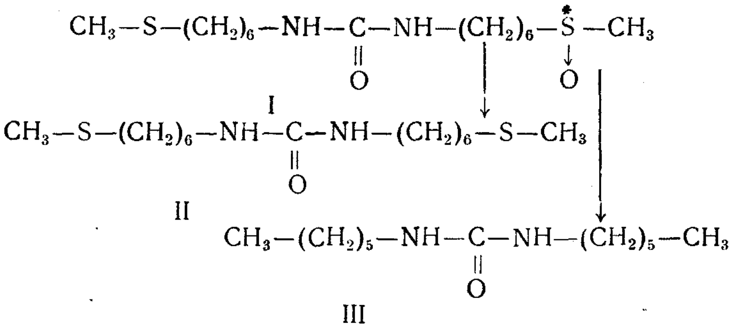


Diptocarpidine is an optically active white crystalline substance with the composition $C_{15}H_{32}N_2O_3S_2$ (IV), mp 135-136°C, $[\alpha]_D^{25}$ $-70.54°$ (MeOH) [1].

According to its IR spectrum, (IV) contains an NH group (3300 cm^{-1}), an amide carbonyl (1640 cm^{-1}) and a $S\rightarrow O$ bond (broad band at 1040 cm^{-1}).

The NMR spectrum of diptocarpidine showed signals at (ppm) 1.0-1.9 (methylene protons); 2.52 (6H, s, $2\overset{O}{\nearrow}\!S{-}CH_3$); 2.63 (4H, t, $2CH_2{-}S\rightarrow O$); 3.04 (4H, t, $2CH_2{-}N$); 4.89 (2NH groups).

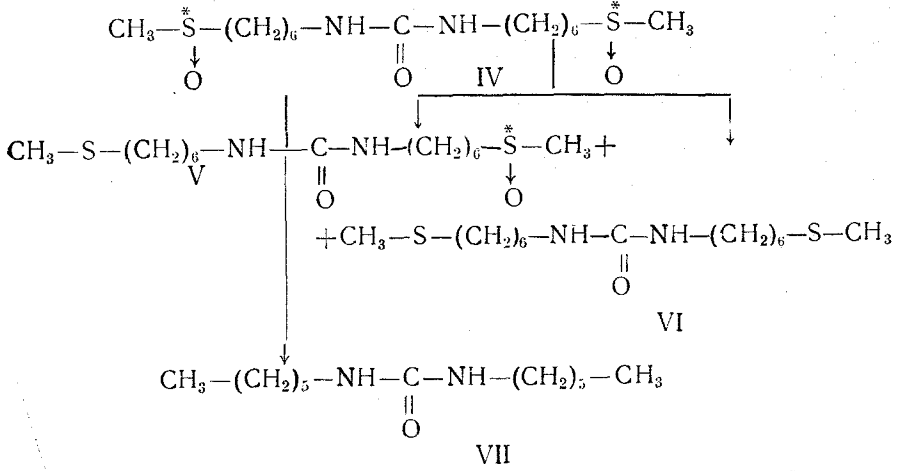
The mass spectrum of (IV) contains the peaks of ions with m/e: 352 (M^+), 336 $(M-16)^+$, 289 $(M-\overset{O}{\nearrow}\!S{-}CH_3)^+$, 273, 190, 173 (100%), 147, 61.

A comparison of the mass spectra of diptocarpidine and diptocarpiline shows that they contain the same set of peaks with the exception of the peaks of the molecular ions, which differ by 16 mass units:

	Ion peaks, m/e							
Diptocarpidine	352	336	289	273	190	173(100%)	147	61
Diptocarpiline		336	289	273	190	173(100%)	147	61

on the basis of a comparative study of the IR, NMR, and mass spectra it was assumed that diptocarpidine is the S-oxide of diptocarpiline. In actual fact, when (IV) was reduced with zinc in hydrochloric acid we obtained two products, one of which proved to be identical with diptocarpiline (V) and the other, mp 57-59°C, with the deoxy product of diptocarpiline.

When diptocarpidine was hydrogenated in a current of nitrogen over Raney nickel, we obtained a dethio product with mp 73-74°C (VII), identical with the product obtained under similar conditions from diptocarpiline. Consequently, diptocarpidine is 6,6'-di(methylsulfinyl)-N,N'-di-n-hexylurea.



The existence of optical density in diptocarpiline and diptocarpidine is explained by the presence of the sulfoxy groups in the molecule [3].

EXPERIMENTAL

The IR spectra were taken on a UR-10 instrument (tablets with KBr), the mass spectra on an MKh-1303 mass spectrometer, and the NMR spectra on a JNM-4H-100/100 MHz instrument, δ scale (in deuterochloroform).

Isolation and Separation of the Combined Alkaloids. From 23 kg of the epigeal part of the plant collected in the flowering period close to the village of Dzhilga, Chimkent oblast, we obtained 34 g of chloroform-soluble and 18 g of ether-soluble alkaloids (0.22% of the weight of the dry plant). The combined alkaloids (18 g) were chromatographed on a column of alumina (1:20). Elution was performed with hexane, benzene, benzene–chloroform, and chloroform.

The hexane eluates yielded an oil (0.2 g) with R_f 0.82 (TLC in the benzene–chloroform–methanol (5:3.5:1.5) system). The chloroform eluates yielded 0.3 g of diptocarpiline and 0.8 g of diptocarpidine.

Reduction of Diptocarpiline and of Diptocarpidine. In portions, 1 g of zinc dust was added to a solution of 0.1 g diptocarpiline in 10 ml of 20% hydrochloric acid (in methanol), and the mixture was heated on the water bath under reflux for 4 h. Then it was filtered with suction and the methanol was evaporated off in vacuum. The concentrated mass was made alkaline with concentrated NH_4OH and extracted with chloroform, and evaporation of the chloroform extract yielded 0.071 g of reduction product with mp 57-59°C. Under similar reduction conditions, 0.2 g of diptocarpidine gave 0.12 g of a mixture of crystals which was chromatographed on a column of alumina and reduction products with mp 57-59°C and 95-97°C were isolated.

Desulfuration of Diptocarpiline and Diptocarpidine. A mixture of 0.1 g of diptocarpiline and 1 g of Raney nickel in 10 ml of methanol was shaken in a current of hydrogen for 4 h. The catalyst was filtered off with suction, and the solvent was distilled off. This gave 0.06 g of a product with mp 72-73°C (acetone). The similar desulfuration of 0.1 g of diptocarpidine also gave a product with mp 72-73°C. Yield 0.04 g.

Synthesis of N,N'-di-n-hexylurea. A round-bottomed flask with a reflux condenser was charged with 0.5 g of urea, 2.3 g of n-hexyl bromide, and 2 ml of triethylamine and was heated in a sand bath for 3 h. Then the reaction mixture was cooled and the precipitate that had deposited was filtered off on a Büchner funnel and was washed with chloroform (4 × 15 ml). The filtrate and the chloroform washings were combined and were treated with 5% sulfuric acid solution. The acid solution was shaken with ether several times. The combined ethereal extracts were concentrated and then the ether was distilled off to dryness. The dry residue (1.2 g) was chromatographed on a column of alumina. An ethereal eluate yielded 0.2 g of N,N'-di-n-hexylurea with mp 72-73°C $[\alpha]_D \pm 0°$, M^+ 228.

SUMMARY

1. From the epigeal part of the plant *Dipthychocarpus strictus* collected in the flowering period close to Dzhilga, Chimkent oblast, the new alkaloids diptocarpiline and diptocarpidine have been isolated.

2. In a study of some chemical transformations and the spectral characteristics, it has been established that diptocarpiline has the structure of 6-methylsulfinyl-6'-methylthio-N,N'-di-n-hexylurea, and diptocarpidine that of 6,6'-di(methylsulfinyl)-N,N'-di-n-hexylurea.

LITERATURE CITED

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