SYNTHESIS OF 3',5-DI(PIPERIDIN-2-YL)-2,4'-BIPYRIDYL FROM ANABASINE

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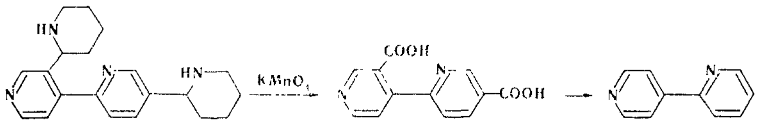
The possibility of the formation of 3',5-di(piperidin-2-yl)-2,4'-bipyridyl by the dehydrogenative condensation of anabasine in the presence of metallic sodium at 50-60°C has been shown.

Previously [1, 2], by applying the Emmert reaction to some 3-substituted pyridines, we obtained a number of new derivatives of 4,4'- and 2,2'-bipyridyls. In the present paper we describe the results of an investigation of the reaction of anabasine and metallic sodium at 50-60°C. From the reaction mixture by chromatography we isolated the known 3,3'-di(piperidin-2-yl)-4,4'-bipyridyl and a substance $C_{20}H_{26}N_4$ (I) the IR spectrum of which showed bands in the 840- and 740-cm^{-1} regions. The presence of these bands gives grounds for assuming that compound (I) contains the 2,4'-bipyridyl fragment [3]. Its UV spectrum has two absorption bands with λ_{max} 236 and 270 nm (ε 8650 and 8025, respectively), which is characteristic for 2,4'-bipyridyl [4]. The fall in the intensity of the absorption bands in comparison with unsubstituted 2,4'-bipyridyl is obviously connected with a decrease in the degree of conjugation caused by a disturbance of the coplanarity of the molecule because of the presence of a piperidine group in the ortho position to the internuclear C–C bond.

The PMR spectrum of the base (I) permits the structure of 3',5-di(piperidin-2-yl)-2,4'-bipyridyl to be ascribed to it. This is shown, in particular, by the presence of the signal of one proton in position 4 of a pyridine ring.

A definitive proof of the structure of (I) was its oxidation with potassium permanganate under the conditions for the oxidation of anabasine [5]. This reaction gave 2,4'-bipyridyl-3',5-dicarboxylic acid (II), the decarboxylation of which gave 2,4'-bipyridyl (III).



I II III

EXPERIMENTAL

The mass spectra were recorded on an MKh-1303 mass spectrometer with the direct introduction of the substance into the ion source at an ionizing voltage of 40 V, a cathode emission current of 25 mA, and a temperature of 125-150°C. The IR spectra were taken on a UR-10 spectrophotometer in potassium bromide tablets. The UV spectra were obtained on an SF-4A spectrophotometer in ethanolic solution with a concentration of 10^{-3} M. The PMR spectrum of the base was taken on a Hitachi H-60 instrument with CCl_4 as the solvent and TMS as the internal standard.

Dehydrogenative Condensation of Anabasine. With constant stirring, 0.23 g (0.01 g-atom) of sodium dispersed in m-xylene was added in portions to a mixture of 10 g (61 mmoles) of anabasine and 50 ml of absolute benzene. The reaction was performed in a current of nitrogen at 50-60°C for 6 h. When all the

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sodium had reacted, the mixture was oxidized with oxygen carefully freed from carbon dioxide. Then the benzene was distilled off and the residue was decomposed with water. The aqueous solution was extracted with chloroform, and the extract was dried with sodium sulfate. It was then chromatographed [Al_2O_3 of activity grade II; benzene–chloroform–methanol (8 : 22 : 2) system], and anabasine (R_f 0.50) and the products of its dimerization (R_f 0.11 and 0.26) were detected. After the solvent and the unchanged anabasine had been distilled off at 140-142°C (12 mm), 1.6 g (16%) of a viscous oil was obtained.

To isolate the 3',5-di(piperidin-2-yl)-2,4'-bipyridyl (I), 1.6 g of the reaction products was deposited on a column filled with Al_2O_3 of activity grade II and elution was performed with benzene–chloroform–methanol (8 : 22 : 2). The process was monitored by the TLC method using the same solvent system. The eluates containing the substance with R_f 0.26 were combined. After the solvent had been distilled off, 0.8 g (8%) of (I) was obtained in the form of a dark yellow oil which could not be crystallized. R_f 0.81 (Al_2O_3, methanol); 0.39 [Al_2O_3, acetone–water (100 : 8)]; 0.33 [Leningrad No. 2 paper, butanol–acetic acid–water (4 : 1 : 5)]. Mass spectrum: M^+ 322.

PMR spectrum, δ, ppm: 8.75 (singlet, 2'-H), 8.48 (doublet, $J_{4,6}$ 2 Hz, 6-H), 8.32 (doublet, $J_{5',6'}$ 6 Hz, 6'-H), 7.68 (doublet of doublets, $J_{3,4}$ 8 Hz, 4-H), 7.25 (doublet, 3-H), 7.00 (doublet, 5'-H), and 3.5-1.5 ppm (multiplet of the protons of piperidine rings). Dipicrate, mp 187-189°C (from ethanol). Found, %: N 19.2, 19.1. $C_{20}H_{26}N_4 \cdot 2C_6H_3N_3O_7$. Calculated, %: N 19.0.

2,4'-Bipyridyl-3',5-dicarboxylic Acid (II). A saturated aqueous solution of potassium permanganate was added to an aqueous solution of 3 g of (I) until a pink coloration appeared which did not disappear in the course of a day. The precipitate of manganese oxide was filtered off and washed with water. The action of copper acetate on the concentrated aqueous solution precipitated the copper salt of the acid (II). This was carefully washed with water, suspended in hot water, and decomposed with hydrogen sulfide. The precipitate of copper sulfide was filtered off and washed with hot water. The filtrate was evaporated to dryness, and the residue was recrystallized from absolute ethanol, giving 0.61 g (30%) of the acid (II) in the form of grayish crystals with mp 276-277°C (subl.). Found, %: C 58.9, 58.9; H 3.2, 3.3; N 11.4, 11.3. equiv. 123, 124. $C_{12}H_8N_2O_4$. Calculated, %: C 59.0; H 3.3; N 11.5, equiv. 122.

2,4'-Bipyridyl (III). A mixture of 1 g of (II) and 3 g of copper bronze in 50 ml of benzene was heated in a sealed tube at 240-250°C for 3 h. After filtration, the benzene was distilled off and the residue was treated with absolute ethanol. This gave 0.28 g (43%) of 2,4'-bipyridyl with mp 61°C (from petroleum ether); according to the literature [6], mp 61.5°C. Picrate, mp 213-214°C (from ethanol); according to the literature [6], mp 214°C.

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