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REACTIONS OF FUNCTIONALLY SUBSTITUTED BENZO[*c*]PYRYLIUM SALTS. SYNTHESIS OF 5H-BENZO-2,3-DIAZEPINES

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5H-Benzo-2,3-diazepine derivatives are formed in the reaction of 4-ethoxycarbonylbenzo[c]pyrylium perchlorates with excess hydrazine hydrate. It was established that the key intermediate in the reaction is the 2-aminoisoquinolinium cation. A method for the recyclization of 4-cyanobenzo[c]pyrylium salts to 5H-benzo-2,3-diazepine derivatives was found.

We have previously reported the synthesis of benzo[*c*]pyrylium derivatives with functional substituents in the heterocyclic part of the molecule [1] and demonstrated, in the case of transformations of 4-cyanobenzo[*c*]pyrylium perchlorates, that the introduction of an electron-acceptor substituent into the benzo[*c*]pyrylium cation substantially expands the spectrum of its transformations in reactions with nucleophiles. We have observed that the recyclization of 1,3-dialkyl-4-cyano-6,7-dimethoxybenzo[*c*]pyrylium salts by the action of excess hydrazine hydrate to 2-amino-4-cyanoisoquinolinium derivatives is accompanied by replacement of the 6-methoxy group by a hydrazine residue [2]. The new pyrazolo[5,4-*c*]isoquinoline heterocyclic system is formed under the same conditions from 1-methyl-3-phenyl-4-cyanobenzo[*c*]pyrylium salts [3]. In the present paper we give the results of a study of the transformations of 4-ethoxycarbonylbenzo[*c*]pyrylium derivatives with hydrazine hydrate, as well as a new pathway for the recyclization of 4-cyanobenzo[*c*]pyrylium salts.

Replacement of the cyano group in the 4 position of the benzo[*c*]pyrylium cation by an ester substituent completely changes the recyclization pathway. Compounds with nonionic character are formed by the action of excess hydrazine hydrate on 4-ethoxycarbonylbenzo[*c*]pyrylium perchlorates Ia, b. The spectral-analytical characteristics make it possible to propose the 5H-benzo-2,3-diazepine structure for IIa, b.

The IR spectrum of 5-hydrazinocarbonyl-1,4-dimethyl-7,8-dimethoxy-5H-benzo-2,3-diazepine (IIa) contains absorption bands of primary (3400, 3350 cm^{-1}) and secondary (3290 cm^{-1}) amino groups, a carbonyl group (1660 cm^{-1}), and C=N and C=C bonds of the heteroring and the benzene ring (1590-1635 cm^{-1}). In addition to singlets of methyl and methoxy

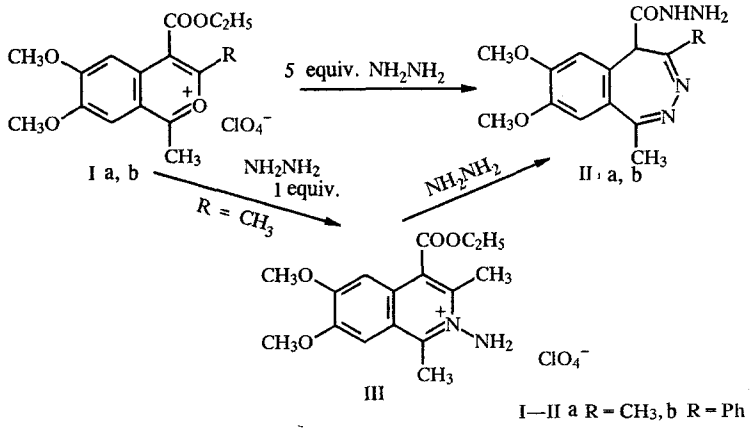

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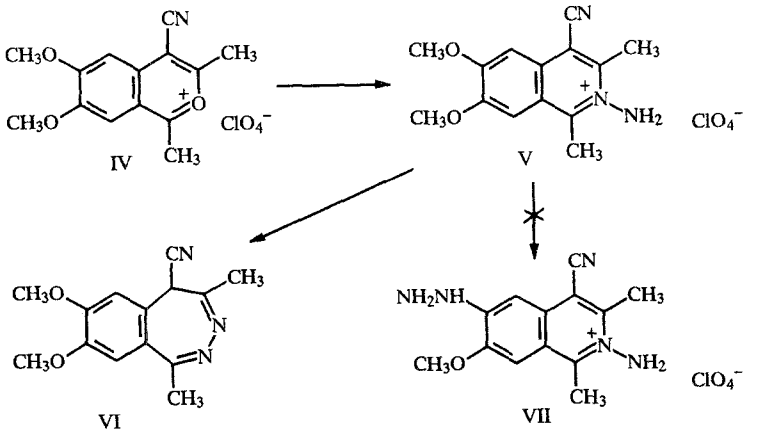
TABLE 1. Characteristics of II, III, V, and VI

Compound	Empirical formula	mp, °C	IR spectrum, ν, cm^{-1}	PMR spectrum, δ, ppm	Yield, %
IIa	$C_{14}H_{18}N_4O_3$	183...184	3400, 3350, 3190 (NH); 1660 (C=O)	3,10 (3H, s, CH_3), 3,40 (3H, s, CH_3), 4,00 (1H, s, CH), 4,20 (3H, s, OCH_3), 4,43 (3H, s, OCH_3), 7,72 (1H, s, H arom.), 7,83 (1H, s, H arom.)	75 (A) 83 (B)
IIb	$C_{19}H_{20}N_4O_3$	217...219	3380, 3300, 3150 (NH); 1655 (C=O)	3,46 (3H, s, CH3), 4,07 (1H, s, CH), 4,20 (3H, s, OCH_3), 4,40 (3H, s, OCH_3), 7,77...7,92 (7H, m, H arom.)	63
III	$C_{16}H_{21}ClN_2O_8$	251...253	3380, 3290 (NH); 1740 (C=O); 1630 (C=N); 1105 (ClO_4^-)	1,50 (3H, s, CH_3), 2,80 (3H, s, CH_3), 3,23 (3H, s, CH_3), 4,10 (6H, s, $2\times OCH_3$), 4,73 (2H, CH_2), 7,27 (1H, s, H arom.), 7,70 (1H, s, H arom.)	90
V	$C_{14}H_{16}ClN_3O_6$	283...285	3370, 3300 (NH); 2230 (C≡N); 1635 (C=N); 1100 (ClO_4^-)	2,90 (3H, s, CH_3), 3,13 (3H, s, CH_3), 3,96 (3H, s, OCH_3), 4,03 (3H, s, OCH_3), 7,23 (1H, s, H arom.), 7,67 (1H, s, H arom.)	87
VI	$C_{14}H_{15}N_3O_2$	203...204	2200 (C≡N); 1640 (C=N)	3,13 (3H, s, CH), 3,30 (3H, s, CH), 4,10 (1H, s, CH), 4,13 (3H, s, OCH), 4,23 (3H, s, OCH), 7,65 (1H, s, H arom.), 7,80 (1H, s, H arom.)	73

groups and aromatic protons, a singlet of a methylidyne proton in the 5 position of the benzo-2,3-diazepine system (4.00 ppm) is also present in the PMR spectrum of a solution in trifluoroacetic acid. Recyclization is accompanied by hydrazinolysis of the ethoxycarbonyl group; products of replacement of the 6-methoxy group were not detected in the reaction mixture.

The reaction of equimolar amounts of perchlorate Ia and hydrazine hydrate leads to 2-aminoisoquinolinium salt III, which was isolated in 90% yield and was converted to diazepine IIa on reaction with hydrazine hydrate:



Having assumed that, as in the case of the recyclization of the 4-cyanobenzo[*c*]pyrylium cation, is the 4-cyano analog (IV) of III, we obtained 2-amino-4-cyanoisoquinolinium salt V and subjected it to reaction with excess hydrazine hydrate. As a result, we isolated 5-cyano-1,4-dimethyl-7,8-dimethoxybenzo-5H-2,3-diazepine (VI) in 73% yield.

2-Amino-4-cyano-6-hydrazinoisoquinolinium perchlorate VII, which was previously obtained by the reaction of benzo[*c*]pyrylium salt IV with excess hydrazine hydrate [2], was not detected in the reaction mixture.

EXPERIMENTAL

The IR spectra of suspensions of the compounds in mineral oil were obtained with a UR-20 spectrometer. The PMR spectra of solutions in trifluoroacetic acid were recorded with a Tesla BS-467 spectrometer (60 MHz) with tetramethylsilane (TMS) as the internal standard.

The results of elementary analysis for II-VI were in agreement with the calculated values.

The characteristics of the synthesized compounds are presented in Table 1. Benzo[*c*]pyrylium perchlorates Ia, b and IV were obtained by the method in [1].

5-Hydrazido-1,4-dimethyl-7,8-dimethoxybenzo-2,3-diazepine (IIa). A. A mixture of 1.5 g (3.8 mmole) of perchlorate Ia and 0.94 ml (19 mmole) of hydrazine hydrate in 10 ml of ethanol was refluxed for 5 h, after which the reaction mixture was poured into 60 ml of water, and the precipitated product was removed by filtration and crystallized from ethanol.

B. A mixture of 2 g (4.9 mmole) of perchlorate IIa and 1.2 ml (24.7 mmole) of hydrazine hydrate in 15 ml of ethanol was refluxed for 5 h.

5-Hydrazido-1-methyl-4-phenyl-7,8-dimethoxybenzo-2,3-diazepine (IIb) was obtained by method A for diazepine IIa from perchlorate Ib and hydrazine hydrate.

2-Amino-4-ethoxycarbonyl-1,3-dimethyl-6,7-dimethoxyisoquinolinium Perchlorate (III). A mixture of 2 g (5.1 mmole) of perchlorate Ia and 0.27 ml (5.6 mmole) of hydrazine hydrate in 10 ml of ethanol was stirred for 7 h, after which the reaction mixture was poured into 50 ml of ether, and the precipitated product was removed by filtration.

2-Amino-4-cyano-1,3-dimethyl-6,7-dimethoxyisoquinolinium perchlorate (V) was obtained in the same way as III from 4-cyanobenzo[*c*]pyrylium salt IV and hydrazine hydrate.

5-Cyano-1,4-dimethyl-7,8-dimethoxybenzo-2,3-diazepine (VI) was obtained in the same way as diazepine IIa by method B from V and hydrazine hydrate.

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