m, 1H), 6.5 (N'H, m, 1 H), 4.54 (5-H, s, 1 H), 0.89 (CH_3, m, 6H). Found, %: C 57.9, H 9.1, N 20.7. $C_{13}H_{24}N_4O_2$. Calculated, %: C 58.2, H 9.0, N 20.9.

N-[2(6-Butylaminouracil-1-yl)ethyl] butylamine (IIc) was obtained from the amine (Ib) and butylamine in a similar manner to (IIa). Yield 55%. mp 205-206°C; Rf 0.52. UV spectrum (pH 7): λ_{max} 275 nm (log ε 5.3). PMR spectrum, ppm: 10.98 (3-H, s, 1H), 7.8 (N"H, m, 1 H), 6.54 (N'H, m, 1 H), 4.60 (5-H, s, 1 H), 0.90 (CH_3, m, 6H). Found, %: C 59.3, H 9.5, N 19.5. $C_{14}H_{26}N_4O_2$. Calculated, %: C 59.6, H 9.2, N 19.9.

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FORMYLATION OF 4-ARYL-2,3-DIHYDRO-1H-1,5-BENZODIAZEPIN-2-ONES

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UDC 547.892

The formylation of 8-chloro- and 8-methoxy-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-ones with the Vilsmeier reagent leads to 3-dimethylaminomethylene derivatives which, in the case of the 8-chloro derivative, have been converted by hydrolysis in acetic acid into 8-chloro-3-formyl-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-ones.

The formulation of lactams under the conditions of the Vilsmeier reaction takes place with the production of N-formyl [1], chloroformyl [2, 3], or dimethylaminoalkylidene [3, 4] derivatives. A single example of the formylation of 4-phenyl-2,3-dihydro-1-H-1,5-benzodiazepin-2-one (I) with N-methylpyrrolidone and phosphorus oxychloride has been described. It led to 3-(N-methylpyrrolidin-3-ylidene)-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepinone [5].

The present investigation was devoted to a study of the formylation of the benzodiazepinone derivatives (Ia, b) containing substituents of different natures in the fused-on benzene ring.

On reacting with the Vilsmeier complex, 8-chloro-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one formed 8-chloro-3-dimethylaminomethylene-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (IIa), the yield of which rose considerably with an increase in the amount of formylating agent from 1 to 4 moles. The formylation of 8-methoxy-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (Ib) could be achieved only by using 6 moles of the Vilsmeier reagent, and then the yield did not exceed 30%. When a smaller amount of reagent was used, the formation of the 3-dimethylaminomethylene derivative (IIb) was detected only chromatographically, together with the initial substance.

The IR spectra of compounds (IIa, b) had absorption bands of the stretching vibrations of NH and C=O groups in the 3135-3230 and 1667 cm^{-1} regions, and also absorption bands in the 1116, 1060, and 944 cm^{-1} regions that are characteristic for the vibrations of a dimethylamino group [6].

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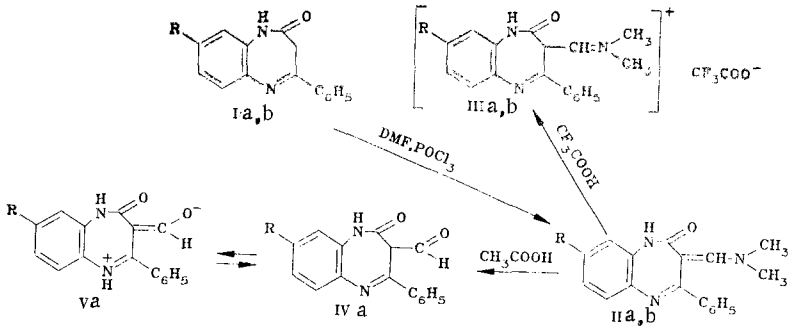
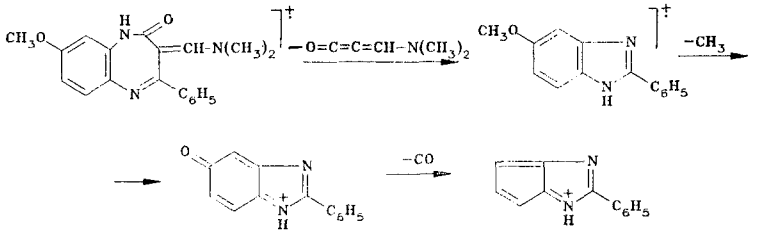


a R=Cl; b R=OCH$_3$

The PMR spectrum of compound (IIa) in trifluoroacetic acid showed the signals of the protons of the two NH groups at 9.56 and 8.70 ppm. The appearance of the signals of the second NH group is due to the protonation of the imine nitrogen in the acid medium, which is responsible for the appearance of two signals of methyl groups at 2.60 and 3.0 ppm. A similar influence of the protonation of such a group on the form of the PMR spectrum has been observed recently [7, 8]. The signal of the methine proton was present at 7.97 ppm. In the PMR spectrum taken in DMSO, a broadened signal of the proton of a methyl group was obtained at 2.6 ppm, and in the low-field region there was no signal of the proton of the second NH group, which is in harmony with the hypothesis put forward above. A similar PMR spectrum was observed for compound (IIb).

The structure of compound (IIb) was confirmed by the results of mass-spectral fragmentation. The mass spectrum had the peak of the molecular ion, the main direction of the fragmentation of which was the splitting out of dimethylaminomethyleneketene, i.e., the fragmentation of this substance under the action of electron impact took place similarly to that of the 2,3-dihydro-1H-1,5-benzodiazepin-2-ones [9].



Compound (IIa) was converted by hydrolysis in acetic acid into 8-chloro-3-formyl-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (IVa), the IR spectrum of which contained the absorption bands of an NH group at 3147-3267 cm^{-1} and of a C=O group at 1654-1680 cm^{-1} (two unresolved bands). The decrease in the degree of resolution of the bands is due to the fact that, as the result of conformational changes of the 1,5-benzodiazepinone [10], the carbonyl groups do not lie in the same plane. The IR spectrum contained, in addition to the absorption bands of aromatic rings (1600, 1580, and 1500 cm^{-1}), a strong absorption band at 1525-1540 cm^{-1}, which may be assigned to the vibrations of the carbonyl group of a tautomeric zwitter-ionic structure (V). This feature of the IR spectra has been reported previously for 1-methyl-1H-indeno[2,1-b]pyridine [11]. The IR spectrum of compound (IVa) also had a doublet at 2760-2854 cm^{-1}, which is characteristic for an aldehyde group [12]. The PMR spectrum of compound (IVa) in CF_3COOH showed the signals of aldehydic and NH protons in the 10.36 and 8.67 ppm regions. The signal of the methine proton was overlapped by a complex multiplet of the protons of the aromatic nucleus, which is in harmony with the ratio of the intensities in the spectrum. The presence of this proton was shown by double resonance.

It was impossible to convert 3-dimethylaminomethylene-8-methoxy-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one into the corresponding 3-formyl derivative by hydrolysis in an acid medium.

The UV spectra of the compounds synthesized corresponded to the structure of benzodiazepinones [13]. In the UV spectra of the 3-dimethylaminomethylene derivatives (IIa, b), as compared with the corresponding benzodiazepinones, bathochromic shifts of the absorption bands of the carbonyl groups [by 60 nm for compounds (IIa) and by 40 nm for compounds (IIb)],

accompanied by hyperchromic effects, were observed. For the 3-formyl derivative of benzodiazepinone (IVa), as compared with compound (IIa), a hypsochromic shift (by 60 nm) and a decrease in the intensity of the absorption band of the carbonyl group were characteristic, which corresponds to the structure of a 3-formylbenzodiazepinone.

In view of the very poor solubility of the compound in organic solvents, the investigation of the various tautomeric structures of the 3-formyl derivative is difficult.

EXPERIMENTAL

IR spectra were taken on a Specord IR-75 instrument in KBr tablets, UV spectra on a Specord UV-vis spectrophotometer in ethanol, PMR spectra on a Tesla-60 instrument in trifluoroacetic acid or dimethyl sulfoxide, with HMDS as internal standard, and mass spectra on a MKh-1303 spectrometer with direct introduction of the sample into the ion source at an ionizing energy of 50 eV, an emission current of 150 mA, and a temperature of the ionization chamber of 150°C. The course of the reaction was followed and the individuality of the substances was checked by means of TLC on Silufol UV-254 plates in the chloroform–ethanol (10:1) system.

8-Chloro-3-dimethylaminomethylene-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (IIa). A. In drops, 1.25 ml (16 mmole) of DMFA was added to 0.5 ml (5 mmole) of $POCl_3$ at 0-5°C, and the mixture was stirred at 15-18°C for 15 min. Then, 1.35 g (5 mmole) of 8-chloro-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one in 25 ml of THF was added over 20 min at 5-10°C, and the mixture was stirred at 10-15°C for another 20 min and was left overnight. The solution was poured into ice water and neutralized with 25% ammonia solution to pH 8. The precipitate was separated off. Yield 0.3 g (20%), mp 215-220°C (from ethyl acetate). R_f 0.39. UV spectrum, λ_{max}, nm (log ε): 221 (4.56), 260 (4.38), 297 (4.26), 381 (3.96). PMR spectrum (CF_3COOH): 9.56 (1H, s, NH), 8.70 (1H, s, NH), 6.80-7.82 (8 H, m, Ar), 7.97 (1 H, s, CH), 3.00 (3 H, s, NCH_3), 2.60 (3 H, s, NCH_3). Found, %: N 12.4, Cl 11.2. $C_{18}H_{16}ClN_3O$. Calculated, %: N 12.9, Cl 10.9.

B. The formylation of 1.35 g (5 mmole) of substance (Ia) with 1 ml (11 mmole of $POCl_3$) and 2.5 ml (32 mmole) of DMFA was carried out similarly. Yield 0.72 g (45%).

C. The formylation of 1.35 g (5 mmole) of substance (Ia) with 2 ml (22 mmole) of $POCl_3$ and 5 ml (64 mmole) of DMFA was carried out similarly. Yield 1.29 g (80%).

8-Chloro-3-formyl-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (IVa). With heating, 1 g (3 mmole) of compound (IIa) was dissolved in 50 ml of isopropanol and the solution was poured hot into 25 ml of dilute acetic acid (2:1). The mixture was left for 2 h, and then the precipitate (0.76 g) of a mixture of the initial benzodiazepinone (Ia) and the 3-formyl derivative (IVa) was separated off. Substances (Ia) and (IVa) were separated by boiling in chloroform. The filtrate yielded 0.3 g (37%) of compound (Ia), mp 217°C. A mixture with the substance obtained by a method described previously [13] gave no depression of the melting point. The IR spectra of the substances were identical. The yield of the aldehyde (IVa) was 0.46 g (50%), mp 203-205°C. UV spectrum, λ_{max}, nm (log ε): 217 (4.55), 243 (4.29), 258 (4.24), 325 (3.95). PMR spectrum (CF_3COOH), ppm: 10.36 (1 H, s, NH), 8.67 (1 H, s, CHO), 7.67-6.70 (8 H, m, Ar and CH=). Found, %: N 9.4, Cl 11.9. $C_{16}H_{11}ClN_3O_2$. Calculated, %: N 9.4, Cl 11.9.

3-Dimethylaminomethylene-8-methoxy-4-phenyl-2,3-dihydro-1H-1,5-benzodiazepin-2-one (IIb). In drops, 3.25 ml (48 mmole) of DMFA was added to 1.5 ml (15 mmole) of $POCl_3$ at 0-5°C and the mixture was stirred at 15-18°C for 15 min, and then 0.67 g (25 mmole) of the benzodiazepinone (IIb) in 40 ml of THF was added over 20 at 5-10°C. The mixture was stirred at room temperature for 20 min and was left overnight. Then it was poured into water containing ice and was neutralized with 10% ammonia solution to pH 8. The precipitate was separated off. Yield 0.24 g (30%), mp 215-220°C (from ethyl acetate). UV spectrum, λ_{max}, nm (log ε): 206 (4.37), 252 (4.29), 341 (3.99), 269 (3.86). PMR spectrum (CF_3COOH), ppm: 9.80 (1 H, s, NHCO), 9.0 (1 H, s, NHC), 8.0-6.6 (8 H, m, Ar and CH), 3.83 (3 H, s, OCH_3), 3.25 (3 H, s, NCH_3), 2.88 (3 H, s, NCH_3). Found, %: C 71.1, H 6.1, N 13.0. $C_{17}H_{16}N_3O_2$. Calculated, %: C 71.0, H 5.9, N 13.1. Mass-spectrum, m/z (I, %): 321 (3.5), 224 (100), 209 (74), 181 (2).

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HETEROCYCLIC COMPOUNDS CONTAINING DIAZO AND CYANO GROUPS.

1. DIAZOACETONITRILE DERIVATIVES IN THE SYNTHESIS OF 5-HALO-1H-1,2,3-TRIAZOLES

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Carbonyl-substituted derivatives of diazoacetonitrile have been obtained by the diazotization of amines and by diazo-group transfer which, under the action of hydrogen halide, have been converted into 4-carbonyl-substituted 5-halo-1H-1,2,3-triazoles. The structures of these compounds have been confirmed by mass spectrometry and independent synthesis.

The cyclization of diazo compounds having a cyano group in the α position under the action of nucleophilic reagents is represented only by the reaction of alkyl and phenyl derivatives of diazoacetonitrile with hydrogen sulfide [1]. At the same time, it may be expected that other diazoacetonitrile derivatives would also take part in various addition reactions at the nitrile group with the formation of heteroanalogs of the pentadientyl anion cyclizing to five-membered heterocycles.

The present communication is devoted to an investigation of the reactions of derivatives of 2-carbonyl-2-diazoacetonitrile (I) with hydrogen halides.

The initial ethyl 2-cyano-2-diazoacetate (Ia) and the corresponding acetamide (Ib) and N-methylacetamide (Ic) were obtained by the diazotization of the corresponding amines (IIa-c), and the acetophenone (Id) by a diazo-group transfer reaction to benzoylacetonitrile (IId) [2].

It has been shown previously [3] that diazomalononitrile does not react with hydrogen chloride. We have found that, in contrast to diazomalononitrile, the diazonitriles (Ia-d) react with hydrogen chloride, bromide, and iodide but, instead of the ethoxytriazoles (III), this process forms the 5-halo-1H-1,2,3-triazoles (IV-VI). The replacement of the solvent by chloroform or hexane did not change the nature of the products of this reaction.

The IR spectra of each of the triazoles (IV-VI) contained absorption bands at 3540-3350 cm^{-1} (NH) and 1730-1640 cm^{-1} (CO), and lacked absorption bands characteristic for C≡N and N=N bonds (Table 1). In the mass spectra of the ester (IVa) and of the amide (IVb) the peaks

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