SPIRO COMPOUNDS WITH FRAGMENTS OF 4-AZAFLUORENE-[INDENO(2,3-e)-1,2-DIHYDROPYRIDINE] AND PYRAZOLINE

Ammar Mustafa, N. M. Mikhailova, and N. S. Prostakov

9-Phenacylidene-4-azafluorene and 9-bromo-9-(α -bromophenacyl)-4-azafluorene have been used in the synthesis of spiro compounds with fragments of substituted pyrazolines. 1-Methyl-2-oxo-5-phenacylidene-indeno[2,3-e]-1,2-dihydropyridine and hydrazine gave 1-methyl-2-oxo-3'-phenylspiro[indeno(2,3-e)-1,2-dihydropyridine-5,5'-pyrazoline-2'].

The use of 9-phenacylidene-4-azafluorene (I) in the synthesis of spiro compounds with indene, indane, and pyrazoline fragments has been described in [1]. In order to develop further the methods for the synthesis of analogous spiro compounds, we have prepared 9-bromo-(α -bromophenacyl)-4-azafluorene (II) by the bromination of compound I in chloroform. Its condensation with hydrazine in ethanol gives 2-phenylspiro[4-azafluorene-9,5'-pyrazoline-2'] (III). Based on its melting point and spectral characteristics it is identical to a sample of this compound, obtained earlier by a different route [1]. The reaction of the dibromide II with phenylhydrazine was carried out under analogous conditions. According to the elemental analysis and the mass spectrum (molecular ion peak with m/z 373) the isolated substance corresponds to spiro[4-azafluorenepyrazoline], diphenyl-substituted in the pyrazoline ring. Hereby spiranes can be formed with the phenyl substituents at the atoms N₍₁₎ and C₍₃₎, and N₍₂₎ and C₍₃₎. The IR spectrum of the compound prepared contains a $\nu_{\rm NH}$ band at 3100-3270 cm⁻¹; this permits us to ascribe to the discussed compound the structure 2',3'-diphenylspiro[4-azafluorene-9,5'-pyrazoline-3'] (IV).



This reaction probably passes through the formation of 9-phenylhydrazyl-9-(α -bromophenacyl)-4-azafluorene and is caused by the activity of bromine at the C₍₉₎ atom; further cyclization leads to compound IV. An isomer of the spiro compound IV – 1,3-diphenylspiro[4-azafluorene-9,5'-pyrazoline-2'] (V) – was obtained in the condensation of the phenacylidene derivative I with phenylhydrazine by heating in methanol. In the PMR spectrum of this compound the CH₂ protons of the pyrazoline ring appear as a singlet signal at 3.80 ppm. The band of the NH-bond stretching vibrations is missing in the IR spectrum of the spirane V.

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The condensation of 1-methyl-2-oxo-5-phenacylidene-indeno[2,3-e]-dihydropyridine (VI) [2] gave 1-methyl-2-oxo-3'-phenylspiro[indeno(2,3-e)-1,2-dihydropyridine-5,5'-pyrazoline-2'] (VII).



The structure of compound VII is in agreement with the PMR data; the multiplet character and position of the signals of the pyridone-ring protons are analogous to those obtained for compounds containing the indeno- α -pyridine fragment [3]. The protons of the methylene group of the pyrazoline ring appear as a singlet signal at 3.50 ppm.

EXPERIMENTAL

The IR spectra were recorded on a UR-20 spectrometer (KBr). The PMR spectra of solutions in CDCl₃ (with TMS as internal standard) were obtained on a Bruker WP-80 spectrometer at 80 MHz. The mass spectra were obtained on a MKh-1303, equipped with a facility for the direct injection of the sample into the ion source at an ionizing voltage of 70 eV and different admission temperatures. The progress of the reactions and the purity of the compounds obtained was checked by TLC on Silufol UV-254 foils; the eluent was heptane-ethyl acetate 1:2, the spots were revealed by exposure to iodine vapors. The elemental analysis data for C, H, and N correspond to the calculated values.

9-Bromo-9-(α -bromophenacyl)-4-azafluorene (II). A solution of 1 g (3.53 mmole) of compound I in 20 ml chloroform is treated with 5 ml chloroform containing 0.56 g (3.53 mmole) bromine. The mixture is refluxed for 6 h. The chloroform is stripped to bring the volume to 1/4 and is treated with 10 ml absolute ether. The yellow crystals formed are filtered off and washed with ether. Yield 0.9 g (57.7%) of dibromide II; mp 124-126°C. PMR spectrum: 6.17 (1H, s, CHBr); 8.86 (1H, d.d. 3-H); 7.29-8.75 ppm (12H, m, H_{arom}). Found, %: C 54.5, H 2.8, N 3.2, Br 36.4. C₂₀H₁₃NOBr₂. Calculated, %: C 54.2, H 2.9, N 3.2, Br 36.1.

3'-Phenylspiro[4-azafluorene-9,5'-pyrazoline-2'] (III). A solution of 0.4 g (0.9 mmole) of dibromide III and 6 ml of hydrazine in 20 ml ethanol is refluxed for 6 h. The solution is evaporated to dryness in vacuum, treated with 60 ml water, and extracted with ether. After stripping of the ether the yield is 0.12 g (40%) of light yellow crystals of compound III; mp 145-148°C (decomp.). M⁺: 297. The PMR spectrum is identical to that of a reference sample (literature); mp 149-152°C (decomp.) [1]. Found, %: C 80.7, H 5.1, N 12.7. C₂₀H₁₉N₃. Calculated, %: C 80.8, H 5.1, N 12.8.

2',3'-Diphenylspiro[4-azafluorene-9,5'-pyrazoline-3'] (IV). A solution of 0.4 g (0.9 mmole) of dibromide II and 0.4 g (3.7 mmole) phenylhydrazine in 20 ml ethanol is refluxed for 2 h; 50 ml water is added and the mixture extracted with ether. The ether is stripped off and the residue treated with 10 ml ethyl acetate, followed by heptane until the precipitate formation ceases. Yield 0.12 g (35.3%) of the spiro compound IV in the form of orange-colored crystals; mp 210-212°C (from ethanol). M^+ : 373. PMR spectrum: 5.63 (1H, s, NH), 8.25 (1H, d.d. 3-H), 6.50-8.10 (17H, m, H_{arom}). IR spectrum: 3180-3400 cm⁻¹ (NH). Found, %: C 83.9, H 4.9, N 11.1. C₂₆H₁₉N₃. Calculated, %: C 83.6, H 5.1, N 11.3.

1'-3'-Diphenylspiro[4-azafluorene-9,5'-pyrazoline-2'] (V). A solution of 0.5 g (1.8 mmole) of compound I and 1 g (9.26 mmole) of phenylhydrazine in 20 ml methanol is refluxed for 2.5 h. After cooling the reaction mass is treated with 10 ml of diethyl ether. The precipitate formed is filtered off and recrystallized from ethanol. Yield 0.12 g (18.2%) of spiro compound V; mp 171-175°C. M⁺: 373. PMR spectrum: 3.80 (2H, s, 4-CH), 7.10 (1H, d.d, 2'-H), 8.08 (1H, d.d, 1'-H), 8.58 (1H, d.d, 3'-H), 6.60-7.80 ppm (14H, m, H_{arom}). Found, %: C 83.5, H 5.1, N 11.3. C₂₆H₁₉N₃. Calculated, %: 83.6, H 5.1, N 11.3.

1-Methyl-2-oxo-3'-phenylspiro[indeno(2,3-e)-1,2-dihydropyridine-5,5'-pyrazoline-2'] (VII). A solution of 0.17 g (0.543 mmole) of compound VI and 4 ml (0.125 mole) of hydrazine in 50 ml ethanol is refluxed for 4 h and the alcohol stripped off. The reaction mass is treated with 30 ml water and the precipitate formed is filtered off and washed with distilled water to pH 7. The residue is dried in vacuum over P_2O_5 . Yield 0.07 g (40%) of spirane VII in the form of dark violet (almost black) crystals with mp 119-124°C. PMR spectrum: 3.50 (2H, s, CH₂), 4.01 (3H, s, NCH₃), 5.87 (1H, s, NH), 6.50 (1H,

d, J = 9.0 Hz, 3-H). 7.45 (d, J = 9.0 Hz, 4-H), 7.00-8.25 ppm (9H, m, 5,6,7,8-H and C₆H₅). IR spectrum: 1662 (C=O), 3200-3400 cm⁻¹ (NH). Found, %: C₂₁H₁₇N₃O. Calculated, %: C 77.1, H 5.2, N 12.8.

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