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> LETTERS TO THE EDITOR

Heterocyclizations Based on Products of Cycloaddition of Malononitrile to Substituted 1,2,4-Thiadiazol-5(2*H*)-imines

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Substituted 1,2,4-thiadiazol-5(2*H*)-imines I react with acetonitrile to give [3+2]-cycloaddition products. The reaction occurs quite regioselectively and involves the N=C-S triad, with opening of the initial

heterocycle [1]. We found that such a reaction of compounds \mathbf{I} with malononitrile gives an unexpected result: cycloadducts \mathbf{II} with an active methylene group rearrange into 2,3-dihydrothiazole derivatives \mathbf{III} .



Ar = 4-MeC₆H₄ (Ia-IIIa, VI), 4-MeOC₆H₄ (Ib-IIIb, IV, V).

Recyclization produts III appeared to be suitable for preparing new fused heterocyclic compounds IV– VII. Annelations similar to cyclizations III \rightarrow IV and III \rightarrow VI were studied previously with certain carboand heterocyclic compounds containing CN and NH₂ groups [2, 3]. At the same time, the transformation III \rightarrow V has an analog only in the series of acyclic enamino nitriles [4]. Therefore, the structure of V was proved by single crystal X-ray diffraction. The features of the molecular structure of V and its analogs will be discussed later.

 N^{1} -[4-Amino-3-phenyl-5-cyanothiazol-2(3*H*)-ylidene]-4-methyl(methoxy)- N^{2} -phenylbenzamidines

1827

IIIa and IIIb. A mixture of 20 mmol of Ia or Ib obtained by the general procedure [1], 20 mmol of malononitrile, and 10 ml of dioxane was refluxed with stirring for 3 h and cooled to 20°C; the precipitate was filtered off, washed with dioxane, and dried at 100°C. Yield of IIIa 76%, mp 215°C (dec.) (MeCN). IR spectrum (KBr), v, cm⁻¹: 2200 (C=N), 3220–3380 (NH₂). ¹H NMR spectrum, δ , ppm: 2.18 s (CH₃), 6.69 d (2H arom.), 6.84 s (NH₂), 6.92–7.05 m (5H arom.), 7.17– 7.25 m (2H arom.), 7.47-7.60 m (5H arom.). Found, %: C 71.48; H 4.80; N 17.41; S 7.87. $C_{24}H_{19}N_5S$. Calculated, %: C 70.39; H 4.68; N 17.10; S 7.83. Yield of IIIb 75%, mp 219°C (dec.) (dioxane). IR spectrum (KBr), v, cm⁻¹: 2200 (C≡N), 3220, 3270, 3340, 3460 (NH₂). ¹H NMR spectrum, δ , ppm: 3.66 s (CH₃), 6.67-6.73 m (4H arom.), 6.83 s (NH₂), 6.95-7.27 m (5H arom.), 7.48-7.62 m (5H arom.). Found, %: C 66.91; H 4.61; N 16.59; S 7.42. C₂₄H₁₉N₅OS. Calculated, %: C 67.74; H 4.50; N 16.46; S 7.54.

Ethyl 7-amino-5-methyl-2-(4-methoxy-N-phenylbenzimidoyl)imino-3-phenyl-2,3-dihydrothiazolo-[4,5-b]pyridine-6-carboxylate IV. A 5-mmol portion of $SnCl_4$ was added to a mixture of 2.5 mmol of **IIIb**, 2.5 mmol of ethyl acetoacetate, and 20 ml of 1,2-dichloroethane. The mixture was refluxed for 6 h and then cooled to 20°C and neutralized with 10 ml of 2 M sodium carbonate; the precipitate was filtered off, and the organic layer was separated, kept over CaCl₂, and evaporated to dryness in a vacuum. Yield 89%, mp 189°C (EtOH– C_6H_6). IR spectrum (CH₂Cl₂), v, cm⁻¹: 1670 (C=O), 3340, 3460 (NH₂). ¹H NMR spectrum (mixture of stereoisomers), δ, ppm: 1.42 t (CH₃CH₂), 2.53, 2.62 s (CH₃C), 3.72, 3.83 s (CH₃O), 4.38 q (CH₃CH₂), 5.77, 6.13 s (1:4, NH₂), 6.63-7.87 m (2C₆H₅, C₆H₄). Found, %: N 13.20; S 6.01. C₃₀H₂₇N₅O₃S. Calculated, %: N 13.03; S 5.96.

4-Methoxy-N¹-{2,2,4-trimethoxy-7-phenyl-2,2dihydrothiazolo[4,5-d][1,3, $2\lambda^5$]diazaphosphorin-6(7H)-ylidene}- N^2 -phenylbenzamidine V. A mixture of 2 mmol of IIIb, 2.2 mmol of PCl₅, and 6 ml of dry chlorobenzene was refluxed with stirring for 20 min; then the mixture was cooled to 20°C, and the precipitate was filtered off and vacuum-dried. This product was suspended in 5 ml of dioxane, and 1.9 ml of a 4.3 M solution of sodium methylate in methanol, diluted with 3 ml of dioxane, was added dropwise. The mixture was stirred for 2 h, the precipitate of NaCl was filtered off, the filtrate was vacuum-evaporated, and the residue was treated with methanol to initiate crystallization; the precipitate was filtered off. Yield 77%, mp 186°C (AcOMe). ¹H NMR spectrum (mixture of stereoisomers), δ, ppm: 3.59, 3.63, 3.66, 3.71, 3.83, 3.95 s (4CH₃), 6.60–7.87 m (2C₆H₅,

 C_6H_4). Found, %: N 13.03; P 5.53; S 5.91. $C_{27}H_{26}$ · N_5O_4PS . Calculated, %: N 12.79; P 5.66; S 5.86. Single crystal X-ray diffraction study showed that the bicyclic system is almost planar; the deviations of the atoms from the least-squares plane do not exceed 0.092 Å. Bond lengths (*d*, Å): N¹–P² 1.607(4), P²–N³ 1.602(4), N³–C⁴ 1.324(6), C⁴–C^{4a} 1.384(6), C^{4a}–C^{7a} 1.384(6), N¹–C^{7a} 1.339(6).

4-Methyl- N^1 -{**7-oxo-3,5-diphenyl-6,7-dihydrothiazolo**[**4,5-**d]**pyrimidin-2**(**3**H)**ylidene**}- N^2 -**phenylbenzamidine VI.** A mixture of 5 mmol of **IIIa**, 10 mmol of benzoyl chloride, and 5 ml of pyridine was refluxed with stirring for 4 h; then the mixture was cooled to 20°C, and the precipitate was filtered off and washed with ethanol. Yield 66%, mp 322°C (DMF). IR spectrum (KBr), v, cm⁻¹: 1660 (C=O), 3050 (NH). Found, %: N 13.37; S 6.10. C₃₁H₂₃N₅OS. Calculated, %: N 13.64; S 6.24.

3,5-Diphenylthiazolo[**4,5-***d*]**pyrimidine-2,7**(*3H*,-**6***H*)-**dione VII.** A solution of 2 mmol of **VI**, 10 ml of acetic acid, and 0.5 ml of concentrated HCl was refluxed for 40 h and then allowed to stand at 20–25°C for 24 h. The precipitate was filtered off and washed with ethanol. Yield 54%, mp 325°C (DMF). IR spectrum (KBr), v, cm⁻¹: 1680 (C=O), 3060 (NH). Found, %: C 62.95; H 3.35; N 13.35; S 9.92. $C_{17}H_{11}N_3O_2S$. Calculated, %: C 63.54; H 3.45; N 13.08; S 9.98.

The IR spectra were recorded on Specord IR-71 (CH₂Cl₂ solutions) and UR-20 (KBr pellets) spectrometers. The ¹H NMR spectra were measured on Varian VXR-300 (300 MHz; **IV** and **V**) and Varian Gemini-200 (200 MHz; **IIIa** and **IIIb**) spectrometers; solvent DMSO- d_6 , internal reference TMS. X-ray diffraction study of **V** was performed with an Enraf–Nonius CAD-4 diffractometer (Cu K_{α} radiation, λ 1.54180 Å) in cooperation with A.N. Chernega (Institute of Organic Chemistry, National Academy of Sciences of Ukraine).

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