

Reaction of Dithiomalonic Acid Dianilide with Methyl Propiolate

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Abstract—Dithiomalonic acid dianilide reacted with methyl propiolate in acetic acid in the presence of excess perchloric acid to give 4-anilino-2-methoxycarbonylmethyl-1,3-dithiine-6-phenyliminium perchlorate.

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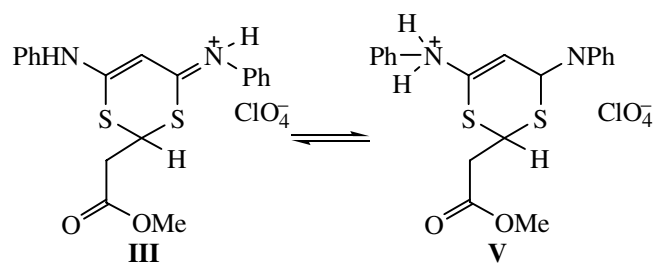
Methyl propiolate is known to react with thioacetamide and thiobenzamide in methanol at 20°C to form *E,E*- and *Z,E*-bis(methoxycarbonylvinyl) sulfides in a ratio 1:1 [1]. A reaction of heterocyclic thioamides with dimethyl acetylenedicarboxylate in anhydrous ethanol at 20°C led to the formation of substituted 1,3-thiazolidin-4-ones [2, 3]. A convenient synthetic procedure was developed for 5-methylenethiazolidin-4-ones based on a reaction of malonic acid substituted thioamides with dimethyl acetylenedicarboxylate in chloroform [4]. A prolonged heating of substituted thioamides with dimethyl acetylenedicarboxylate in toluene or dichloroethane provided unexpected results: The main reaction products were substituted pyrroles (yield 56%) and thiophenes (yield 12%) [5]. Yet the dithioamides reactions with acetylenedicarboxylic acids esters are still poorly understood.

It was established formerly that terminal acetylene ketones and 1-bromo-2-acylacetylenes reacted with

dithiomalonamide and dithiomalonic acid dianilide in acetic acid at 20°C in the presence of equimolar quantity of HClO₄ to provide substituted 1,3-dithiyn-6-iminium perchlorates [6, 7]. We report here on a study of reaction between dithiomalonic acid dianilide (**I**) and methyl propiolate (**II**).

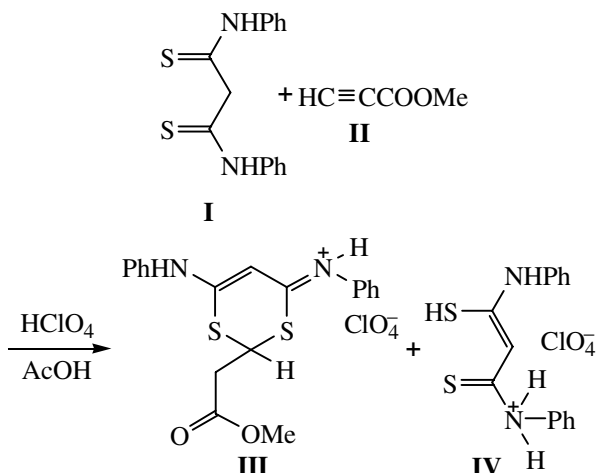
The reaction proceeded in acetic acid in the presence of excess perchloric acid at 65°C leading to the formation of 4-anilino-2-methoxycarbonylmethyl-1,3-dithiine-6-phenyliminium perchlorate (**III**) in 42% yield.

The ¹H and ¹³C NMR spectra suggest that compound **III** exists in equilibrium with its tautomer **V**.



In the ¹H NMR spectrum the proton signals of the =CH group and carbon peaks of =CH and C=N groups in the ¹³C NMR spectrum are broadened, presumably due to an exchange process.

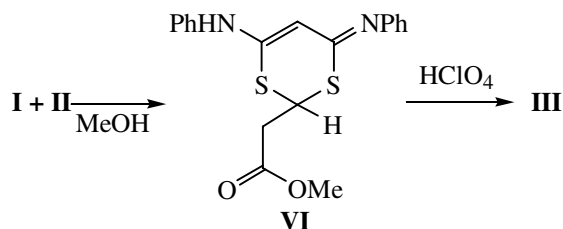
From the reaction mixture obtained from dianilide **I** and methyl propiolate (**II**) alongside the main product, substituted 1,3-dithiine-6-phenyliminium perchlorate **III**, dithiomalonic acid dianilide perchlorate (**IV**) was isolated in 27% yield. We failed to obtain compound **III** by prolonged heating dithiomalonic acid dianilide perchlorate (**IV**) with methyl propiolate (**II**) in acetic acid at 65–75°C.



The reaction of dianilide **I** with methyl propiolate (**II**) in anhydrous methanol at 20°C gave rise to 4-anilino-2-methoxycarbonylmethyl-6-phenylimino-1,3-dithiine (**VI**) in 32% yield.

Treating dithiine **VI** with 58% perchloric acid at 20°C we obtained perchlorate **III** in 82% yield.

The reaction of dianilide **I** with methyl propiolate **II** carried out for three days in acetic acid at 20°C without perchloric acid resulted in formation of compound **VI** with a yield no more than 5%.



Thus it may be inferred that the perchloric acid catalyzed the reaction by protonating the oxygen atom in methyl propiolate (**II**) thus increasing the positive charge on the carbon atom of the acetylene bond and enhancing its electrophilicity.

In the UV spectrum of compound **I** recorded in acetonitrile the π - π^* electron transitions in the fragment $S=CNHPh$ appear as absorption bands with the maxima at 218 and 299 nm. A large red shift of these bands to 235 and 374 nm in compound **III** is caused by enhanced conjugation system in the molecule and by the salt form of compound **III**.

The stretching vibrations band of N-H bonds in the IR spectrum of compound **IV** recorded from KBr pellets and mulls in mineral oil was observed at 3280 cm^{-1} . In the UV spectrum of perchlorate **IV** recorded in acetonitrile the bands of the fragment $S=CNHPh$ are shifted to longer waves compared with the spectrum of compound **I** and appear at 222 and 336 nm.

EXPERIMENTAL

IR spectra of compounds synthesized were recorded on a spectrophotometer Specord 75 IR from KBr pellets. ^1H , ^{13}C , and ^{15}N NMR spectra were registered on a spectrometer Bruker DPX-400 at operating frequencies 400.13, 101.61, and 40.56 MHz respectively from solutions in $\text{DMSO}-d_6$, internal references HMDS and MeNO_2 . Mass spectrum was measured on a GC-MS instrument Shimadzu GCMS-QP5050A, chromatographic column SPB-5ms, 60 m long, internal diameter

250 μm , stationary phase 0.25 μm thick, injector temperature 250°C, carrier gas helium, flow rate 2.7 ml/min, quadrupole mass analyzer, electron impact ionization, ionizing electrons energy 70 eV, ion source temperature 250°C, detected mass range 34–650. Chromatograms were recorded at full ion current.

4-Anilino-2-methoxycarbonylmethyl-1,3-dithiine-6-phenyliminium perchlorate (III). To a solution of 0.86 g (3 mmol) of dithiomalononitrile dianilide (**I**) in 20 ml of acetic acid was added slowly at stirring a solution of 0.25 g (3 mmol) of methyl propiolate (**II**) in 10 ml of acetic acid and 0.45 ml (0.37 g) of 58% perchloric acid (3.7 mmol of 100% perchloric acid); the mixture was stirred for 2 h at 20°C. Then the reaction mixture was heated to 65°C, stirred at this temperature for 2 h, and left standing for 12 h. The separated precipitate was filtered off, washed on the filter with water, cold ether, and dried in a vacuum. Yield of compound **IV** 0.3 g (27%), mp 199–200°C. IR spectrum, cm^{-1} : 690 (C-S), 1125 (C-S), 1590 (C=C), 3350 (NH). ^1H NMR spectrum, δ , ppm: 6.65 (1H, =CH), 7.38–7.54 m (10H, $2\text{C}_6\text{H}_5$), 11.82 br.s (2H, 2NH). ^{13}C NMR spectrum, δ , ppm: 98.16 (=CH), 122.62, 127.72, 130.39, 138.46 (C_{arom}), 174.71 (C=S). Found, %: C 46.66; H 3.63; Cl 9.24; N 7.35; S 16.38. $\text{C}_{15}\text{H}_{15}\text{ClN}_2\text{O}_4\text{S}_2$. Calculated, %: C 46.58; H 3.91; Cl 9.18; N 7.24; S 16.55.

The filtrate after isolating compound **IV** was cooled to 0°C, the precipitated crystals were filtered off, washed on the filter with cold ether, and dried in a vacuum. Yield of compound **III** 0.56 g (42%), yellow crystals, mp 150–151°C. IR spectrum, cm^{-1} : 605 (C-S), 1090 (COC), 1470 (CH_2), 1590 (C=C), 1660 (C=N), 1710 (C=O), 3200, 3280 (NH). ^1H NMR spectrum, δ , ppm: 3.24 d (2H, CH_2 , J 7.2 Hz), 3.66 s (3H, OCH_3), 5.38 t (1H, CHS, J 7.2 Hz), 6.37 br.s (1H, =CH), 7.31–7.49 m (10H, $2\text{C}_6\text{H}_5$), 11.50 s (1H, NH). ^{13}C NMR spectrum, δ , ppm: 38.75 (CHS), 40.01 (CH_2), 52.25 (OCH_3), 91.57 (=CH), 124.94, 127.88, 129.76, 136.62 (C_{arom}), 165.80 (C=N), 169.21 (C=O). ^{15}N NMR spectrum, δ , ppm: -135.7 (C=N). Found, %: C 48.31; H 4.11; Cl 7.83; N 6.18; S 13.64. $\text{C}_{19}\text{H}_{19}\text{ClN}_2\text{O}_6\text{S}_2$. Calculated, %: C 48.46; H 4.04; Cl 7.55; N 5.95; S 13.60.

4-Anilino-2-methoxycarbonylmethyl-6-phenylimino-1,3-dithiine (VI). a. A mixture of 0.34 g (1.2 mmol) of dianilide **I**, 0.12 g (1.4 mmol) of methyl propiolate (**II**), and 10 ml of anhydrous methanol was stirred for 30 h at 20°C. The reaction mixture was cooled to 0°C, the separated precipitate was filtered off and washed on the filter with cold ether. Yield 0.17 g (32%)

orange crystals, mp 54–56°C. IR spectrum, ν , cm^{-1} : 1150 (COC), 1585 (C=C, C=N), 1685 (C=O), 3420 (NH). ^1H NMR spectrum, δ , ppm: 3.26 d (2H, CH_2 , J 7.2 Hz), 3.66 (3H, OCH_3), 5.40 t (1H, CHS, J 7.2 Hz), 6.08 br.s (1H, =CH), 7.30–7.42 m (10H, $2\text{C}_6\text{H}_5$), 11.45 s (1H, NH). ^{13}C NMR spectrum, δ , ppm: 39.41 (CHS), 43.70 (CH_2), 52.35 (OCH_3), 89.71 (=CH), 124.94, 127.90, 129.74, 136.62 (C_{arom}), 165.55 (C=N), 195.52 (C=O). Mass spectrum, m/z (I_{rel} , %): 370 [M] $^+$ (12), 280 (61), 279 (100), 265 (40), 251 (42), 219 (36), 207 (40), 148 (21), 110 (18), 91 (46), 77 (33), 65 (22), 44 (76), 39 (26). Found, %: C 61.41; H 4.72; N 7.80; S 17.00. $\text{C}_{19}\text{H}_{18}\text{N}_2\text{O}_2\text{S}_2$. Calculated, %: C 61.62; H 4.86; N 7.57; S 17.30.

b. The reaction of 0.34 g (1.2 mmol) of dianilide **I** with 0.12 g (1.4 mmol) of methyl propiolate (**II**) in anhydrous ethanol under similar conditions resulted in a yield 0.29 g (54%) of orange crystals, mp 54–56°C (benzene–hexane, 1:1).

4-Anilino-2-methoxycarbonylmethyl-1,3-dithiine-6-phenyliminium perchlorate (III). To 0.37 g

(1.0 mmol) of 1,3-dithiine **VI** was slowly added dropwise 1.0 ml of 58% perchloric acid, and the mixture was stirred for 3 h at 20°C. The reaction occurred with slight heat evolution, and the temperature rose to 35°C. The reaction mixture was cooled to 0°C, the separated crystals were filtered off, washed on the filter with water, cold ether, and dried in a vacuum. Yield 0.39 g (82%), yellow crystals, mp 150–151°C.

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