

CONDENSATION OF RHODANINE WITH  $\beta$ -DICARBONYL COMPOUNDS

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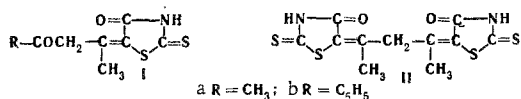
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Reaction of acetylacetone with rhodanine in ethanol solution, in the presence of ammonia and ammonium chloride gives two condensation products, containing one or two rhodanine groups. Under the same conditions benzoylacetone condenses with one molecule of rhodanine. Methylation of these compounds with methyl iodide takes place at an exocyclic sulfur atom, to give mono- and dimethylmercapto derivatives. The condensation products from the above carbonyl compounds and rhodanine have an active methylene group which can react with nitroso compounds and diazonium salts.

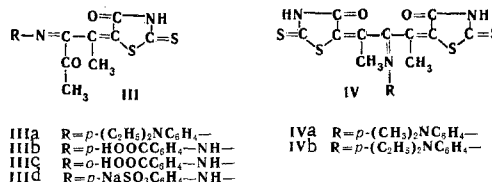
Hitherto only an inconsiderable number of  $\beta$ -dicarbonyl compounds have been brought to react with rhodanine, mainly acetoacetic ester and its derivatives [1, 2]. There, under the high temperature and pressure conditions used, condensation was accompanied by ester group saponification and decarboxylation, to give 5-alkylidene derivatives analogous to those obtained from rhodanine and the corresponding ketones [3-5]. Use of milder conditions of reaction of rhodanine with acetoacetic ester resulted in condensation only, and formation of 5-ethoxycarbonylisopropylidene-rhodanine [2].

The present work investigated the possibility of condensing rhodanine with acetylacetone and benzoylacetone in various solvents, such as methanol, ethanol, glacial acetic acid, and in the presence of various condensation catalysts, such as zinc chloride, sodium acetate, ammonia, and ammonium chloride. It was found that these dicarbonyl compounds react with rhodanine only in methanol or ethanol solution, in the presence of concentrated aqueous ammonia and ammonium chloride, to give products with the following structures:



In compound **Ia** the carbonyl of the acetyl group readily condenses with hydroxylamine, semicarbazide, and thiosemicarbazide, to give the corresponding derivatives. Reaction with rhodanine converts **Ia** to **II**. Compounds **Ia**, **Ib**, and **II** form brightly colored solutions with alkalis, which lose their color in the course of time, with accumulation of SCN<sup>-</sup> ions, indicating splitting of the thiazolidine ring. The carbonyl group of **Ib** exhibits depressed reactivity, and unlike compound **Ia**, it does not react with rhodanine and typical reagents for ketones.

The methylene group of compounds **Ia** and **II** is rather reactive, and reacts with nitroso compounds and diazonium salts to give deeply-colored compounds of structures **III** and **IV**.



Methyl iodide methylation of compounds **Ia** and **II** in the presence of sodium methoxide takes place at the exocyclic sulfur, giving methylmercapto derivatives.

## EXPERIMENTAL

**5-( $\alpha$ -Methyl- $\beta$ -acetyl)ethylidenerhodanine (Ia) and 2,4-bisrhodanilidenepentane (II).** A mixture of 13.3 g (0.1 mole) rhodanine, 10 ml acetylacetone, 5 g NH<sub>4</sub>Cl, 5 ml conc. ammonia, and 50 ml EtOH was refluxed for 15 hr. The yellow crystals of **II** formed were filtered off, and washed with boiling EtOH and water. Yield 4.2 g (25%), yellow needles, mp over 246° C (ex dioxane), insoluble in alcohols, acetone, CHCl<sub>3</sub>, dichloroethane, AcOH, and benzene, readily soluble in alkalis, giving bright-blue solutions. Heating brought about rapid decolorization of the solutions, and the thiocyanate ion was found in them. Found: N 8.66; S 38.36%. Calculated for C<sub>11</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>S<sub>4</sub>: N 8.48; S 38.81%.

On cooling the EtOH filtrate deposited 9.7 g (45%) **Ia** crystals, colorless needles, mp 170°-171° C (ex EtOH), soluble in alcohols, acetone, and AcOH. When an EtOH solution of **Ia** was boiled with aqueous ammonia plus ammonium chloride, yellow crystals of **II** formed. Found: N 6.19; S 29.97%. Calculated for C<sub>8</sub>H<sub>9</sub>NO<sub>2</sub>S<sub>2</sub>: N 6.51; S 29.78%.

**5-( $\alpha$ -Methyl- $\beta$ -benzoyl)ethylidenerhodanine (Ib).** 2.25 g (0.017 mole) rhodanine and 1.62 g (0.01 mole) benzoylacetone were dissolved in 10 ml MeOH containing 3 g NH<sub>4</sub>Cl and 3 ml conc. ammonia, and the whole refluxed for 10 hr. After distilling off the solvent the residue was treated with 5% NaOH (to decompose unreacted rhodanine), and the alkali-insoluble benzoylacetoneamine filtered off, the filtrate acidified with HCl, to give a yellow precipitate of **Ib**, yield 0.31 g (11%), pale-yellow acicular crystals, mp 177° C (ex 50% EtOH); soluble in alcohols, CCl<sub>4</sub>, and AcOH. It dissolved in alkalis to give rose-colored solutions. Found: N 5.49; S 22.84%. Calculated for C<sub>13</sub>H<sub>11</sub>NO<sub>2</sub>S<sub>2</sub>: N 5.05; S 23.12%.

**Ia semicarbazone.** 3 ml of an aqueous solution containing 0.56 g (0.005 mole) semicarbazide hydrochloride and 0.5 g NaOAc, was added to an EtOH

solution of 0.53 g (0.0025 mole) **Ia**, the whole left for 24 hr, then 20 ml water added, and the solid filtered off, yield 0.6 g (88%) pale-yellow **Ia** semicarbazone, forming, on recrystallization from EtOH, colorless flat plates, mp 195° C (ex EtOH). Found: N 20.00; S 23.41%. Calculated for  $C_9H_{12}N_4O_2S_2$ : N 20.57; S 23.54%.

**Ia thiosemicarbazone.** Prepared similarly to the semicarbazone, from **Ia** and thiosemicarbazide hydrochloride, yield 70%. Colorless plates, mp 206° C (ex EtOH). Found: N 20.14; S 33.93%. Calculated for  $C_9H_{12}N_4OS_3$ : N 19.43; S 33.35%.

**Ia oxime.** Prepared similarly to the semicarbazone, from **Ia** and hydroxylamine HCl, yield 85%. Colorless crystals mp 177° C. Found: N 12.75; S 28.24%. Calculated for  $C_8H_{10}N_2O_2S_2$ : N 12.17; S 27.84%.

**Condensation of Ia with p-nitrosodiethylaniline (IIIa).** 1.07 g (0.005 mole) **Ia** and 0.89 g p-nitrosodiethylaniline were dissolved in 20 ml MeOH, kept 24 hr at room temperature, the solution diluted with water, the solid filtered off, dissolved in 5% ammonia, and precipitation effected with AcOH, to give 1.22 g (65%) of the desired compound. Brown solid, mp 109°–110° C, soluble in alcohols, dioxane,  $CHCl_3$ , toluene, AcOH, HCl, and alkalis. Found: N 11.34%. Calculated for  $C_{18}H_{21}N_3O_2S_2$ : N 11.20%.

**Condensation of II with p-nitrosodiethylaniline (IVb).** 1.65 g (0.005 mole) **II** and 0.89 g (0.005 mole) p-nitrosodiethylaniline were dissolved in 25 ml dioxane, and refluxed for 30 min. After cooling, unreacted **II** was filtered off, and the filtrate diluted with water. The dark precipitate formed was filtered off, and dissolved in 5% aqueous ammonia, then precipitated with AcOH. Yield of violet-black solid 1.8 g (73%), mp 138° C. Found: N 11.36%. Calculated for  $C_{21}H_{22} \cdot N_4O_2S_4$ : N 11.43%. The compound was soluble in  $Me_2CO$ , alcohols, and dioxane; it dissolved when heated with HCl, forming a yellow hydrochloride.

**Condensation product from II and p-nitrosodimethylaniline (IVa).** Prepared similarly to IVb, from **II** and p-nitrosodimethylaniline, yield 70%. Blackish-violet compound, mp 158° C. Found: N 12.21%. Calculated for  $C_{19}H_{18}N_4O_2S_4$ : N 12.11%.

**5-[ $\alpha$ -Methyl- $\beta$ -acetyl- $\beta$ -(p-carboxy)phenylhydrazo]ethylidenerhodanine (IIIb).** An equimolecular quantity of p-carboxylbenzenediazonium chloride was added to a solution, cooled to 0°, of 1.07 g (0.005 mole) **Ia** in 30 ml 8% aqueous ammonia, after which the mixture was acidified with HCl and 1 g (55%)

solid product isolated. It was dark-red, and did not melt when heated to 225° C. It was readily soluble in organic solvents. Found: N 11.51; S 17.27%. Calculated for  $C_{15}H_{13}N_3O_4S_2$ : N 11.56; S 17.64%.

**5-[ $\alpha$ -Methyl- $\beta$ -acetyl- $\beta$ -(o-carboxy)phenylhydrazo]ethylidenerhodanine (IIIc).** Prepared similarly to IIIb, from **Ia** and o-carboxylbenzenediazonium chloride, yield 66%. It formed a microcrystalline red powder, mp 224° C, readily soluble in organic solvents. Found: N 12.04; S 17.83%. Calculated for  $C_{15}H_{13}N_3O_4S_2$ : N 11.56; S 17.64%.

**5-[ $\alpha$ -Methyl- $\beta$ -acetyl- $\beta$ -(p-sulfo)phenylhydrazo]ethylidenerhodanine (IIIId).** Prepared from **Ia** and p-benzenesulfonic acid diazonium chloride. The compound was isolated as its Na salt, by salting out, with NaCl, from a HCl solution. Yield 1.5 g (75%), dark-brown powder (ex water). Found: N 9.34; S 21.13%. Calculated for  $C_{14}H_{12}NaN_3O_5S_3$ : N 9.48; S 21.69%.

**Methylmercapto derivative of Ia (VIII).** Prepared by treating an EtOH solution of **Ia** with MeI in the presence of MeONa. The EtOH was evaporated off, along with excess MeI, the residue dissolved in water, and acidified with HCl. Pale-yellow compound, mp 118° C (ex aqueous EtOH), soluble in alkalis and HCl. The mercaptan was precipitated when these solutions were boiled. Found: N 6.00; S 27.10%. Calculated for  $C_9H_{11}NO_2S_2$ : N 6.11; S 27.96%.

**Dimethylmercapto derivative of II (IX).** Prepared similarly to VII, from MeI and **II**. Dark-red compound, mp 223° C. Found: N 7.86; S 35.19%. Calculated for  $C_{13}H_{14}N_2O_2S_4$ : N 7.82; S 35.72%.

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