ture of 3.2 g (20 mmoles) of 2-mercaptoquinoline, 4.5 g (20 mmoles) of dichloronaphthoquinone, and 25 ml of acetic acid was heated to boiling. The hot solution was filtered from the precipitated thianthrene [2]. To the hot filtrate was added 3 ml of 58% perchloric acid. After cooling, the precipitate was filtered off and washed with acetic acid and acetone. PMR spectrum (CF_3COOD): 8.86 (1H, d, 6-H, J = 9 Hz), 8.78 (1H, d, 1-H, J = 8 Hz), 8.54 (1H, d, 5-H, J = 9 Hz), and 8.0-8.5 ppm (7H, m).

5-Methyl-8,13-dioxo-8,13-dihydronaphtho[2',3':4,5]thiazolo[3,2-*a*]quinolinium perchlorate (VIIb) was obtained analogously to (VIIa) from 2-mercaptolepidine. PMR spectrum (CF_3COOD): 8.0-8.7 (9H, m) and 3.10 ppm (3H, s, CH_3).

5-(p-Dimethylaminostyryl)-8,13-dioxo-8,13-dihydronaphtho[2',3':4,5]thiazolo[3,2-*a*]quinolinium perchlorate (IX). A mixture of 0.4 g (1 mmole) of perchlorate (VIIb), 0.15 g (1 mmole) of p-dimethylaminobenzaldehyde, and 3 ml of acetic anhydride was boiled for 5 min. After cooling the precipitated product was filtered off and washed with acetic anhydride.

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SYNTHESIS OF 4-SUBSTITUTED 2-AMINOTHIAZOLES AND THIAZOLIUM SALTS DERIVED FROM 2-CHLOROACETYL-1,3-CYCLOHEXANEDIONES

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The reaction of 2-chloroacetyl-1,3-cyclohexanediones with thiourea and substituted thioureas forms 2-amino-4-(1,3-dioxo-2-cyclohexyl)thiazolium chlorides; in the presence of triethylamine 2-aminothiazole bases are formed.

We have previously found that the action of nucleophilic reagents on 2-chloroacetyl-1,3-cyclohexanediones (Ia, b) causes a nucleophilic intramolecular heterocyclization that leads to the formation of 3,4-dioxo-2,3,4,5,6,7-hexahydrobenzo[b]furanes (IIa, b) [1]; α-halocarbonyl compounds, however, react by bimolecular nucleophilic substitution [2]. Since β-triketones are completely enolized and are highly acidic [3-5], the strong anionic nucleophiles that we took for the reaction do not react with the chloroacetyl group; instead they remove a proton from the β-triketone to form an enolate that favors intramolecular attack by the chloroacetyl group, so that hexahydrobenzofurane (II) is obtained.

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TABLE 1. Properties of Compounds (IIIa-d), (IV), and (V)

Compound	Empirical formula	Reaction time, h	T_{mp} °C*	M*	IR spectrum, ν, cm⁻¹	UV spectrum, λ_{max}, nm (log ε)	PMR spectrum, δ, ppm**	Yield, %
IIIa	$C_9H_{10}N_2O_2S \cdot HCl$	24	138...140	210	1560, 1645, 3210, 3410, 3470	221 (4,10), 229 (4,06), 278 (4,04), 294 (4,03)	1,68 (2H, m 5′-H); 2,34 (4H, t, 4′-H, 6′-H); 6,98 (1H, s, 5-H)	64
IIIb	$C_{11}H_{14}N_2O_2S \cdot HCl$	24	154...156	238	1555 sh, 1620, 3260, 3430	221 (4,09), 232 (4,01), 268 (4,01), 295 (3,97)	0,97 (6H, s, 5′-CH_3); 2,45 (4H, s, 4′-H, 6′-H); 7,62 (1H, s, 5-H)	73
IIIc	$C_{15}H_{14}N_2O_2S \cdot HCl$	24	168...171	266	1565 sh, 1625, 3260, 3440	200 (4,33), 251 (4,29), 307 (4,17)	2.05 (2H, m, 5′-H); 2,67 (4H, t, 4′-H, 6′-H); 7,33 (1H, s, 5-H); 7,46 (5H, m Ar)	88
IIId	$C_{17}H_{18}N_2O_2S \cdot HCl$	60	169...172	314	1565 sh 1625, 3260, 3440	200 (4,32), 250 (4,26), 307 (4,17)	1,13 (6H, s 5′-CH_3); 2,19 (4H, s, 4′-H, 6′-H); 7,21 (1H, s, 5-H); 7,43 (5H, m, Ar); 7,70 (1H, s NH)	83
IV	$C_{25}H_{26}N_2O_4S \cdot HCl$	48	198...203	450	1570, 1635 sh 3150, 3450	200 (4,69), 218 (4,36), 277 (4,28)	0,60 (3H, s, 5′-CH_3); 1,00 (3H, s 5′-CH_3); 2,28 (2H, s, 6′-H); 2,40 (2H, s, 4′-H); 3,86 (3H, s, CH_3O); 3,97 (3H, s, CH_3O); 6,70 (1H, s, 5-H); 7,07 (4H, m Ar); 7,43 (4H, s Ar)	66
V	$C_{11}H_{14}N_2O_2S$	3	252...255	238	1560, 1680, 2490...3300, 3440	221 (4,16), 268 (4,07), 300 (4,05)	1,00 (6H, s 5′-CH_3); 2,30 (4H, s, 4′-H, 6′-H); 7,18 (1H, s 5-H); 7,77 (2H, s NH_2); 15,68 (1H, s, OH)	72

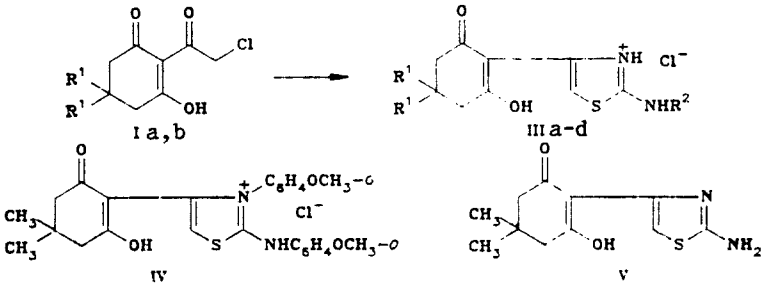
*(IIIa, d) were crystallized from acetone; (IIIb) from alcohol–ether; (IIIc) from 5:1 alcohol–ether; (IV) from ether.

**Spectra of (IIIa, b) were obtained in pyridine-D_5, (IIIc) in $CDCl_3$–10% CD_3OD; (IIId, IV) in $CDCl_3$; (V) in DMSO-D_6.

TABLE 2. ^{13}C NMR Spectra of Compounds (IIIa-d) and (IV)

Compound	Chemical shifts, δ, ppm (in 2:1 CD_3OD–CH_3OH, 2:1)									
	$C_{(2)}$, s	$C_{(4)}$, s	$C_{(5)}$, d	$C_{(1')}$, s	$C_{(2')}$, s	$C_{(3')}$, s	$C_{(4')}$, t	$C_{(5')}$	$C_{(6')}$, t	Other C
IIIa	170,2	133,1	104,9	190,7	105,9	190,7	34,7	21,0 t	34,7	28,1 q (5′-CH_3)
IIIb	170,1	133,5	104,7	189,4	104,7	189,4	48,2	32,4 s	48,2	122,5 d; 122,9 d; 128,1 d; 128,7 d; 131,4 d; 139,1 s (Ph)
IIIc	166,8	136,0	104,9	191,5	105,7	191,5	34,7	21,1 t	34,7	28,1 q (5′-CH_3); 122,4 d; 128,0 d; 131,3 d; 138,8 s (Ph)
IIId	166,8	135,1	104,6	190,1	104,6	190,1	48,1	32,4 s	48,1	29,3 q (CH_3); 26,8 q (CH_3); 56,5 q (CH_3O); 56,6 q (CH_3O); 114,0 d; 114,2 d; 122,0 d;
IV	172,0	137,4	108,0	190,8	105,9	187,4	47,8	32,3 s	46,8	122,5 s; 122,6 d; 127,0 s; 128,6 d; 130,3 d; 132,1 d; 134,1 d; 155,7 s; 156,6 s (Ar)

On the basis of the proposed mechanism it might be presumed that strong nucleophiles of relatively low basicity, such as thiourea [6], could react with the chloroacetyl group but not with the β-triketone enol. The cyclocondensation of α-halocarbonyl compounds with thiourea or N-substituted thioureas is the most efficient way to synthesize 2-aminothiazoles and their N-substituted derivatives (the Hantzsch reaction) [7]. In this connection, in order to study the possible reaction at the chloroacetyl group and the synthesis of 2-aminothiazoles and thiazolium salts we studied the reaction of triketones (Ia, b) with thiourea and N-phenylthiourea, as well as the reaction of triketone (Ib) with N,N'-di(2-methoxyphenyl)thiourea.



I a, b

III a-d

IV

V

I a R^1=H, b R^1=Me; III a R^1=R^2=H; b R^1=Me, R^2=H; c R^1=H, R^2=Ph; d R^1=Me, R^2=Ph

The reaction of (Ia, b) with thiourea and N-phenylthiourea gave the hitherto unknown 2-aminothiazolium chlorides containing a cyclohexane-1,3-dione radical in position 4 (IIIa-d). The reaction of (Ib) with N,N'-di(2-methoxyphenyl)thiourea formed thiazolium chloride (IV). Previously, except for one mentioned in [8], 2-aminothiazoles having a cycloalkane substituent in position 4 of the thiazole ring had not been described.

The mass spectra of (IIIa-d) and (IV) contain peaks of the molecule ions M^+ that correspond to the calculated molecular weights of the respective bases. The IR spectra of (IIIa-d) and (IV) (Table 1) show absorption bands at 3100-3450 cm^{-1} (NH, OH), 1620-1645 cm^{-1} (C=O of the β-diketone enol), and 1560-1565 cm^{-1} (thiazole ring). The absence of a ketone carbonyl band from the IR spectra indicates that in (IIIa-d) and (IV) the cyclohexane-1,3-dione radical at position 4 is in the enol form.

All the PMR spectra contain signals of the proton of $C_{(5)}$ of the thiazole ring at 6.70-7.62 ppm, and signals of the protons of the cyclohexane ring and the aromatic substituents. The absence of a signal of cyclohexane 2-H confirms the enolization of the cyclohexane-1,3-dione segment of these compounds.

The ^{13}C NMR spectra of (IIIa-d) and (IV) (Table 2) contain, besides the signals of other carbon atoms, the signals of all the thiazole ring carbons [9, 10], while the $C_{(5)}$ signal in spectra with partial isolation from ^1H appears as a doublet; this confirms the presence of a substituent at position 4 of the thiazole ring. In the ^{13}C NMR spectra, comparison of chemical shifts of (IIIa-d) with those of 2-aminothiazoles [9, 10] indicates that the thiazole $N_{(3)}$ is protonated; this agrees with the data of [9, 11, 12].

The reaction of (Ib) with thiourea in the presence of triethylamine forms the 2-aminothiazole base (V). The PMR spectrum of (V) contains, along with the signals of the thiazole and cyclohexane-1,3-dione protons, an NH_2 signal at 7.77 ppm, and the signal of the strongly bonded OH proton at 15.68 ppm. The presence of the latter and the absence of the signal of the cyclohexane 2-H indicate that the cyclohexane-1,3-dione ring is completely enolized. This conclusion is confirmed by the IR data.

It can be assumed that the hydroxyl of 2-aminothiazole (V) forms an intramolecular hydrogen bond with the thiazole nitrogen. When the nitrogen is completely protonated, as in the case described in [13], its signal is most likely to be located in the stronger field.

EXPERIMENTAL

IR spectra were obtained in KBr tablets with a UR-20 instrument; UV spectra were obtained in ethanol with a Specord UV-vis instrument; PMR spectra were obtained with Jeol JNM-PS-100 and Bruker WM-360 instruments; ^{13}C NMR spectra were obtained with a Bruker WM-360 instrument (90.56 MHz), with TMS as internal standard. Mass spectra were obtained with a Varian MAT-311 instrument at 70 eV ionizing voltage. The course of the reaction was monitored by TLC on Silufol UV-254 plates, using ether and ethyl acetate.

Elemental composition (C, H, N) agreed with the calculated values.

2-Amino-4-(1,3-dioxo-2-cyclohexyl)thiazole Hydrochloride (IIIa). To a solution of 0.59 g (3.1 mmoles) of triketone (Ia) in 20 ml of absolute acetone at room temperature was added a solution of 0.253 g (3.3 mmoles) of thiourea in 10 ml of acetone. After 24 h the crystals were filtered off, washed with acetone, and dried.

Compounds (IIIb-d) and (IV) were obtained similarly.

2-Amino-4-(5,5-dimethyl-1,3-dioxo-2-cyclohexyl)thiazole (V). To a solution of 10 g (46.2 mmoles) of (Ib) in 20 ml of ethanol were added 3.52 g (46.2 mmoles) of thiourea and 6.5 ml (46.2 mmoles) of triethylamine. The precipitated crystals were filtered off and washed with acetone. Compound (V), 8 g (72.2%); mp 252-255°C (crystals darken at 235°C).

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