AMINOLYSIS OF 3-PHENYLSULFONYL-2(3H)-BENZOTHIAZOLONES BY SECONDARY CYCLIC AMINES

A. Ts. Antonova and D. Simov

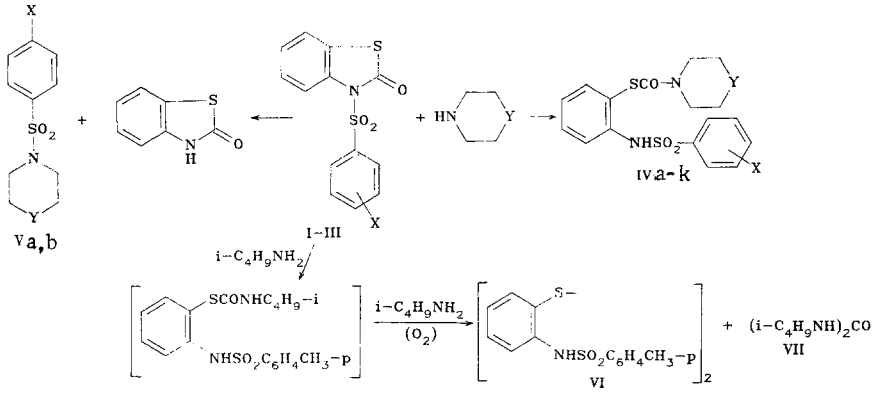
UDC 547.789.6'867.5;543.51'25'27.4

Derivatives of 2-benzenesulfonamidophenyl esters of N,N-disubstituted thiocarbamic acids, the structures of which were confirmed by the IR, PMR, and mass spectra, were obtained by the reaction of 3-phenylsulfonyl-2(3H)-benzothiazolones with secondary amines.

In previous communications [1, 2] we established that a phenylsulfonyl group in the 3 position of 2(3H)-benzothiazolone facilitates and changes the direction of opening of the heteroring by amines. The reaction with secondary cyclic amines leads to 2-benzenesulfonamidophenyl esters of N,N-disubstituted thiocarbamic acids, one of which has displayed herbicidal activity [2].

For further research on the synthesis and properties of 2-benzenesulfonamidophenyl esters of N-substituted thiocarbamic acids in the present research we studied the reaction of 3-(p-tolylsulfonyl)-, 3-(p-nitrophenylsulfonyl)-, and 3-(m-nitrophenylsulfonyl)-2(3H)-benzothiazolones (I-III) with some secondary cyclic and primary amines.

The heterocyclic ring of benzothiazolones I-III opens at the N–$C_{(2)}$ bond under the influence of secondary cyclic amines such as pyrrolidine, piperidine, morpholine, and 1-methylpiperazine in ethanol or in a medium of the reacting amine at 20-45°C. o-Substituted phenyl esters (IV) of thiocarbamic acids are obtained in 31-71% yields (Table 1).



I X=*p*-CH_3; II X=*p*-NO_2; III X=*m*-NO_2; Va X=CH_2, Y=CH_2; Vb X=CH_2, Y=O

In conformity with the literature data for thiocarbamates [1, 3], an intense band of a carbonyl group at 1665-1675 cm^{-1}, which is found at a higher frequency (1720 cm^{-1}) for the starting benzothiazolones, is observed in the IR spectra of IV. The appearance of an absorption band of NH stretching vibrations at 3330-3360 cm^{-1} and the presence of two bands at 1335-1350 and 1155-1160 cm^{-1} confirm the presence of a secondary sulfonamido group and demonstrates unambiguously that the heteroring is opened at the N–$C_{(2)}$ bond.

The data from the PMR spectra of thiocarbamates IVa-c and the mass spectrum* of S-[2-(benzenesulfonamido)phenyl]1-piperidinocarbothioate (IV*l*] are also in agreement with the pro-

*The mass-spectrometric measurements were made at M. V. Lomonosov Moscow State University, for which the authors express their thanks.

K. Okhridskii Sofia University, Sofia, Bulgaria 1126. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 6, pp. 765-768, June, 1984. Original article submitted September 17, 1983.

 0009-3122/84/2006-0618$08.50

posed structure. The PMR spectrum of thiocarbamate IVb contains a singlet of a methyl group at 2.4 ppm and signals of the protons of a piperidine ring at 1.7 and 3.52 ppm. The signal of the imino proton of the sulfonamido group is probably overlapped by the signals of the aromatic protons, since a multiplet with an integral intensity of 9 proton units is located at 7.0-7.92 ppm. A molecular-ion peak with m/z 376 (2.3%) was recorded in the mass spectrum of thiocarbamate IVl. The most intense peak corresponds to an isocyanate ion, as in the case of phenyl N,N-dimethylthiocarbamate [4]. The spectrum also contains peaks corresponding to the following fragments: Ph^+ at 77 (11.4), piperidine at 84 (7.2) and 85 (13.5), $PhSO_2^+$ at 141 (4.0), and $[M - 85]^+$ at 291 (2.3).

The aminolysis of benzothiazolones I-III with cyclic amines is a convenient method for the synthesis of phenyl esters of N,N-disubstituted thiocarbamic acids of the IV type that contain a bulky (sulfonamido in this case) substituent in the ortho position of the benzene ring. In contrast to other methods [5, 6] for the preparation of thiocarbamates, the utilization of phosgene and thiophenols is excluded here.

The sulfonamides V and 2(3H)-benzothiazolone that were isolated in some cases are evidently obtained as a result of transamination of the tosyl group of benzothiazolone I by the corresponding secondary cyclic amine.

Experiments with primary amines, viz., n-butyl-, isobutyl-, cyclohexyl- and benzylamine, showed that the reaction proceeds in a complex manner under the same conditions. The presence of several products in the reaction mixtures was established by thin-layer chromatography (TLC): from benzothiazolone I and isobutylamine we were able to isolate in ~50% yield bis[2-(p-toluenesulfonamido)phenyl] disulfide (VI) and N,N'-diisobutylurea (VII), which are products of additional aminolysis, as shown in [1].

EXPERIMENTAL

The IR spectra of solutions of the compounds in chloroform were recorded with a Specord 71 IR spectrometer. The PMR spectra of solutions in $CDCl_3$ were obtained with a Tesla BS 487C spectrometer (80 MHz) with tetramethylsilane as the internal standard. The mass spectrum was recorded with a JMS-01-SG-2 spectrometer at an ionization energy of 75 eV at 160°C. The course of the reaction and the purity of the compounds were monitored by TLC on plates with a fixed layer of SIF silica gel (Riedel) in a benzene–ethyl acetate system (5:1) with development in UV light and by means of iodine vapors. The melting points were determined in capillaries and were not corrected.

3-(p-Tolylsulfonyl)-2(3H)-benzothiazolone (I). This compound was obtained by the method described in [7]. IR spectrum: 1720 (CO); 1385, 1115 cm^{-1} (SO_2).

3-(p-Nitrophenylsulfonyl)-2(3H)-benzothiazolone (II). A 24.3-g (0.11 mole) sample of p-nitrobenzenesulfonyl chloride was added to a solution of 15.1 g (0.1 mole) of 2(3H)-benzothiazolone in 70-80 ml of dry pyridine, after which the mixture was allowed to stand at room temperature for 2 days. It was then poured into a tenfold amount of crushed ice, and the resulting precipitate was removed by filtration, washed with water, and treated with 5% sodium hydroxide. The alkali-insoluble benzothiazolone II was removed by filtration and washed with water until the wash water was neutral to give 2.6 g (77%) of a product with mp 205-209°C; recrystallization gave a product with mp 207-209°C (from ethanol). IR spectrum: 1720 (CO); 1390, 1350, 1115 cm^{-1}. Found: C 46.7; H 2.4; N 8.2; S 19.3%. $C_{13}H_8N_2O_5S_2$. Calculated: C 46.4; H 2.4; N 8.3; S 19.1%.

3-(m-Nitrophenylsulfonyl)-2(3H)-benzothiazolone (III). The similar reaction of 2(3H)-benzothiazolone and m-nitrobenzenesulfonyl chloride with standing for 4 days gave benzothiazolone III, with mp 149-151°C (from ethanol), in 70% yield. IR spectrum: 1715 (CO); 1525, 1385, 1345, 1105 cm^{-1}. Found: N 8.5; S 18.6%. $C_{13}H_8N_2O_5S_2$. Calculated: N 8.3; S 19.1%.

S-[2-(p-Toluenesulfonamido)phenyl] 1-Piperidinocarbothioate (IVb). A mixture of 1.52 g (5 mmole) of benzothiazolone I, 1.7 g [2 ml (20 mmole)] of piperidine, and 15 ml of ethanol was stirred at 40-45°C for 1.5 h. The reaction mixture gradually became a solution, after which a colorless precipitate of carbothioate IVb formed immediately. The precipitated IVb was removed by filtration and washed with 15 ml of ethanol. Water was added to the filtrate until a precipitate formed, and the mixture was acidified with 5% HCl. The precipitate that was liberated after standing for no less than an hour was removed by filtration and treated with 5% NaOH. The alkali-insoluble 1-(p-tolylsulfonyl)piperidine (Va) was recrystallized from ethanol–water (1:1) to give 0.18 g (15%) of a product with mp 101-103°C. The purified

TABLE 1. 2-Benzenesulfonamidophenyl Esters (IV) of N,N-Disubstituted Thiocarbamic Acids

Compound	X	Y[a]	Reaction time, h	mp,[b] °C	IR spectrum, cm^{-1}
IVa	*p*-CH_3	—	1,5	165—167	3360, 1675, 1335, 1155
IVb	*p*-CH_3	CH_2	1,5	167—169	3350, 1675, 1335, 1155
IVc	*p*-CH_3	O	6	164—165	3360, 1675, 1335, 1160
IVd	*p*-CH_3	NCH_3	4	133—135	3340, 1665, 1335, 1155
IVe	*p*-NO_2	—	4	141—143	3350, 1670, 1375, 1350, 1155
IVf	*p*-NO_2	CH_2	4	157—159	3340, 1665, 1400, 1350, 1150, 1120
IVg	*p*-NO_2	O	8	154—156	3340, 1670, 1400, 1350, 1160, 1110
IVh	*p*-NO_2	NCH_3	6	176—178	3330, 1670, 1525, 1400, 1350, 1160
IVi	*m*-NO_2	—	6	150—152	3360, 1670, 1375, 1350, 1155, 1120
IVj	*m*-NO_2	CH_2	5	120—122	3350, 1670, 1400, 1120, 1350, 1160
IVk	*m*-NO_2	O	6	145—147	3330, 1670, 1400, 1350, 1160, 1110

Compound	Found, %			Empirical formula	Calc., %			Yield, %
	C	H	N (S)		C	H	N (S)	
IVa	57,6	5,5	7,5	$C_{18}H_{20}N_2O_3S_2$	57,4	5,4	7,4	65
IVb	58,7	5,7	7,3	$C_{19}H_{22}N_2O_3S_2$	58,4	5,7	7,2	65
IVc	55,3	5,4	7,1	$C_{18}H_{20}N_2O_4S_2$	55,1	5,1	7,1	56
IVd			10,3 10,4	$C_{19}H_{19}N_3O_3S_2$			10,4	50
IVe	50,1	4,5	(15,7)	$C_{17}H_{17}N_3O_5S_2$	50,1	4,2	(15,7)	44
IVf	51,5	4,8	(14,9)	$C_{18}H_{19}N_3O_5S_2$	51,3	4,5	(15,2)	71
IVg	48,4	4,2	10,0	$C_{17}H_{17}N_3O_6S_2$	48,2	4,1	9,9	32
IVh	49,8	4,9	12,6	$C_{18}H_{20}N_3O_5S_2$	49,5	4,6	12,8	31
IVi	50,1	4,7	10,4	$C_{17}H_{17}N_3O_5S_2$	50,1	4,2	10,3	60
IVj	51,6	4,8	10,0	$C_{18}H_{19}N_3O_5S_2$	51,3	4,5	10,0	66
IVk	48,4	4,1	10,0	$C_{17}H_{17}N_3O_6S_2$	48,2	4,1	9,9	70

[a]The dash (IVa, e, i) indicates that Y = pyrrolidino. [b]Recrystallized from ethanol—water in ratios of 1:2 (IVa-c, f, i, j), 2:1 (IVd), 1:1 (IVe, g, h), and 1:3 (VIk).

product had mp 101-103°C. IR spectrum: 2940, 2860 m; 1445 m; 1340, 1150 s (SO_2). Compound Va was identical to 1-(p-tolysulfonyl)-piperidine [8].

Acidification of the alkaline filtrates gave 0.22 g of a mixture of IVb and Va. Crystallization from ethanol—water (2:1) gave another 0.14 g (5%) of carbothioate IVb.

Compound IVa was similarly obtained. PMR spectrum: 1.92 (t, 4H, CH_2), 2.35 (s, 3H, CH_3), 3.45 (t, 4H, CH_2), and 7.0-7.9 ppm (m, 9H, Ar and NH). Found: M^+ 376. $C_{18}H_{20}N_2O_3S_2$. Calculated: M 376.

S-[2-(p-Toluenesulfonamido)phenyl] 4-Morpholinocarbothioate (IVc). A 1.75-g (20 mmole) sample of morpholine was added to 1.52 g (5 mmole) of benzothiazolone I suspended in 15 ml of ethanol, and the mixture was stirred at 42-45°C for 6 h. It was then poured into 90-100 ml of water, and the aqueous mixture was acidified with 5% HCl. The resulting precipitate was washed with water and treated with 20-25 ml of 5% NaOH. Acidification of the alkaline filtrates precipitated morpholinocarbothioate IVc. PMR spectrum: 2.35 (s, 3H, CH_3), 3.60 [t, 4H, $N(CH_3)_2$], 3.68 [t, 4H, $O(CH_2)_2$], and 7.0-7.85 ppm (m, 9H, Ar and NH).

The alkali-insoluble product (0.4 g) was treated again with 5% NaOH, and 0.33 g of undissolved 4-(p-tolylsulfonyl)morpholine (Vb) was removed by filtration and crystallized from water—ethanol (2:1) to give 0.25 g (20%) of a product with mp 149-151°C (mp 146-147°C [9]). IR spectrum: 2960, 2860 m; 1350, 1145 cm^{-1} (SO_2). Compound Vb was identical to the product obtained by the following method. A solution of 2 g (11 mmole) of p-toluenesulfonyl chloride and 0.87 g (10 mmole) of morpholine in 10 ml of pyridine was stirred at 50°C for 2 h, after which it was maintained at room temperature for 20 h. It was then poured into 100 parts by volume crushed ice, and the resulting copious precipitate was removed by filtration and washed with water to give 1.95 g (81%) of a product with mp 150-152°C [from water—ethanol (2:1)].

Evaporation of the filtrates prior to the first treatment with alkali gave 0.1 g (13%) of 2(3H)-benzothiazolone.

Compounds IVe-g were similarly obtained from benzothiazolone II.

S-[2-(p-Toluenesulfonamido)phenyl] 4-Methyl-1-piperazinocarbothioate (IVd). A suspension of 1.52 g (5 mmole) of benzothiazolone I in 15 ml of ethanol and 2.2 ml [2 g (20 mmole)] of 1-methylpiperazine was stirred at 45°C for 3.5 h, during which the mixture was gradually converted to a solution. The ethanol was removed by vacuum distillation, water was added to the residue until the mixture became turbid (60-70 ml), and the mixture was neutralized with 5% HCl. The liquid was decanted from the resinous product, which was washed with water and crystallized from water–ethanol (2:1) (refluxing with charcoal).

S-[2-(p-Nitrobenzenesulfonamido)phenyl] 4-Methyl-1-piperazinocarbothioate (IVh). A suspension of 1.68 g (5 mmole) of benzothiazolone II in 17 ml of ethanol and 2 g (20 mmole) of 1-methylpiperazine was stirred at room temperature for 6 h, after which 100 ml of water was added, and the mixture was neutralized with 5% HCl and allowed to stand for 1 h. It was then treated with 20 ml of 5% NaOH, as a result of which 0.5 g (30%) of unchanged benzothiazolone II remained undissolved. Neutralization of the alkaline filtrates gave 1.1 g of carbothioate IVh. Compounds IVi, j, k were similarly obtained.

Bis[2-(p-toluenesulfonamido)phenyl] Disulfide (VI) and N,N'-Diisobutylurea (VII). A 1.52-g (5 mmole) sample of benzothiazolone I suspended in 15 ml of ethanol was stirred with 1.45 g (20 mmole) of isobutylamine at 40°C for 2.5 h, during which the mixture was gradually converted to a solution, and a precipitate formed again after 30 min. The mixture was treated with 150 ml of water, and the aqueous mixture was acidified with 5% HCl. The precipitate was removed by filtration, washed with water, and treated with 25 ml of 5% NaOH. The NaOH-insoluble precipitate of N,N'-diisobutylurea [0.45 g (52%)] had mp 133-135°C [from water–ethanol (2:1)] (mp 135-136°C [10]). IR spectrum: 3480 (NH_2); 1675 (C=O); 1390, 1370 cm^{-1}. The IR spectra of VII and N,N'-diisobutylurea [1] were identical. No melting-point depression was observed for a mixture of samples of these products.

Acidification of the alkaline filtrates gave 0.65 g (47%) of disulfide VI with mp 166-167°C [ethanol–water (3:1)] (mp 163-165°C [7]). IR spectrum: 3340 (NH); 1390, 1340, 1155 cm^{-1}. The IR spectra of VI and bis[2-(p-toluenesulfonamido)phenyl] disulfide [7] were identical. No melting-point depression was observed for a mixture of samples of these products.

LITERATURE CITED

1. D. Simov and A. Antonova, Khim. Geterotsikl. Soedin., No. 9, 1192 (1976).
2. D. Simov, A. Antonova, and E. Karanov, Bulgarian Inventor's Certificate No. 27153.
3. R. Nyquist and W. Potts, Spectrochim. Acta, 17, 679 (1961).
4. J. B. Thomson, P. Brown, and C. Djerassi, J. Am. Chem. Soc., 88, 4049 (1966).
5. R. Riemschneider and O. Lorenz, Monatsh. Chem., 84, 518 (1953).
6. N. N. Mel'nikov, The Chemistry and Technology of Pesticides [in Russian], Khimiya, Moscow (1974), p. 342.
7. H. Zinner and W. Nimmich, J. Prakt. Chem., 14, 139 (1961).
8. L. Gloves, E. Turner, and G. Sharp, J. Chem. Soc., No. 2, 512 (1929).
9. F. E. Scully, I. Bowdring, and K. Bowdring, J. Org. Chem., 46, 5077 (1981).
10. A. E. Dixon, J. Chem. Soc., 67, 556 (1895).