FUNCTIONAL DERIVATIVES OF THIOPHENE. XI.* THIOPHENE ANALOGS OF ISATIN — 4,5-DIOXOTHIENO[2,3-b]- AND 5,6-DIOXOTHIENO[3,2-b]PYRROLES

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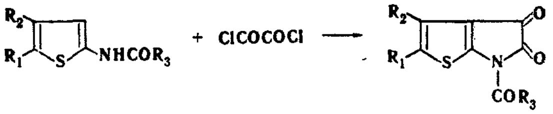
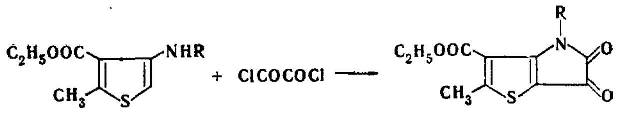
UDC 547.735'741:543.422.4.6

A method is proposed for the synthesis of isatin analogs — 4,5-dioxothieno[2,3-b]pyrroles and 5,6-dioxothieno[3,2-b]pyrroles — by reaction of oxalyl chloride with amino-substituted α-amino- and β-aminothiophene. The thiosemicarbazones of 4-aryl-5,6-dioxothieno[3,2-b]pyrroles were synthesized.

For the first time we have synthesized isatin analogs — 4,5-dioxothieno[2,3-b]pyrroles (I-III) and 5,6-dioxothieno[3,2-b]pyrroles (IV-VII) — by the action of oxalyl chloride on substituted aminothiophenes [2].



I-III

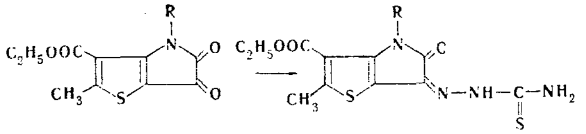


IV-VII

I $R_1=R_2=CH_3$, $R_3=C_6H_5$; II $R_1R_2=(CH_2)_4$, $R_3=C_6H_5$; III $R_1R_2=(CH_2)_4$, $R_3=4\text{-}CH_3C_6H_4$; IV $R=COC_6H_5$; V $R=C_6H_5$; VI $R=4\text{-}CH_3C_6H_4$; VII $R=4\text{-}CH_3OC_6H_4$

Whereas the synthesis of isatins from aromatic amines and oxalyl chloride is realized under severe conditions only by the action of aluminum chloride [3], the synthesis of I-VII, owing to the high reactivity of 2-amino- [4] and 3-aminothiophene [5] derivatives, proceeds extremely readily and without the use of any catalyst. The reaction of 2-aroylaminothiophene derivatives with oxalyl chloride is carried out at room temperature in ether or in dichloroethane at 35-40°C. 3-Arylaminothiophene derivatives react with oxalyl chloride in ether at temperatures below —5°.

The IR spectra of dioxothienopyrroles I-VII contain three intense absorption bands at 1700-1800 cm^{-1}, which correspond to the vibrations of carbonyl groups; this in in agreement with the spectra of substituted isatins [6]. Like isatin, the dioxothienylpyrroles form thiosemicarbazones (VIII-X).



V-VII VIII-X

V, VIII $R=C_6H_5$; VI, IX $R=4\text{-}CH_3C_6H_4$; VII, X $R=4\text{-}CH_3OC_6H_4$

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*See [1] for communication X.

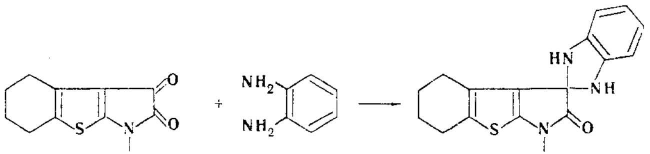
S. Ordzhonikidze All-Union Scientific-Research Pharmaceutical-Chemistry Institute, Moscow. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 6, pp. 767-769, June, 1975. Original article submitted July 10, 1974.

TABLE 1. Characteristics of the Compounds Obtained

Compound	mp, °C	Empirical formula	Found, %				Calculated, %				Yield, %, by method	
			C	H	N	S	C	H	N	S	A	B
I	185—186	$C_{15}H_{11}NO_3S$	63,0	3,7	4,8	11,2	63,1	3,9	4,9	11,2	28,6	49
II	172—173	$C_{17}H_{13}NO_3S$	65.6	4,2	4,1	10,0	65,6	4,2	4,5	10,3	50	51,6
III	188—189	$C_{18}H_{15}NO_3S$	66.7	4,8	4,4	10,0	66,4	4,6	4,3	10,0	—	58,5
IV*	212—213	$C_{17}H_{13}NO_5S$	59,5	3,8	4,1	9,4	59,5	3,8	4,1	9,3	—	37,7
V	181—182	$C_{16}H_{13}NO_4S$	60,7	4.4	4,7	10,3	60,9	4,2	4,4	10,2	34	
VI	177—178	$C_{17}H_{15}NO_4S$	62,0	4,6	4,3	9,9	62,0	4,6	4,2	9,7	20	
VII	152—153	$C_{17}H_{15}NO_5S$	59,2	4,5	4,0	9,3	59,1	4,4	4,1	9,3	12,6	
VIII	218—219	$C_{17}H_{16}N_4O_3S_2$	52,5	4,1	14,6	16,4	52,5	4,2	14,4	16,5	54	
IX	280—281	$C_{18}H_{18}N_4O_3S_2$	53,8	4,5	13,8	15,9	53,7	4,5	13,9	15,9	63,6	
X	234—235	$C_{18}H_{18}N_4O_4S_2$	51,8	4,3	13,2	15,4	51,7	4,3	13,4	15,3	55,5	

*Compound IV was obtained by refluxing the reaction solution for 3 h.

Like isatin [6], dioxothienylpyrrole II reacts with o-phenylenediamine to give derivatives XI.



II

XI

EXPERIMENTAL METHOD

The IR spectra of mineral oil suspensions of the compounds were recorded with a UR-20 spectrometer.

4,5-Dioxothieno[2,3-b]pyrroles (I-III). A) A solution of 0.014 mole of oxalyl chloride in 30 ml of absolute ether was added at 1-5° to a solution of 0.01 mole of 2,3-dialkyl-5-aroylaminothiophene in 400 ml of absolute ether, after which the mixture was allowed to stand at room temperature for 20 h. The solvent was then removed by distillation to give 4,5-dioxothieno[2,3-b]pyrrole (see Table 1).

B) A solution of 0.014 mole of oxalyl chloride in 5 ml of dry dichloroethane was added at 10-15° to a solution of 0.01 mole of 2,3-dialkyl-5-aroylaminothiophene in 175 ml of dry dichloroethane, after which the mixture was held at 30-40° for 1 h. It was then cooled and washed successively with sodium bicarbonate solution and water until the wash waters were neutral. The dichloroethane was removed by distillation to give I-III.

5,6-Dioxothieno[3,2-b]pyrroles (V-VII). A solution of 0.04 mole of 2-methyl-3-carbethoxy-4-arylaminothiophene in 50 ml of absolute ether was added at below –5° in the course of 15 min to a solution of 0.07 mole of oxalyl chloride in 50 ml of absolute ether, and the resulting precipitate was separated and washed with ether. See Table 1 for data on V-VII.

5,6-Dioxothieno[3,2-b]pyrrole Thiosemicarbazones (VIII-X). A solution of 1 mmole of thiosemicarbazide hydrochloride in 1 ml of water was added to a solution of 1 mmole of 5,6-dioxothieno[3,2-b]pyrrole in 15 ml of dioxane–methanol (1:2), and the mixture was allowed to stand at room temperature for 48 h. The resulting precipitate was removed by filtration and washed with water and methanol. See Table 1 for data on VIII-X.

Spiro[(1,2-dihydrobenzimidazolyl)-2,4'-(6'-benzoyl-5'-oxo-2',3'-tetramethylenethieno)-[2,3-b]pyrrole] (XI). A solution of 4 mmole of II and 4 mmole of o-phenylenediamine in 45 ml of acetic acid was heated on a water bath for 30 min, after which it was cooled, and the precipitated XI was removed by filtration. An additional amount of XI was isolated from the mother liquor by dilution with water. The overall yield of XI, with mp 264-265° (from alcohol), was 77.4%. Found: C 68.7; H 4.8; N 10.6; S 7.9%. $C_{22}H_{19}N_3O_2S$. Calculated: C 68.8; H 4.8; N 10.5; S 8.0%.

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