THIOUREA DERIVATIVES OF β-DICARBONYL COMPOUNDS

X. SYNTHESIS OF ISOINDOLO[2',3':3,4]IMIDAZOLE-2-THIONES

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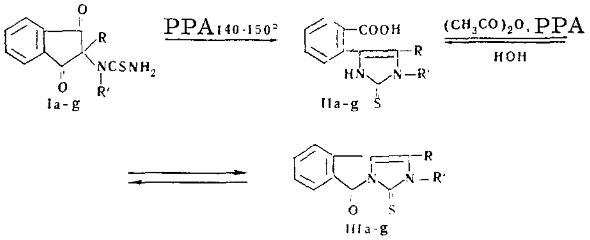
Under the action of polyphosphoric acid (PPA), N-2-aryl- and N-(2-methylindan-1,3-dion-2-yl)thioureas are converted into isoindolo[2',3':3,4]imidazole-2-thione derivatives (III), which can also by synthesized by cyclizing derivatives of 4-(o-carboxyphenyl)imidazole-2-thiones (II) by means of PPA or acetic anhydride. The interconversion of III and II under the action of alkalis and cyclizing agents has been shown. Their structures have been confirmed by IR and UV spectroscopy.

Our investigation of the reactions of N-aryl- and N-methylindandion-2-ylthioureas (I) [1, 2] has shown that in concentrated sulfuric acid the carbon skeleton of the diketone system is modified with the formation of imidazole-2-thione derivatives (II). PPA containing 82–84% of P_2O_5 is less acidic than concentrated sulfuric acid but is a good cyclizing agent [3] and converts I into yellow crystalline substances sparingly soluble in polar and insoluble in nonpolar solvents (Table 1, method A). The same substances can be synthesized by the intramolecular cyclization of II (Table 1, method B). Thus, it has been shown by independent synthesis that these compounds have the structure of 1'-oxo-5-R-1-R'-isoindolo[2',3':3,4]imidazole-2-thiones (III). The splitting out of a molecule of water from II takes place readily when they are treated with acetic anhydride or PPA



I-III a R = R' = H; b R = C_6H_5, R' = H; c R = C_6H_5, R' = CH_3;

d R = C_6H_5, R' = C_2H_5; e R = C_6H_5, R' = $CH_2-C_6H_5$;

f R = R' = CH_3; g R = CH_3, R' = C_2H_5

In spite of the fact that in the solid state thioureidoindan-1,3-diones exist in the cyclic form [4], these reactions show that when they are dissolved in concentrated sulfuric acid and PPA they react in the open form I. Under these conditions, the hydrolytic cleavage of the indandione ring and the cyclization of the II formed as intermediates into III takes place. Compounds II, which are the final products in the transformation of I under the action of concentrated sulfuric acid, could not be isolated in the reactions using PPA.

Under the action of alkalis, compounds III are readily cleaved with the formation of II.

In the solid state, the IR spectra of III are characterized by a strong ν_{CO} absorption band at 1740–1750 cm^{-1}, which is frequently split into two (IIId, IIIf, and IIIh) (Table 2). However, in solutions these compounds exhibit only one strong carbonyl absorption band in the 1750–1760 cm^{-1} range. The fact that the compounds with several carbonyl absorption frequencies and with a single one belong to the same structural type is confirmed by the UV spectra of these compounds, which are similar—λ_{max}, nm (log ε): 260 (4.30), 310 (3.95), and 425 (3.90).

The phenomenon of the splitting of the C=O absorption bands in cyclic lactones containing a C=C bond conjugated with the carbonyl is known [5]. It is considered that the cause of the splitting is Fermi resonance with an overtone. However, in many cases such an explanation of the splitting is the C=O is difficult. It is possible that this is connected with differences in the structure of the solid material.

Compound III shows $\nu_{C=C}$ arom. 1612–1579 cm^{-1} and $\nu_{C=C}$ 1642–1652 cm^{-1}. Compounds IIIa and IIIb have ν_{NH} at about 3100 cm^{-1}.

EXPERIMENTAL

1-Ethyl-1'-oxo-5-phenylisoindolo[2',3':3,4]imidazole-2-thione (IIId). **Method A.** a) With heating to 140–150° C, 2.0 g of Id was dissolved in 15 ml of PPA, and the solution was kept at this temperature for about 5 min, cooled, and poured on to ice. On the following day the precipitate was filtered off; yield of IIId 1.67 g (88%). Mp 192–193° C (from a mixture of dioxane and ethanol).

b) With heating to 140–150° C, 0.40 g of IId was dissolved in 4 ml of PPA, and the solution was kept at this temperature for 30 min, cooled, and poured onto ice. On the following day the precipitate was filtered off giving a yield of IIId of 0.34 g (90%), mp 192–193° C (from a mixture of dioxane and ethanol), showing no depression of the melting point with samples obtained by methods A and B.

1-Benzyl-1'-oxo-5-phenylisoindolo[2',3':3,4]imidazole-2-thione (IIIe). Method B. A solution of 0.5 g of IIe in 2 ml of acetic anhydride was boiled for a few minutes and was cooled and the precipitate was filtered off. This gave 0.40 g (84%) of IIIe, mp 202–204° C (from dioxane).

The other compounds of type III were obtained similarly by methods A and B.

Hydrolysis of 1-ethyl-1'-oxo-5-phenylisoindolo[2',3':3,4]imidazole-2-thione (IIId). A solution of 0.25 g of IIId in a small amount of dioxane was treated with 1 ml of 5% NaOH and the mixture was heated

Table 1

1'-Oxo-5-R-1-R'-isoindolo[2',3':3,4]imidazole-2-thiones

Compound	R	R'	Method	Mp, °C	Empirical formula	Found, %				Calculated, %				Yield, %
						C	H	N	S	C	H	N	S	
IIIa	H	H	B	230—247*	$C_{10}H_6N_2OS$	59.40	3.08	14.00	15.98	59.21	2.99	13.85	15.87	98
IIIb	C_6H_5	H	A	300—306*	$C_{16}H_{10}N_2OS$	—	—	10.09	11.41	69.02	3.62	10.07	11.52	84
			B	300—304*		68.80	3.44	10.09	11.40					80
IIIc	C_6H_5	CH_3	A	221—223	$C_{17}H_{12}N_2OS$	—	—	9.68	10.49	69.85	4.13	9.58	10.96	95
			B	221—223		69.50	3.97	9.63	10.96					85
IIId	C_6H_5	C_2H_5	A	192—193	$C_{18}H_{14}N_2OS$	—	—	9.31	10.44	70.57	4.60	9.14	10.46	88
			B	192—193		70.71	4.76	9.17	10.34					83
IIIe	C_6H_5	$CH_2C_6H_5$	A	200—202	$C_{23}H_{16}N_2OS$	—	—	7.63	8.61	74.98	4.37	7.60	8.70	84
			B	200—202		74.84	4.33	7.45	8.79					84
IIIf	CH_3	CH_3	A	258—261	$C_{12}H_{10}N_2OS$	—	—	12.07	13.89	62.56	4.37	12.16	13.92	86
			B	258—261		62.96	4.25	12.11	13.82					90
IIIg	CH_3	C_2H_5	A	225—226	$C_{13}H_{12}N_2OS$	—	—	11.60	13.21	63.90	4.94	11.47	13.12	96
			B	225—226		63.69	5.09	11.35	13.11					88

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*Melts with decomposition

Table 2

IR Spectra of the 1'-Oxo-5-R-1-R'-isoindolo-[2', 3': 3, 4] imidazolethiones

Compound	1800—1500cm^{-1}*	$\nu_{C=O}$, cm^{-1}**
IIIa	1748; 1649; 1612	—
IIIb	1748; 1607; 1579	—
IIIc	1744; 1651; 1598	1755
IIId	1757; 1734; 1652; 1604	1757
IIIe	1752; 1642; 1601	1762
IIIf	1740; 1705; 1607	—
IIIg	1742; 1715; 1601	1755

*For mulls in paraffin oil.

**For solutions in dioxane.

for a few minutes until the solution had become decolorized. Then it was poured into water, the excess of alkali was neutralized with dil HCl, and the precipitate was filtered off. This gave 0.15 g (94%) of IId, mp 249–251° C (from ethanol), showing no depression of the melting point with the IId obtained by the previous method [1].

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