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A CONVENIENT SYNTHESIS OF ISOTHIOCYANATES FROM DITHIOCARBAMATES

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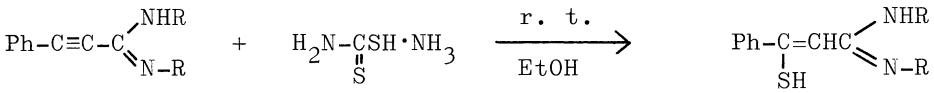
Reactions of N,N'-disubstituted phenylpropiolamidines with triethylammonium N-substituted dithiocarbamates at room temperature afforded corresponding β-mercaptocinnamamidines and isothiocyanates in good yields, respectively. This constitutes a convenient route to isothiocyanates from dithiocarbamates.

During synthetic studies of heterocyclic compounds from phenylpropiolamidines and bifunctional nucleophiles, we found that a facile dehydrosulfurization of thioamides or thioureas takes place under moderate conditions.[1] Although 1,3-thiazines or diethyl β,β'-thiodiacrylate formation was reported in reactions of dithiocarbamates with acetylenic acid[2] or ester,[3] we felt that dehydrosulfurization might occur in reactions of dithiocarbamates with phenylpropiolamidines and these reactions would lead to a new synthetic route to isothiocyanates.

N,N'-diphenylphenylpropiolamidine (I) reacted with ammonium dithiocarbamate[4] exothermally at room temperature in ethanol to give red solution, and then immediately N,N'-diphenyl-β-mercaptocinnamamidine (III. mp 162-164°C (from ethanol)) precipitated. A reaction of N,N'-dicyclohexylphenylpropiolamidine (II) with ammonium dithiocarbamate also afforded the corresponding β-mercaptocinnamamidine (IV. mp 158-159°C (from ethanol)).



I, R=Ph

II, R=cyclohexyl

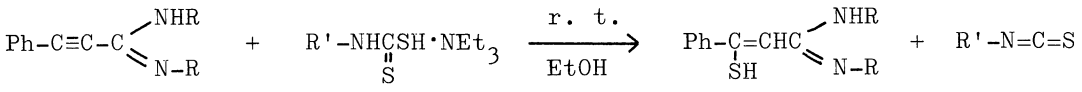
III, R=Ph

IV, R=cyclohexyl

Scheme 1.

These results indicated that dehydrosulfurization occurred predominantly and isothiocyanates synthesis from N-substituted dithiocarbamates might be realized under mild conditions.

Consequently, readily available triethylammonium N-substituted dithiocarbamates[5] were subjected to dehydrosulfurization by means of phenylpropiolamidines. Triethylammonium N-phenyldithiocarbamate reacted smoothly with I or II at room temperature to afford phenylisothiocyanate, along with III or IV, as was expected.



I or II III or IV

Scheme 2

Not only N-aryldithiocarbamates but alkyl and aralkyl analogs were also easily dehydrosulfurized to give corresponding isothiocyanates in fair yields. N,N'-Diphenylphenylpropiolamidine (I) is more suitable as a dehydrosulfurization agent than II, because III could more easily be separated from reaction mixture than IV, owing to its lower solubility in ethanol.

Table 1. Isothiocyanates prepared from triethylammonium N-substituted dithiocarbamates and phenylpropiolamidines in ethanol

No.	Amidine	R'-N=C=S R'	Yield (%)
1	I	Phenyl	45.7
2	II	Phenyl	33.7
3	I	p-Tolyl	85.9
4	I	p-Methoxyphenyl	83.9
5	I	p-Chlorophenyl[a)]	81.4
6	I	1-Naphthyl[b)]	88.3
7	I	Benzyl	61.9
8	I	Cyclohexyl	65.1

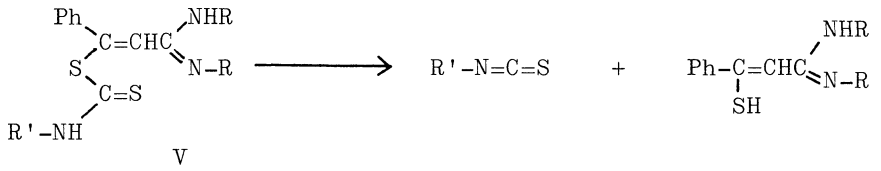
a) mp 43.5-45°C (Lit.[6] mp 46.5°C)

b) mp 54-55°C (Lit.[7] mp 55-56°C)

A typical procedure is as follows: a mixture of 1.48 g (5 mmol) of I and triethylammonium N-substituted dithiocarbamate (5 mmol) in 20 ml ethanol was stirred at room temperature for 3.5 hr, III was filtered off and ethanolic filtrate was evaporated in vacuo. The residue was treated with n-hexane to separate red solids and n-hexane soluble materials were chromatographed on a short column of silica gel (n-hexane was used as an eluent) to remove red substances to afford the corresponding isothiocyanate. The results are summarized in Table 1.

Although a number of routes to isothiocyanates from dithiocarbamate derivatives have been reported,[6,8-10] fair yields, simplicity of operation and mild reaction conditions of our procedure make the method comparable to other excellent methods.

This reaction would proceed through an intermediate V and decomposition of V might be induced by protonation of the amidine nitrogen. It is also supposed that triethylamine acts as a base and V decomposes in a similar fashion to the Kaluza reaction.[8]



Scheme 3

The amidine group, however, has no electron withdrawing character and would not activate the C-S bond to be cleaved. Therefore, we assumed that the amidine nitrogen itself is a base and the electron withdrawing character of the resulting protonated amidine group prompts fission of the C-S bond as in the case of nitrile formation from thioamides.[1]

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