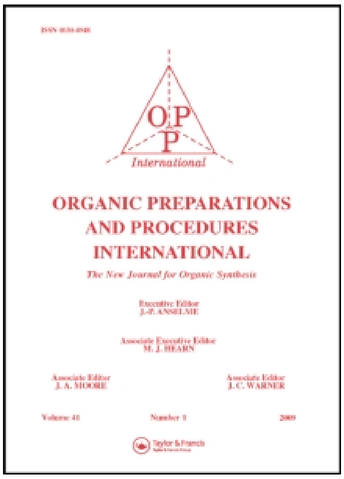

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ONE-POT SYNTHESIS OF ISOTHIOCYANATES FROM PRIMARY AMINES SYNTHESIS USING CYANAMIDE?

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ONE-POT SYNTHESIS OF ISOTHIOCYANATES FROM PRIMARY AMINES SYNTHESIS USING CYANAMIDE[†]

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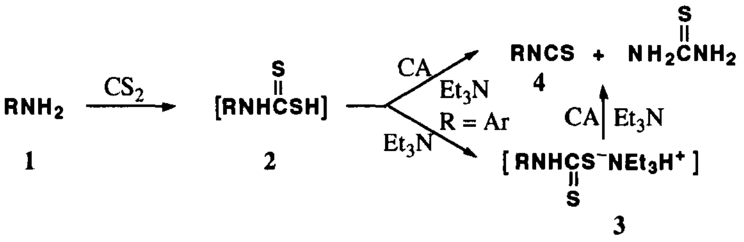
Isothiocyanates have been prepared mainly (a) by the reaction of primary amines with thiophosgene, [1] (b) by the decomposition of 1, 3-disubstituted thiourea with acids, [1] (c) by the decomposition of dithiocarbamates from primary amines and carbon disulfide in the presence of heavy metal salts, 3 or N,N′-dicyclohexylcarbodiimide (DCC).[4] The method using DCC is an effective and convenient route to isothiocyanates in a non-aqueous system.[5]

Since the tautomeric form of cyanamide (CA) is carbodiimide, it might be useful as an agent to dehydrosulfurize dithiocarbamic acids (or their salts). We now report a one-pot synthesis of isothiocyanates in good yield using CA.



a) R = n-C_3H_7 b) R = n-C_4H_9 c) sec-C_4H_9 d) t-C_4H_9 e) n-C_6H_{13}
f) R = $PhCH_2CH_2$ g) R = $(CH_3O)_3Si(CH_2)_3$ h) R = $(C_2H_5O)_3Si(CH_2)_3$
i) R = C_6H_5 j) R = 4-$CH_3C_6H_4$ k) R = 4-$CH_3OC_6H_4$ m) R = 4-ClC_6H_4

n-Propyl, *n*-butyl, *sec*-butyl, *t*-butyl, *n*-hexyl, 2-phenylethyl, 3-(trimethoxysilyl)propyl and 3-(triethoxysilyl)propylamines were converted to dithiocarbamic acid with carbon disulfide and then to the corresponding isothiocyanates with CA in THF in high yields except for bulky amines. Even water-sensitive isothiocyanates (**4g** and **4h**) were obtained in high yields.

Since the reaction of aniline, *p*-toluidine, *p*-anisidine and *p*-chloroaniline with carbon disulfide do not give dithiocarbamic acids in the absence of base,[5] their dithiocarbamate were first prepared by using a large excess of carbon disulfide and equimolar amount (to arylamines) of triethylamine. These salts were then converted to the corresponding isothiocyanates with CA in THF. The yields of isothiocyanates using CA are lower by 20-30%, compared to those obtained using DCC.[5] The difference might be caused by the weaker basicity of intermediate anion $[RNHC(S)SC(=NH)\bar{N}H]$.

TABLE. Preparation of Isothiocyanates Using Cyanamide[a]

RNCS	Yield (%)	IR (NCS) (cm^{-1})	^{1}H NMR[b] (δ)
4a	83	2080-2190	1.03 (t, 3H, J = 7.3), 1.47-2.01 (m, 2H), 3.50 (t, 2H, J = 7.3)
4b	90	2080-2190	0.98 (t, 3H), 1.1-1.9 (m, 4H), 3.55 (t, 2H, J = 6.3)
4c	62	2000-2160	0.99 (t, 3H, J = 7.4), 1.34 (d, 3H, J = 7.2) 1.2-2.0 (m, 2H), 3.4-4.0 (m, 1H)
4d	27	2100	1.51 (s, 9H)
4e	93	2090-2170	0.85 (t, 3H, J = 4.0), 1.1-2.0 (m, 8H), 3.49 (t, 2H, J = 6.0)
4f	93	2070-2180	2.81 (t, 2H, J = 6.6), 3.55 (t, 2H, J = 6.6) 7.25 (s, 5H)
4g	96	2100-2190	0.6-0.9 (m, 2H), 1.6-2.2 (m, 2H), 3.64 (t, 2H, J = 8.9), 3.66 (s, 9H)
4h	95	2060-2170	0.5-0.8 (m, 2H), 1.19 (t, 9H, J = 7.0), 1.5-2.1 (m, 2H), 3.52 (t, 2H, J = 6.7), 3.81 (q, 6H, J = 7.0)
4i	53	2080-2170	7.29 (m, 5H)
4j	55	2000-2100	2.24 (s, 3H), 6.8-7.2 (m, 4H)
4k	56	2000-2100	3.68 (s, 3H), 6.72 (d, 2H, J = 8.8), 7.03 (d, 2H, J = 8.8)
4m	28	2040-2100	7.0-7.4 (m, 4H)

a) A molar ratio of 1.5:1 of CS, to aliphatic amine and a molar ratio of 27.5:1:1 of CS_2 and NEt_3 to aromatic amine were used. In dehydrosulfurization, an equimolar amount of CA to amine and two or three drops of NEt_3 were used. b) J values are in Hz.

EXPERIMENTAL SECTION

All melting points and boiling points are uncorrected. The IR Spectra were recorded neat on a Shimazu IR-435 spectrophotometer and ^{1}H NMR spectra in $CDCl_3$ on a JNM-PMX60 spectrometer using TMS as an internal standard. Cyanamide which was a reagent of Tokyo Kasei Kogyo Co., Ltd. was used after dehydration. All primary amines (reagents of Tokyo Kasei Kogyo Co., Ltd.) and solvents were used after dehydration.

General Procedure for Isothiocyanation of Alkyl Amines.- To a stirred solution of alkylamine (6.0 mmol) in 20 mL of THF, was added dropwise 9.0 mmol of carbon disulfide at 0-5°. After 3 hrs stirring at 0-5°, a solution of cyanamide (CA, 9.0 mmol) in 10 mL of THF and one or two drops of triethylamine was added in one portion into the solution containing dithiocarbamic acid at room temperature. After stirring at 40° for 3 hrs, the solvent was removed by distillation. The residue was extracted with ether (10 mL x 4) and the ethereal extract was evaporated to give the corresponding isothiocyanate as an oily residue. Purification was carried out by distillation or column chromatography (basic alumina and dichloromethane). The structures of the known isothiocyanates were confirmed by the accordance of their IR and NMR spectra with those in the references.

***n*-Propyl isothiocyanate (4a)**: Oil, bp. 152-153°, lit.[9a] 153°. IR (neat)[6]: 2980-2880, 2190-2080 cm^{-1}.

NMR: δ 1.03 (t, 3H, $J = 7.3$ Hz), 1.47-2.01 (m, 2H), 3.50 (t, 2H, $J = 7.3$ Hz).

n-Butyl isothiocyanate (4b): Oil, bp. 164-165°, lit.[9b] 166°. IR (neat)[6]: 2980-2880, 2190-2080 cm^{-1}. NMR[8]: δ 0.98 (t, 3H, $J = 5.9$ Hz), 1.10-1.90 (m, 4H), 3.55 (t, 2H, $J = 6.3$ Hz).

sec-Butyl isothiocynate (4c): Oil, bp. 157-159°, lit.[9c] 159.5°. IR (neat)[6]: 2980-2840, 2160-2000 cm^{-1}. NMR: δ 0.99 (t, 3H, $J = 7.4$ Hz), 1.34 (d, 3H, $J = 7.2$ Hz), 1.20-2.00 (m, 2H), 3.40-4.00 (m, 1H).

t-Butyl isothiocyanate (4d): Oil. IR (neat)[6]: 2980-2840, 2100 cm^{-1}. NMR[8]: δ 151 (s, 9H).

n-Hexyl isothiocyanate (4e): Oil, bp. 98°/27 mm, lit.[9d] 210°. IR (neat): 2970-2850, 2170-2090 cm^{-1}. NMR: δ 0.85 (t, 3H, $J = 4.0$ Hz), 1.10-2.00 (m, 8H), 3.49 (t, 2H, $J = 6.0$ Hz).

2-Phenylethyl isothiocyanate (4f): Oil, bp. 124-126°/20 mm, lit.[9e] 247.5°. IR (neat)[6]: 3050-2850, 2180-2070, 1600, 745, 695 cm^{-1}. NMR[7]: δ 2.81 (t, 2H, $J = 6.6$ Hz), 3.55 (t, 2H, $J = 6.6$ Hz), 7.25 (s, 5H).

3-(Trimethoxysilyl)propyl isothiocyanate (4g): Oil, bp. 109-111°/7 mm. IR (neat): 2950-2840, 2190-2100, 1088 cm^{-1}. NMR: δ 0.60-0.90 (m, 2H), 1.60-2.20 (m, 2H), 3.64 (t, 2H, $J = 8.9$ Hz), 3.66 (s, 9H).

Anal. Calcd. for $C_7H_{15}NO_3SSi$: C, 37.99; H, 6.83; N, 6.33. Found: C, 38.01; H, 6.71; N, 6.18

3-(Triethoxysilyl)propyl isothiocyanate (4h): Oil, bp. 121-124°/10 mm. IR (neat): 2980-2850, 2170-2060, 1075 cm^{-1}. NMR: δ 0.50-0.80 (m, 2H), 1.19 (t, 9H, $J = 7.0$ Hz), 1.50-2.10 (m, 2H), 3.52 (t, 2H, $J = 6.7$ Hz), 3.81 (q, 6H, $J = 7.0$ Hz).

Anal. Calcd. for $C_{10}H_{21}NO_3SSi$: C, 45.59; H, 8.04; N, 5.32. Found: C, 45.31; H, 8.16; N, 5.13

General Procedure for Isothiocyanation of Arylamines.- To a stirred solution of an arylamine (6.0 mmol) and triethylamine (6.0 mmol) in 20 mL of THF was added dropwise 10 mL of carbon disulfide at 0-5°. After the solution was stirred at 40° for 3 hrs, a solution of cyanamide (6.0 mmol) in 10 mL of THF and one or two drops of triethylamine was added to the reaction mixture at room temperature. The resulting solution was stirred at 40° for 3 hrs. The mixture was worked up as described for the alkyl isothiocyanates.

Phenyl isothiocyanate (4i): Oil, bp. 103-104°/20 mm, lit.[9f] 221°. IR (neat)[6]: 3060, 2170-2080, 1600, 749, 685 cm^{-1}. NMR[7]: δ 7.29 (m, 5H).

4-Methylphenyl isothiocyanate (4j): mp 25°, lit.[9g] 26°. IR (neat)[6]: 3020-2840, 2100-2000, 1600, 810 cm^{-1}. NMR: δ 2.24 (s, 3H), 6.80-7.20 (m, 4H).

4-Methoxyphenyl isothiocyanate (4k): Oil. IR (neat)[6]: 3070-2840, 2100-2000, 1600, 1240, 1030, 830 cm^{-1}. NMR[8]: δ 3.68 (s, 3H), 6.72 (d, 2H, $J = 8.8$ Hz), 7.03 (d, 2H, $J = 8.8$ Hz).

4-Chlorophenyl isothiocyanate (4m): mp. 44-46°, lit.[11] 44.5-46°. IR (KBr)[6]: 2100-2040, 1590, 825 cm^{-1}. NMR[8]: δ 7.00-7.40 (m, 5H).

REFERENCES

[†] Part II of Synthesis of Isothiocyanates in non-aqueous systems; for part I, see ref. 5.

1. C. C. Overberger and H. A. Friedman, *J. Org. Chem.*, **30**, 1926 (1965).

2. For decomposition using phosphoric acid, see A. W. Hofmann, *Ber.*, **15**, 985 (1882).

3. F. B. Dains, R. Q. Brewster, and C. P. Olander, *Org. Syn., Coll. Vol. I*, 447 (1967).

4. J. C. Jochims and A. Seelinger, *Angew. Chem.*, **79**, 151 (1967).

5. T. Yamamoto, M. Iwata, T. Misono, and T. Takahashi, Part I of this series see *Bull. Fac. Ind. Kanto Gakuin Univ.*, **34-2**, 192 (1991).

6. C. J. Pouchert, "*The Aldrich Library of FT IR Spectra*" Ed. I, Aldrich Chemical Co. (1985).

7. "*Handbook of Proton NMR Spectra and Data*" Academic Press (1985).

8. C. J. Pouchert, "*The Aldrich Library of NMR Spectra*" Ed. II, Aldrich Chemical Co. (1983).

9. *Beilstein's Handbuch der Organishen Chemie*: a) **4**, EII 627; b) **4**, EII 635; c) **4**, 162; d) **4**, EII 650; e) **12**, EII 635; f) **12**, 453. g) **12**, 956.

10. J. N. Kinkel, B. Anspach, K. K. Ungerlinger, R. Wieser, and G. Brunner, *J. Chromatogr.*, **297**, 167 (1984).

11. G. Barnikow and H. Kunzek, *J. prakt. Chem.*, **29**, 323 (1965).

12. "*Nuclear Magnetic Resonance Spectra*", Sadtler Research Laboratories, Philadelphia (1971).

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AN IMPROVED SYNTHESIS OF 2,4-HEXADIEN-1-OL[†]

Submitted by
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2,4-Hexadien-1-ol (**3**), an useful intermediate for the synthesis of 8 (E), 10 (E)-dodecadien-1-ol[1] which is a sex pheromone component of many insect species,[2] can be prepared from 2,4-hexadienoic acid (**1a**)[3] by reduction with lithium aluminum hydride, however, the yield is very poor (~10-15%). Although esters of **2** can be reduced with LAH in yields of 50%, hexanol is also formed in addition to the target compound (**3**). Red-Al [sodium *bis*(2-methoxyethoxy)aluminum hydride in