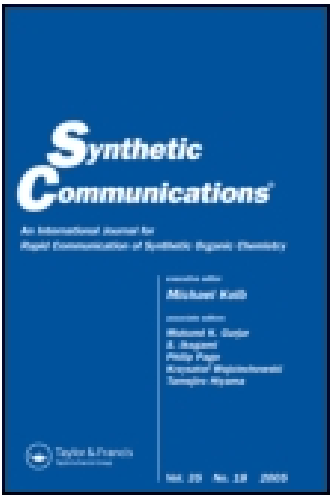

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A NEW AND EFFICIENT SOLID STATE SYNTHESIS OF DIARYL THIOUREAS

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A NEW AND EFFICIENT SOLID STATE SYNTHESIS OF DIARYL THIOUREAS

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ABSTRACT

Fourteen diaryl thioureas which are physiologically active have been synthesized in the solid state at room temperature. The reaction needs only simple equipment and gives excellent yields.

In recent years, particularly intense interest has been directed towards the generation of small organic molecules by solid state reactions.[1] These reactions are especially appealing because they have such advantages as high efficiency and selectivity,[2] easy separation and purification, mild reaction conditions,[3] and environmental acceptability.[4,5] This approach has been widely used in a variety of organic reactions including substitution,[6] condensation,[7] oxidation-reduction,[8,9] rearrangement[10] and elimination.[11] However, the solid state addition to thiocyanates of aromatic primary amines has not been reported.

Recently, we found that the addition of thiocyanates and aromatic primary amine to form diaryl thioureas can easily be achieved in the solid state.

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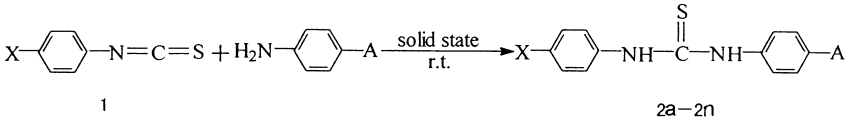
N,N′-Disubstituted thioureas are known to exhibit antiviral,[12] antituberculous,[13] fungicidal,[14] and herbicidal[15] activities. Generally, the preparation of these compounds has been carried out in solution.

In this paper, a new solid state addition of thiocyanates and aromatic primary amine is studied and fourteen diaryl thioureas have been synthesized in excellent yields at room temperature. This method requires only simple equipment and short reaction time. The structures of the products were confirmed by IR and ^{1}H NMR spectroscopy, and by elemental analysis.



1 2a–2n

a: X=Cl, A=CH_3 b: X=Cl, A=OCH_3 c: X=Cl, A=α-$C_{10}H_7$

d: X=Cl, A=Cl e: X=Cl, A=Br f: X=Cl, A=I

g: X=Br, A=CH_3 h: X=Br, A=OCH_3 i: X=Br, A=α-$C_{10}H_7$

j: X=Br, A=Br k: X=Br, A=I l: X=OEt, A=CH_3

m: X=OEt, A=OCH_3 n: X=OEt, A=α-$C_{10}H_7$

Scheme 1.

EXPERIMENTAL

Melting points were determined with a Kofler micro melting point apparatus and were uncorrected. IR spectra were recorded on a SP3-300 spectrophotometer in KBr. ^{1}H NMR spectra were measured on a Bruker DPX-400M spectrometer using TMS as internal standard and $CDCl_3$ as solvent. Elemental analyses were performed on PE-2400 CHN elemental analyser.

General Procedure

A mixture of aryl isothiocyanate[16] (1 mmol) and aromatic primary amine (1 mmol) was ground thoroughly in an agate mortar. The reaction was traced with thin-layer chromatography. After the reaction was complete

(5∼40 min), the crude products were recrystallized with ethanol or acetone, and dried under vacuum to yield the pure products.

2a: white–tabular; Yield: 95.2%; m.p. 174–176°C; IR (KBr)ν: 3210, 3030, 2985, 2850, 1595, 1490, 1250, 830 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 2.367 (s, 3H, CH_3), 7.20l∼7.367 (m, 8H, Ar–H), 7.791(s, 1H, NH), 8.098(s, 1H, NH); Calcd. for $C_{14}H_{13}N_2SCl$: C, 60.76; H, 4.70; N, 10.13. Found: C, 60.51; H, 4.45; N, 9.96.

2b: white–tabular; Yield: 98.0%; m.p. 176–178°C; IR (KBr)ν: 3215, 3030, 2990, 2850, 1600, 1500, 1350, 1250, 840 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 3.828 (s, 3H, CH_3), 6.937∼7.373 (m, 8H, Ar–H), 7.592 (s, 1H, NH), 7.877 (s, 1H, NH); Calcd. for $C_{14}H_{13}N_2SClO$: C, 57.44; H, 4.44; N, 9.57. Found: C, 57.31; H, 4.25; N, 9.30.

2c: white–needle; Yield: 97.7%; m.p. 188–190°C; IR (KBr)ν: 3220, 3030, 1595,1500, 1235, 820, 780 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.261∼7.961 (m, 11H, Ar–H), 8.052–8.072 (d, 2H, NH); Calcd. for $C_{17}H_{13}N_2SCl$: C, 65.28; H, 4.16; N, 8.96. Found: C, 65.12; H, 3.89; N, 8.67.

2d: white–stick; Yield: 90.4%; m.p. 174–176°C; IR (KBr)ν: 3220, 3180, 3030, 1590, 1550, 1490, 1245, 820 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.303∼7.402 (m, 8H, Ar–H), 7.815 (s, 2H, NH); Calcd. for $C_{13}H_{10}N_2SCl_2$: C, 52.70; H, 3.38; N, 9.46. Found: C, 52.45; H, 3.02; N, 9.09.

2e: white–stick; Yield: 92.1%; m.p.179–181°C; IR (KBr)ν: 3210, 3030, 1595, 1495, 1235, 830 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.261∼7.553 (m, 8H, Ar–H), 7.728∼7.742 (d, 2H, NH); Calcd. for $C_{13}H_{10}N_2SBrCl$: C, 45.81; H, 2.94; N, 8.22. Found: C, 45.50; H, 2.72; N, 7.97.

2f: pale–red–stick; Yield: 91.9%; m.p. 180–182°C; IR (KBr)ν: 3220, 3030, 1600, 1500, 1240, 825 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.255∼7.546 (m, 8H, Ar–H), 7.723∼7.438 (d, 2H, NH); Calcd. for $C_{13}H_{10}N_2SClI$: C, 40.26; H, 2.58; N, 7.23. Found: C, 40.01; H, 2.33; N, 6.95.

2g: white–tabular; Yield: 97.0%; m.p. 180–182°C; IR (KBr)ν: 3220, 3030, 2990, 2850, 1600, 1495, 1350, 1245, 835 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 2.372 (s, 3H, CH_3), 7.210∼7.376 (m, 8H, Ar–H), 7.801 (s, 1H, NH), 8.120 (s, 1H, NH); Calcd. for $C_{14}H_{13}N_2SBr$: C, 52.34; H, 4.05; N, 8.72. Found: C, 52.14; H, 3.76; N, 8.41.

2h: white–tabular; Yield: 93.7%; m.p. 182–184°C; IR (KBr)ν: 3215, 3030, 2985, 2850, 1595, 1550, 1350, 1250, 840 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 3.821(s, 3H, CH_3), 6.940∼7.541 (m, 8H, Ar–H), 7.546 (s, 1H, NH), 7.841 (s, 1H, NH); Calcd. for $C_{14}H_{13}N_2SBrO$: C, 49.85; H, 3.86; N, 8.31. Found: C, 49.72; H, 3.57; N, 8.02.

2i: white–needle; Yield: 92.9%; m.p. 182–183°C; IR (KBr)ν: 3220, 3030, 1595, 1495, 1235, 820, 780 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.267–7.968 (m, 11H, Ar–H), 8.060∼8.079 (d, 2H, NH); Calcd. for $C_{17}H_{13}N_2SBr$: C, 57.14; H, 3.64; N, 7.84. Found: C, 56.84; H, 3.47; N, 7.56.

2j: white–tabular; Yield: 92.2%; m.p. 188–190°C; IR (KBr)ν: 3220, 3180, 3030, 1600, 1500, 1245, 825 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.290~7.392 (m, 8H, Ar–H), 7.820 (s, 2H, NH); Calcd. for $C_{13}H_{10}N_2SBr_2$: C, 40.41; H, 2.59; N, 7.25. Found: C, 40.19; H, 2.31; N, 6.98.

2k: white–tabular; Yield: 89.5%; m.p. 179–181°C; IR (KBr)ν: 3225, 3030, 1595, 1495, 1240, 820 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 7.251~7.541 (m, 8H, Ar–H), 7.720~7.433 (d, 2H, NH); Calcd. for $C_{13}H_{10}N_2SBrI$: C, 36.03; H, 2.31; N, 6.47. Found: C, 35.74; H, 2.02; N, 6.19.

2l: white–tabular; Yield: 92.3%; m.p. 138–140°C; IR (KBr)ν: 3210, 3030, 2995, 2930, 2890, 1600, 1530, 1400, 1250, 835 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 1.420 (t, 3H, CH_3), 2.362 (s, 3H, CH_3), 4.040 (q, 2H, CH_2), 6.910–7.690 (m, 8H, Ar–H), 7.640~7.643 (d, 2H, NH); Calcd. for $C_{16}H_{18}N_2SO$: C, 67.13; H, 6.29; N, 9.79. Found: C, 66.81; H, 5.92; N, 9.53.

2m: white–tabular; Yield: 90.5%; m.p. 159–160°C; IR (KBr)ν: 3215 3030, 2995, 2895, 1600, 1500, 1355, 1250, 840 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 1.417 (t, 3H, CH_3), 3.814 (s, 3H, CH_3), 4.032 (q, 2H, CH_2) 6.902~7.631 (m, 8H, Ar–H), 7.634~7.637 (d, 2H, NH); Calcd. for $C_{16}H_{18}N_2SO_2$: C, 63.58; H, 5.96; N, 9.27. Found: C, 63.29; H, 5.60; N, 8.99.

2n: white–needle; Yield: 96.8%; m.p. 178–179°C; IR (KBr)ν: 3220, 3030, 2995, 2890, 1595, 1500, 1400, 1355, 825, 785 cm^{-1}; ^1H NMR ($CDCl_3$) δ: 1.397(t, 3H, CH_3), 4.009 (q, 2H, CH_2), 6.871–8.002 (m, 1H, Ar–H), 8.003~8.014 (d, 2H, NH); Calcd. for $C_{19}H_{18}N_2SO$: C, 70.81; H, 5.59; N, 8.70. Found: C, 70.58; H, 5.33; N, 8.35.

REFERENCES

1. Singh, N.B.; Singh, R.J.; Singh, N.P. *Tetrahedron* **1994**, *50*, 6441.
2. Desiraju, G. R. (Ed). *Organic Solid State Chemistry*, Elsevier Science Publishers: Amsterdam, **1987**, p. 179.
3. Rasmussen, M. O.; Axelsson, O.; Tanner, D. *Synth. Commun.* **1997**, *27*, 4027.
4. Wang, L.-M. *Hua Xue Tong Bao* **1992**, *6*, 14.
5. Li, X.-L.; Wang, Y.-M.; Meng, J.-B.; Du, C.-P., *Youji Huaxue*, **1998**, *18*, 20.
6. Goff, D.A.; Zuckermann, R.N. *J. Org. Chem.*, **1995**, *60*, 5744.
7. Toda, F.; Tanaka, K.; Hamai, K. *J. Chem. Soc., Perkin Trans. I* **1990**, 3207.
8. Morey, J.; Frontera, A. *J. Chem. Ed.* **1995**, *72*, 63.
9. Morey, J.; Saa, J.M. *Tetrahedron* **1993**, *49*, 105.
10. Toda, F.; Shigemasa, T. *J. Chem. Soc. Perkin Trans. I* **1989**, 209.

11. Toda, F.; Takumi, H.; Akehi, M. *J. Chem. Soc. Chem. Commun.* **1990**, 1270.
12. Galabov, A.S.; Galabov, B.S.; Neykova, N.A. *J. Med. Chem.* **1980**, *23*, 1048.
13. (a) Doub, L.; Richardson, L.M.; Herbst, D.R. etc., *J. Am. Chem. Soc.* **1958**, *80*, 2205. (b) Glasser, A.C.; Doughty, R.M. *J. Pharm. Sci.* **1962**, *51*, 1031.
14. (a) Vasilev, G.; Tomaleva, Z. *Arch. Phytopathol Pflanzenshuts* **1973**, *9*, 309. (b) Krause, G.; Franke, R.; Vasilev, G.N. *Biochem. Physiol. Pflanz.* **1979**, *174*, 128.
15. Vasilev, G.; Iliev, L.; Vasilev, R. *Mekh Deistviya Gerbits*, **1971**, *187* [Chem. Abstr. **1977**, *86*, 5117d].
16. Hodgkins, J. E.; Reeves, W. P. *J. Org. Chem.* **1964**, *29*(10), 3098.

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