A Simple Route to *N*,*N*-Disubstituted Selenoureas from *N*,*N*-Disubstituted Cyanamides

Dietmar Keil,^a Horst Hartmann*^b

- ^a Sensient Imaging Technologies GmbH, SynTec Division, ChemiePark Bitterfeld-Wolfen, Arial A; Emil-Fischer-Strasse 3, 06766 Wolfen, Germany
- ^b Fachbereich Chemie, Fachhochschule Merseburg, Geusaer Str., 06217 Merseburg, Germany Fax +49(3461)462192; E-mail: Horst.Hartmann@cui.fh-merseburg.de

Received 11 August 2003; revised 22 October 2003

Abstract: *N*,*N*-Disubstituted selenoureas **4** can be obtained in satisfactory yields by addition of an acid to a mixture of freshly prepared sodium selenide and *N*,*N*-disubstituted cyanamides **5**.

Key words: *N*,*N*-disubstituted selenoureas, *N*,*N*-disubstituted cyanamides, nucleophilic substitution, selenium

In analogy to *N*,*N*-disubstituted thioureas **3**,¹*N*,*N*-disubstituted selenoureas **4** are versatile starting materials for the preparation of different types of heterocycles. For instance, they can be used for the synthesis of *N*,*N*-disubstituted 2-aminoselenazoles.² Recently, these compounds have received a special interest as starting materials for a variety of functional dyes useful for, e.g. measuring the solvent polarity,^{3–5} manufacturing electrophotographic data recording systems,^{6,7} or for preparing compounds absorbing infrared radiation.⁸

Compared to their N,N-disubstituted sulfur analogues 3, N,N-disubstituted selenoureas 4 can not be prepared by heating the corresponding ammonium selenocyanates 2^{2} Similarly, they can not also be prepared, analogous to their sulfur analogues **3**,⁹ by hydrolysis of acylselenoureas 9 which are available by reaction of alkali or ammonium selenocyanides 2 with acyl chlorides 6 and subsequent reaction of the primarily formed acyl isoselenocyanates 8 with amines¹⁰ (Scheme 1). The N,N-disubstituted selenoureas 4 can be prepared, however, from N,N-disubstituted thioureas 3 via their alkyl derivatives,¹¹ or from N,Ndisubstituted cyanamides 5 by reaction with dihydrogenselenide that has been generated from Al₂Se₃ by hydrolysis.² Although both methods seem, at first glance, rather simple they require the use of an extremely toxic reagent.

Now, we have found a more simple method for obtaining *N*,*N*-disubstituted selenoureas **4**. It also starts from *N*,*N*-disubstituted cyanamides, and proceeds by the use of Na₂Se or NaHSe avoiding the free gaseous H₂Se (Scheme 1). These reagents can be prepared, as generally known, very simply from elemental selenium by reaction with sodium borohydride.¹² For carrying out the reaction, it is only necessary to add slowly an equivalent amount of





a mineral acid, like hydrochloric acid, to a mixture of the components. Instead of the acid, a suitable ammonium salt, such as pyridinium hydrochloride, can also be used. The reaction has some analogies to the reported preparation of selenobenzamides from benzonitriles^{13–15} as well as to the preparation of *N*,*N*-disubstituted selenoureas **4** from *N*,*N*-disubstituted cyanamides and LiAlSeH.¹⁶

For obtaining a satisfactory yield of the *N*,*N*-disubstituted selenoureas **4**, it is recommendable to let the reaction mixture stand overnight after the addition of acid. The products formed can be isolated by usual work-up (see experimental).

Melting points were determined by means of a Differential Scanning Calorimeter (Mettler, Toledo) with a heating rate of 5 °C/min. The NMR spectra were recorded with a Varian Gemini 300 MHz spectrometer. The elemental analyses were estimated by means of a LECO analyser CHNS 932.

N,N-Disubstituted Selenoureas 4; General Procedure

Method A: Under inert gas conditions, NaBH₄ (8.1 g, 215 mmol) was slowly added to a cooled and stirred mixture of elemental Se (15.8 g, 200 mmol) in EtOH (200 mL). After decolourisation of the reaction mixture, a *N*,*N*-disubstituted cyanamide **5** (100 mmol), followed by pyridine hydrochloride (46.2 g, 400 mmol), were added slowly and the mixture was stirred overnight. The reaction was quenched by addition of H₂O (500 mL) and the product formed was extracted with CH₂Cl₂ (300 mL). The CH₂Cl₂ solution was dried

SYNTHESIS 2004, No. 1, pp 0015–0016 Advanced online publication: 19.11.2003 DOI: 10.1055/s-2003-44349; Art ID: T08803SS.pdf © Georg Thieme Verlag Stuttgart · New York

and the solvent evaporated in vacuo to give a crystalline product. It was recrystallised from toluene under N_2 .

*Method B (In Analogy to Ref.*¹³): A *N*,*N*-disubstituted cyanamide **5** (100 mmol) was added to a freshly prepared solution of NaSe (200 mmol) in EtOH (200 mL) under an inert gas atmosphere. After adding pyridine (32.4 mL, 400 mmol), aq 2 M HCl (100 mL) was slowly added to the boiling mixture over a period of 4 h. The reaction mixture was quenched by addition of H₂O (500 mL) and worked up as before.

N,N-Dimethylselenourea (4a)

Yield: 50–55%; mp 174 °C (Lit.² mp 173 °C).

¹³C NMR (DMSO- d_6): δ = 177.9 (CSe).

N,N-Diethylselenourea (4b)

Yield 40–45%; mp 122 °C (Lit.² mp 121 °C). ¹³C NMR (CDCl₃): δ = 177.1 (CSe).

N,N-Dibenzylselenourea (4c)

Yield: 45–50%; mp 141 °C (Lit.² mp 139 °C). ¹³C NMR (CDCl₃): δ = 181.6 (CSe).

N-(Selenocarbamido)morpholine (4d)

Yield 30–35%; mp 201 °C (Lit.² mp 195 °C).

¹³C NMR (DMSO- d_6): $\delta = 178.2$ (CSe).

N-(Selenocarbamido)pyrrolidine (4e)

Yield: 49–50%; mp 213 °C (Lit.² mp 212 °C). ¹³C NMR (CDCl₃): δ = 173.7 (CSe).

N-(Selenocarbamido)piperidine (4f)

Yield: 35–40%; mp 147 °C (Lit.² mp 147 °C). ¹³C NMR (CDCl₃): δ = 177.8 (CSe).

References

- (a) Liebscher, J. In Methoden der organischen Chemie (Houben-Weyl), Vol. E8b; Schaumann, E., Ed.; Thieme: Stuttgart, **1994**, 1. (b) Kikelj, D.; Urleb, U. In Science of Synthesis, Vol. 11; Schaumann, E., Ed.; Thieme: Stuttgart, **2002**, 627.
- (2) Keil, D.; Hartmann, H. *Phosphorus, Sulfur Silicon Relat. Elem.* **1999**, *152*, 169; and references cited therein.
- (3) Hartmann, H.; Eckert, K.; Schröder, A. Angew. Chem. Int. Ed. 2000, 39, 556.
- (4) Keil, D.; Hartmann, H.; Zug, I.; Schröder, A. J. Prakt. Chem. 2000, 342, 169.
- (5) Zug, I.; Hartmann, H. Z. *Naturforsch.*, B: Chem. Sci. 2002, 57, in press.
- (6) Keil, D.; Hartmann, H. Dyes Pigm. 2000, 44, 149.
- (7) Keil, D.; Hartmann, H. *High-Tech Chemie 1992-1997*; Firmenschrift Syntec GmbH: Wolfen, **1997**.
- (8) Keil, D.; Flaig, R.; Schröder, A.; Hartmann, H. *Dyes Pigm.* **2001**, *50*, 67.
- (9) Hartmann, H.; Reuther, I. J. Prakt. Chem. 1973, 315, 144.
- (10) Zhou, Y.; Linden, A.; Heimgartner, H. *Helv. Chim. Acta* **2000**, *83*, 539.
- (11) Douglas, I. B. J. Am. Chem. Soc. 1937, 59, 740.
- (12) Klayman, D. L.; Griffin, T. S. J. Am. Chem. Soc. 1973, 95, 197.
- (13) Lai, L.-L.; Reid, D. H. Synthesis 1993, 870.
- (14) Ruan, M.-D.; Zhang, P.-F.; Tao, Y.; Fan, W.-F. Synth. *Commun.* **1996**, *26*, 2617.
- (15) Geisler, K.; Jacobs, A.; Künzler, A.; Mathes, M.; Girrleit, I.; Zimmerman, B.; Bulka, E.; Pfeiffer, W.-D.; Langer, P. *Synlett* **2002**, 1983.
- (16) Koketsu, M.; Fukuta, Y.; Ishihara, H. *Tetrahedron Lett.* 2001, 42, 6333.