Reduction of Some N-substituted Aminoacetonitriles with Lithium Aluminium Hydride

C. Benko and M. Tišler

Department of Chemistry, Faculty of Science, University of Ljubljana, Ljubljana, Slovenia, Yugoslavia

Received December 10, 1958

Reduction of some N-substituted (aryl-, benzyl- and cyclohexyl-) aminoacetonitriles with lithium aluminium hydride gave besides the expected N-substituted ethylenediamines also the corresponding substituted N-methylamines in varying yields.

Some mono N-substituted ethylenediamines, mainly N-monoarylethylene-diamines, were needed for further work. For their preparation the reduction of the corresponding substituted aminoacetonitriles with lithium aluminium hydride was taken into consideration.

It is well known that the reduction of nitriles to primary amines proceeds usually with good yields. There is some evidence for the formation of an intermediate imine since in some cases secondary amines were obtained or, by choice of appropriate reaction conditions, an aldehyde can be obtained. Soffer and Katz were able to demonstrate in their detailed study that the lithium aluminium hydride reduction of nitriles afforded, besides primary amines, aldehydes, hydrogen, 1,3-diamines and other higher products.

There are also some exceptions known in the case of reduction of α- and β-aminonitriles. Besides the normal reduction, the cyano group is split off. However with α-branched β-aminopropionitriles the reduction proceeds normally leading to substituted 1,3-propylenediamines. In a recent publication Wadia, Anaud and Dhar reported that N-monoalkylaminoacetonitriles can be smoothly reduced with lithium aluminium hydride to the corresponding N-monoalkylethylenediamines in 60—70% yield. The formation of any other by-products was not mentioned.

In our experiments we used N-phenyl-, o-, m- and p-tolyl, cyclohexyl- and benzylaminoacetonitrile, prepared from the corresponding amines with formaldehyde-bisulfite and potassium cyanide. These nitriles, when reduced with 100% excess lithium aluminium hydride in boiling ether, afforded the corresponding ethylenediamines only in low yields (up to 25%), but the corresponding substituted N-methylamines were obtained in higher yields. In one experiment the reduction of N-phenylaminoacetonitrile was carried out at lower temperature with cooling and the yield of N-phenylethylenediamine was raised up to 32.0%, although the formation of N-methylaniline couldn't be avoided and it was formed in appreciable amounts. Using boiling tetrahydrofurane as solvent the main reduction product was N-methylaniline. When after destruction of excess hydride the aqueous layer gave positive tests for...
cyanide ion it was evident that the splitting of the cyano group took place during the reduction procedure.

**EXPERIMENTAL**

All melting-points were determined with Kofler's heating microscope.

The substituted aminoacetonitriles were prepared from the corresponding amines with formaldehyde-bisulfite and potassium cyanide as described in literature16,17.

**Reduction of substituted aminoacetonitriles with lithium aluminium hydride.**

17 g. of $N$-phenylaminoacetonitrile were dissolved in 70 ml. of anhydrous ether and added dropwise to a stirred suspension of 4.9 g. lithium aluminium hydride in 300 ml. of anhydrous ether, cooled previously to $5^\circ$C. The addition lasted two hours. The temperature was maintained at $5^\circ$C. After the addition had been completed the mixture was stirred for additional half an hour and excess of lithium aluminium hydride destroyed by adding 20 ml. of water in portions. The ethereal layer was separated, the residue extracted four times with 50 ml. of ether and the combined extracts dried with anhydrous sodium carbonate. After evaporation of the solvent, the residue was dried again with solid potassium hydroxide and amounted to 15 g. After distillation two fractions were obtained.

First fraction, b. p. $77-82^\circ$C/13 mm., amounted to 4.6 g. (yield: 33.4%o) and was identified as $N$-methylaniline; hydrochloride, m. p. $122^\circ$C (reported $18 121-2^\circ$C); acetyl derivative, m. p. 101-2$^\circ$C (reported$^{18} 101-2^\circ$C), undepressed with an authentic specimen.

The second fraction, b. p. $128-133^\circ$C/13 mm., was identified as $N$-phenylethylenediamine $5.6 \text{ g.};$ yield: 32.0%o (Lit.$^{19,20}$ reported b. p. 142-4$^\circ$C/15 mm and $143-59/15 \text{ mm.}$ respectively), Diacetyl derivative, m. p. 118$^\circ$C, (reported$^{21} 116^\circ$C).

Using the above procedure, but performing the reduction in boiling anhydrous tetrahydrofuran, $N$-methylaniline was obtained in 68.3% yield and $N$-phenylethylenediamine in 13.3% yield.

The following reductions were carried out in boiling ether and the results are as follows:

a) $N$-$p$-tolylaminoacetonitrile was reduced to $N$-methyl-$p$-toluidine in 37.5% yield, b. p. $120-128^\circ$C/15 mm., hydrochloride: m. p. 119-120$^\circ$C, (reported$^{18} 119.5^\circ$C) and to $N$-$p$-tolylethylenediamine, b. p. 155-70$^\circ$C/15 mm. (reported$^{20} 150^\circ$C/15 mm.) in 20.1% yield. Diacetyl derivative, m. p. 108-9$^\circ$C (reported$^{21} 107^\circ$C), phenylthiourea derivative from the reaction with phenylisothiocyanate had m. p. 119$^\circ$C.

**Anal.**

3.935 mg. subst.: 0.532 ml. $N_2 \left(26^\circ, 731 \text{ mm.}\right)$

$C_{10}H_{19}N_3S$ (285.40) calc'd: $N 14.73%$

found: $N 14.84%$

b) $N$-$o$-tolylaminoacetonitrile afforded $N$-methyl-$o$-toluidine, b. p. 105-112$^\circ$C/20 mm. (reported$^{18} 98.5-99^\circ$C/17 mm.) in 30.0% yield (hydrochloride: m. p. 124$^\circ$C) and $N$-$o$-tolylethylenediamine in 18.7% yield. B. p. 152-7$^\circ$C/15 mm. (reported$^{20} 157-160^\circ$C/15 mm.). Phenylthiourea derivative, m. p. 113$^\circ$C.

**Anal.**

3.593 mg. subst.: 0.475 ml. $N_2 \left(24^\circ, 734 \text{ mm.}\right)$

$C_{10}H_{19}N_3S$ (285.40) calc'd: $N 14.73%$

found: $N 14.67%$

c) $N$-$m$-tolylaminoacetonitrile gave after reduction $N$-methyl-$m$-toluidine, b. p. 107$^\circ$C/13 mm., 207-8$^\circ$C (reported$^{18} 206-7^\circ$C) in 60.4% yield. Hydrochloride: m. p. 136-7$^\circ$C. The second fraction, b. p. 156-160$^\circ$C/13 mm., was $N$-$m$-tolylethylenediamine, obtained in 16.1% yield. Hydrochloride: m. p. 216-7$^\circ$C (reported$^{20} 188^\circ$C/28 mm. for the base and m. p. 213$^\circ$C for the hydrochloride).

Phenylthiourea derivative: m. p. 109$^\circ$C.

**Anal.**

3.133 mg. subst.: 0.424 ml. $N_2 \left(23^\circ, 734 \text{ mm.}\right)$

$C_{10}H_{19}N_3S$ (285.40) calc'd: $N 14.73%$

found: $N 15.02%$
d) N-cyclohexylaminoacetonitrile afforded N-methyl-cyclohexylamine in 14.8% yield. B. p. 148°C, hydrochloride: m. p. 195°C (reported14 145—7°C for the base and m. p. 198°C for the hydrochloride). N-cyclohexylenediamine was obtained as a fraction with b. p. 95—6°/12 mm. in 19.4% yield. Diphenylthiourea derivative: m. p. 152°C.

\[ \text{Anal.} \quad 3.164 \text{ mg. subst.: } 0.397 \text{ ml. } N_2 \left(25^\circ, 731 \text{ mm.}\right) \]
\[ \text{C}_{22}\text{H}_{25}\text{N}_4\text{S}_2 \left(412.61\right) \text{ calc'd: } N \quad 13.58\% \]
\[ \text{found: } N \quad 13.82\% \]

\[ \text{e) } N\text{-benzylaminoacetonitrile gave after reduction } N\text{-methylbenzylamine in } 3.5\% \text{ yield. B. p. 70°C/13 mm., 180°C, hydrochloride: m. p. 176°C (reported}^{18} 78°C/14 \text{ mm. and } 180—1°C \text{ for the base and m. p. } 175°C \text{ for the hydrochloride). } N\text{-benzylethylenediamine was obtained in } 25.0\% \text{ yield, b. p. } 134-5°C \text{ il8 mm. Diphenylthioura derivative: m. p. } 169°C. \]

\[ \text{Anal.} \quad 3.076 \text{ mg. subst.: } 0.385 \text{ ml. } N_2 \left(27^\circ, 729 \text{ mm.}\right) \]
\[ \text{C}_{22}\text{H}_{24}\text{N}_4\text{S}_2 \left(420.58\right) \text{ calc'd: } N \quad 13.33\% \]
\[ \text{found: } N \quad 13.66\% \]

REFERENCES

5. Houb en-W eyl, Methoden der organischen Chemie, Band XI/1, Stickstoff-
verbindungen II., G. Thieme Verlag, Stuttgart, 1957.
6. V. M. Mićović and M. Lj. Mihailović, Lithium Aluminium Hydride in Organic
Chemistry, Serbian Academy of Sciences Monograph Vol. 237, Naučna
7. N. G. Gaylord, Reduction with Complex Metal Hydrides, Interscience Publ.,
8. Z. Wel vart, Compt. rend. 233 (1951) 1121.
15. P. S. Wadi a, N. Ana ud and M. L. Dh ar, J. Sci. Ind. Research (India) 17 B
(1958) 24.
17. E. Knoe ven agel, Ber. 37 (1904) 4073.

IZVOD

Redukcija nekih \( N \)-supstituiranih aminoacetonitrila s litijevim aluminijevim hidridom

C. Benko i M. Tišler

Pri redukciji nekih \( N \)-supstituiranih (aril, benzil i cikloheksil) aminoacetonitrila s litijevim aluminijevim hidridom nastaju pored \( N \)-supstituiranih etilendiamina i odgovarajući \( N \)-metilamini s različitim iskorištenjem.