

Can Nitroalkanes be Obtained Directly from Alcohols and Sodium Nitrite in Acetic Acid – Hydrochloric Acid Mixture?

Mieczysław Mąkosza,* Michał Barbasiewicz, Krzysztof Wojciechowski

Institute of Organic Chemistry Polish Academy of Sciences, ul. Kasprzaka 44/52, P.O.Box 58, PL 01-224 Warszawa 42, Poland

E-mail: icho-s@icho.edu.pl

Received 17 April 2001

Abstract: The report that nitroalkanes can be obtained from aliphatic alcohols and sodium nitrite in acetic acid - hydrochloric acid mixture was shown erroneous. Under these conditions no nitroalkanes but alkyl nitrites were formed.

Key words: nitroalkanes, alkyl nitrites, sodium nitrite, acetic acid, hydrochloric acid

In the July 2000 issue of *Synlett* the communication entitled *A Simple and Highly Efficient Procedure for the preparation of Aliphatic Nitro Compounds Directly from Alcohols* by Baruah, Kalita and Barua was published.¹ The results presented in this *Letter* appeared very interesting but unusual to us. According to the described procedure aliphatic nitro compounds were prepared in high yields from primary, secondary and tertiary alcohols, also of benzylic character via simple treatment with sodium nitrite and a mixture of acetic and hydrochloric acids in dichloromethane, conditions very similar to those routinely applied in the synthesis of alkyl nitrites.²

The striking discrepancy between the common knowledge and these reported unexpected results, and our continuous interest in the chemistry of nitroalkanes prompted us to verify this procedure. Here we report that these results are entirely erroneous.

To verify these results we have chosen three alcohols of different character which according to the communication¹ were efficiently converted into nitroalkanes (Table in ref. 1 entries 4, 10, and 12). We used as simple primary aliphatic alcohol 1-hexanol analogous to entry 12, as a tertiary alcohol 1-methylcyclohexan-1-ol (entry 10), and 4-methoxybenzyl alcohol (entry 4).

We have repeated several times the reported procedure¹ of synthesis of nitroalkanes from these alcohols and have found that the only nitrogen containing products are the corresponding alkyl nitrites. By comparison of the obtained compounds³ with the corresponding nitro compounds⁴ and 1-hexyl nitrite² prepared independently, we could prove that there are not even traces of the nitro compounds in the reaction mixture. Selected data of the alkyl nitrites obtained in the reactions performed according to the procedure presented in ref. 1 and data of the nitro compounds prepared by known methods are collected in the Table.

We compared the GC⁵ retention times of the independently obtained standards of nitroalkanes with the retention

times of the products in the crude reaction mixtures obtained according to the procedure of ref. 1. In all instances we have not detected even traces of the expected nitroalkanes. The reaction mixtures contained nitrites and unreacted alcohols, and in the case of the reaction with 4-methoxybenzyl alcohol small amounts of anisaldehyde were also detected. In the ¹H NMR spectra the diagnostic chemical shifts of the α -methylene protons of the standard 1-nitrohexane and 4-(nitromethyl)anisole did not match the signals in the NMR spectra of the crude products obtained from the corresponding alcohols. Similarly, the ¹³C NMR chemical shifts of the obtained products did not fit the shifts of the standard nitroalkanes. Also the IR spectra of the crude reaction mixtures did not show the characteristic bands in the region of 1550 cm⁻¹ corresponding to the nitro group.

Thus, there is no doubt that the results presented in ref. 1 are erroneous and that under the described conditions only alkyl nitrites are produced. This is obvious from the mechanistic considerations because the reaction between alcohols and sodium nitrite in acidic medium can proceed via addition of NO⁺ to the oxygen in the case of primary alcohols, or via an addition of carbocation to nitrite anion for tertiary and benzylic alcohols, always with formation of nitrites but not nitro compounds.



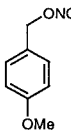
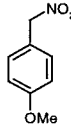
Since nitroalkanes are important and versatile starting materials in organic synthesis⁶ it seems necessary to inform the scientific community that they cannot be obtained as reported in reference 1.

References and Notes

- (1) Baruah, A., Kalita, M., Barua N. C. *Synlett* **2000**, 1064.
- (2) Noyes, W. A., *Org. Synth. Coll. Vol. II*, p. 108. **1-Hexyl nitrite**, ¹H NMR δ (CDCl₃) 0.84-0.95 (m, 3H, C-6 CH₃), 1.20-1.49 (m, 6H, C-3,4,5 CH₂), 1.65-1.82 (m, 2H, C-2 CH₂), 4.69 (t, 2H, *J* = 6.6 Hz, C-1 CH₂). ¹³C NMR δ (CDCl₃) 13.8, 22.5, 25.5, 28.9, 31.4, 68.4. IR 1650, 1605 cm⁻¹. MS (*m/z*, %): 85 (2), 71 (2), 60 (16), 55 (15), 43 (100).
- (3) The crude reaction mixtures obtained following the procedure described in ref. 1.
1-Hexyl nitrite obtained from hexyl alcohol, ¹H NMR δ (CDCl₃) 0.77-1.07 (m), 1.14-1.46 (m), 1.65-1.81 (m, 2H, C-2 CH₂), 4.69 (t, 2H, *J* = 6.6 Hz, C-1 CH₂). ¹³C NMR δ (CDCl₃) 13.9, 22.5, 25.6, 29.0, 31.4, 68.4. IR 1650, 1605 cm⁻¹. MS (*m/z*, %) 85 (2), 71 (2), 60(16), 55(21), 43(100).
1-Methylcyclohexyl nitrite obtained from 1-methylcyclohexanol, ¹H NMR δ (CDCl₃) 0.77-1.00 (m), 1.23-1.34 (m), 1.47-1.78 (m), 2.00-2.13 (m). ¹³C NMR δ

Table Selected data of the obtained compounds

$$\text{R-OH} \xrightarrow[\text{CH}_2\text{Cl}_2]{\text{NaNO}_2, \text{HCl}, \text{AcOH}} \begin{cases} \text{R-ONO} \\ \text{R-NO}_2 \end{cases}$$

Compound	GC retention time (min)	^1H NMR -CH ₂ ONO or -CH ₂ NO ₂ δ (ppm)	^{13}C NMR >C=ONO or >C=NO ₂ δ (ppm)	IR -ONO or -NO ₂ (cm ⁻¹)
n-C ₆ H ₁₃ ONO	2.4 (2.4) ^{a,b}	4.69	68.4	1650
n-C ₆ H ₁₃ NO ₂	7.3 ^b	4.38	75.7	1555
	3.8 ^b	-	83.6	1625
	9.7 ^b	-	88.4	1540
	2.2 ^c	5.60	159.7	1645
	4.3 ^c	5.35	160.7	1555

^a in parentheses the retention time of 1-hexyl nitrite obtained according to the procedure²^b GC parameters 70 °C (5 min) then 5 °C/min to 300 °C^c GC parameters 150 °C (5 min) then 10 °C/min to 300 °C

(CDCl₃) 14.0, 21.9, 22.7, 25.2, 27.7, 31.6, 37.4, 83.6. IR 1625 cm⁻¹. MS (m/z, %) 128 (M⁺, 1), 97 (9), 55 (24), 43 (100).

4-Methoxybenzyl nitrite obtained from p-methoxybenzyl alcohol, ^1H NMR δ (CDCl₃) 3.75 (s, 3H), 5.60 (s, 2H), 6.82–6.91 (m, 2H), 7.19–7.31 (m, 2H). ^{13}C NMR δ (CDCl₃) 55.1, 69.8, 114.0, 129.8, 131.8, 159.7. IR 1645, 1615, 1515 cm⁻¹. MS (m/z, %) 167 (M⁺, 4), 135 (32), 121 (100), 107 (22), 92 (34), 77 (87).

- (4) The standard 1-nitrohexane is commercially available (Fluka). **1-nitrohexane** (CH₃(CH₂)₅NO₂), ^1H NMR δ (CDCl₃) 0.85–0.94 (m, 3H, C-6 CH₃), 1.24–1.48 (m, 6H, C-3,4,5 CH₂), 1.93–2.09 (m, 2H, C-2 CH₂), 4.38 (t, 2H, J = 7.1 Hz, C-1 CH₂). ^{13}C NMR δ (CDCl₃) 13.8, 22.3, 25.8, 27.3, 30.9, 75.7. IR 1555 cm⁻¹. MS (m/z, %) 85 (4), 69 (2), 55 (45), 41 (100).

1-Methyl-1-nitrocyclohexane was prepared according to Kornblum, N., Clutter, R. J., Jones, W. J. *J. Am. Chem. Soc.* **1956**, 78, 4003: **1-methyl-1-nitrocyclohexane** ^1H NMR δ (CDCl₃) 1.28–1.73 (m, 11H), 2.31–2.45 (m, 2H). ^{13}C NMR δ (CDCl₃) 22.4, 24.6, 27.1, 35.6, 88.4. IR 1540 cm⁻¹. MS (m/z, %) 97 (65), 55 (100), 41 (31), 39 (30).

4-(Nitromethyl)anisole was obtained according to the procedure of Hauser, F. M. and Baghdanov, V, M. *J. Org. Chem.* **1988**, 53, 2873–2675 via nitration of the dianion of 4-methoxyphenylacetic acid with methyl nitrate followed by decarboxylation: **4-nitromethyl-anisole**, ^1H NMR δ (CDCl₃) 3.80 (s, 3H, OCH₃), 5.35 (s, 2H, CH₂NO₂), 6.87–6.98 (m, 2H, H_{arom}), 7.31–7.40 (m, 2H, H_{arom}). ^{13}C NMR δ (CDCl₃) 55.2, 79.4, 114.3, 121.9, 131.4, 160.7. IR 1615, 1555, 1515 cm⁻¹. MS (m/z, %) 167 (M⁺, 0.5), 121 (100), 91 (9), 78 (26).

- (5) Gas chromatography was performed on Hewlett-Packard HP 5890 Series II gas chromatograph coupled directly to MSD 5972A mass-sensitive detector. HP-5 MS capillary column (30 m length, 0.25 mm ID) was used. Injector temperature 250 °C. The column temperature was programmed as shown in the footnote to the Table.
- (6) Rossini, G.; Ballini, R. *Synthesis* **1988**, 833.

Article Identifier:

1437-2096,E;2001,0,07,1121,1122,ftx,en;G07501ST.pdf