This article was downloaded by: [University Of Pittsburgh] On: 14 November 2014, At: 02:30 Publisher: Taylor & Francis Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry

Publication details, including instructions for authors and subscription information: http://www.tandfonline.com/loi/lsyc20

Novel System for the Synthesis of Nitriles from Aldehydes Using Aqueous Ammonia and [Bis(Trifluoroacetoxy)iodo]benzene

Vikas N. Telvekar^a, Rajesh A. Rane^a & Tejal V. Namjoshi^a ^a Department of Pharmaceutical Sciences and Technology, University Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai, India Published online: 03 Feb 2010.

To cite this article: Vikas N. Telvekar, Rajesh A. Rane & Tejal V. Namjoshi (2010) Novel System for the Synthesis of Nitriles from Aldehydes Using Aqueous Ammonia and [Bis(Trifluoroacetoxy)iodo]benzene, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 40:4, 494-497, DOI: <u>10.1080/00397910902985549</u>

To link to this article: http://dx.doi.org/10.1080/00397910902985549

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms &

Conditions of access and use can be found at <u>http://www.tandfonline.com/page/terms-and-conditions</u>





NOVEL SYSTEM FOR THE SYNTHESIS OF NITRILES FROM ALDEHYDES USING AQUEOUS AMMONIA AND [BIS(TRIFLUOROACETOXY)IODO]BENZENE

Vikas N. Telvekar, Rajesh A. Rane, and Tejal V. Namjoshi

Department of Pharmaceutical Sciences and Technology, University Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai, India

A simple and mild method for the conversion of varieties of aldehydes to the corresponding nitriles using aqueous ammonia and trivalent hypervalent iodine reagent, [bis(trifluoroacetoxy)iodo]benzene, at room temperature is discussed. Advantages of this system are short reaction time, easy workup, and moderate to good yields.

Keywords: Aldehydes; aqueous ammonia; [bis(trifluoroacetoxy)iodo]benzene; nitriles

INTRODUCTION

A number of methods are known for the conversion of aldehydes into nitriles from the corresponding aldehydes via dehydration of aldoximes or use of reagents such as trimethylsilyl azide,^[1] triazidochlorosilane,^[2] sodium azide, and aluminium chloride.^[3] There are several methods developed using a combination of ammonia with other compounds, such as $NH_3/O_2/CuCl_2 \cdot 2H_2O/MeONa$ in MeOH, $NH_3/Pb(OAc)_4$ in dry benzene,^[4] NH_3/I_2 in tetrahydrofuran (THF)–water,^[5] NH_3/N bromosuccinimide (NBS) in water,^[6] and NH_3/O -iodoxy benzoic acid (IBX) in acetonitrile.^[7] Although most of these methods are satisfactory, the use of more complex, hazardous reagents such as $Pb(OAc)_4$ and potentially explosive reagents such as IBX, as well as sometimes tedious workup and longer reaction time, means that there is still scope for alternative reagent systems for the preparation of nitriles from aldehydes.

Our group has been working extensively to develop novel methodologies under mild reaction conditions using various hypervalent iodine reagents.^[8,9] [Bis(trifluor-oacetoxy)iodo]benzene is commercially available as a colorless crystalline solid. It is fairly stable and can be kept without refrigeration for a long period of time with light protection and is reported for the synthesis of N-arylated and N-alkylated heterocyclic fused aromatic compounds,^[10] synthesis of pyrrolidinone and lactone skeletons,^[11] oxidative deprotection of dithiane containing alkaloids,^[12] and direct α -hydroxylation of ketones.^[13]

Received January 31, 2009.

Address correspondence to Vikas N. Telvekar, Department of Pharmaceutical Sciences and Technology, University Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai 400019, India. E-mail: vikastelvekar@rediffmail.com



Scheme 1. Preparation of nitrile from aldehyde.

We observed that this reagent could be used in combination with aqueous ammonia at room temperature for the direct conversion of aldehydes to the corresponding nitriles. For our initial studies, benzaldehyde was chosen as model substrate (Scheme 1).

A mixture of benzaldehyde, aqueous ammonia, and [bis(trifluoroacetoxy) iodo]benzene [PhI(OOCCF₃)₂] was stirred at room temperature $(25^{\circ}C)$. The starting material was consumed within 30 min as indicated by thin-layer chromatography (TLC). After workup and purification by silica-gel column chromatography, benzonitrile was isolated in 92% yield. To the best of our knowledge, there is no report on the use of [bis(trifluoroacetoxy)iodo]benzene in aqueous ammonia for direct conversion of aldehydes to nitriles.

RESULTS AND DISCUSSION

Encouraged by these results, we subjected various aromatic and aliphatic aldehydes to the reaction condition using [bis(trifluoroacetoxy)iodo]benzene, and the results are presented in Table 1. The results clearly indicate that ether, acetyl, and ester groups are stable in these conditions (Table 1, entries 4–7). Aliphatic aldehydes also underwent this transformation smoothly; pentanal and hexanal (Table 1, entries 12 and 13) were converted to the corresponding nitriles in good yields. Double bonds were not affected under these reaction conditions (Table 1, entries 9 and 10). Under similar reaction conditions, benzyaldehyde was successfully converted into nitrile by using [bis(acetoxy)iodo]benzene, but reaction time was increased to 3 h.

In conclusion, a novel method has been developed for the direct conversion of aldehydes to the corresponding nitriles using [bis(trifluoroacetoxy)iodo]benzene in combination with aqueous ammonia at room temperature. The method is mild and gave good to excellent yields of nitriles in the case of both aliphatic and aromatic substrates.

GENERAL PROCEDURE

PhI(OOCCF₃)₂ (1.2 equiv, 5.4 mmol) was added to a stirred solution of aldehyde (1.0 equiv, 4.5 mmol) in aqueous ammonia (15 mL of a 28–30% solution, sp. gravity 0.89). The resultant mixture was stirred at rt until the starting material had been completely consumed (TLC). The reaction mixture was diluted with water and extracted with chloroform (2 × 20 mL). The combined organic layer was washed successively with 10% aq. sodium bisulfite solution (2 × 15 mL) 10% aq. NaHCO₃ (2 × 15 mL), and finally H₂O (1 × 20 mL). The organic layer was dried over Na₂SO₄

Table 1. Synthesis of nitriles from aldehydes using [bis(trifluoroacetoxy)iodo]benzene and aqueous ammonia^a

Entry	Substrate ^b	Product	Time (min)	Yield (%) ^c
1	CHO	CN	30	92
2	СНО	CN	35	90
3	СНО	CN	36	84
4	н ₃ со—Сно	H ₃ CO-CN	30	86
5	H ₃ CO CHO	H ₃ CO CN	40	85
6	сна сно	CH3 CN	40	90
7	H ₃ CO	H ₃ CO	40	85
8	сі—Сно	CI-CN	35	95
9	СНО	CN	30	85
10	СНО	CN CN	35	82
11	H ₃ CO СНО	H ₃ CO-CN	40	82
12	н₃с∽сно	H ₃ C CN	45	80
13	н _з с Сно	H ₃ C ^{CN}	45	82

"Reaction conditions: substrate (4.5 mmol), [bis(trifluoroacetoxy)iodo]benzene (1.2 equiv, 5.4 mmol), aqueous ammonia (15 mL), rt.

^bStarting compounds were prepared by standard literature procedures.

^cIsolated yields after column chromatography. Structures were confirmed by comparison of IR and ¹H NMR with those of authentic materials.

and concentrated in vacuo. The residue obtained was purified by silica-gel column chromatography (10% EtOAc-hexane) to afford pure nitriles.

ACKNOWLEDGMENT

We gratefully acknowledge the University Grants Commission, India, for financial support under the scheme of a UGC major research project.

REFERENCES

- 1. Nishiyama, K.; Oba, M.; Watanabe, A. Reaction of trimethylsilyl azide with aldehydes: Facial and convenient synthesis of diazides, tetrazoles, and nitriles. *Tetrahedron* **1987**, *43*, 693.
- Elmorsy, S. S.; El-Ahl, A. A. S.; Soliman, H.; Amer, F. A. Synthesis of triazidochlorosilane (TACS), a novel silicon-mediated one-pot conversion of aldehydes to nitriles. *Tetrahedron Lett.* 1995, *36*, 2639.
- Suzuki, H.; Nakaya, C. A. Convenient one-step method for converting electron-rich aromatic aldehydes into nitriles. *Synthesis* 1992, 641.
- Parameswaram, K. N.; Friedman, O. M. Synthesis of nitriles from aldehydes. *Chem. Ind.* (London) 1965, 988.
- 5. Talukdar, S.; Hsu, J. L.; Chou, T. C.; Fang, J. M. Direct transformation of aldehydes to nitriles using iodine in ammonia water. *Tetrahedron Lett.* **2001**, *42*, 1103.
- Bandgar, B. P.; Makone, S. S. Organic reaction in water: Transformation of aldehydes to nitriles using NBS under mild conditions. *Synth. Commun.* 2006, 36, 1347.
- 7. Arote, N. D.; Bhalerao, D. S.; Akamanchi, K. G. Direct oxidative conversion of aldehydes to nitriles using IBX in aqueous ammonia. *Tetrahedron Lett.* 2007, 48, 3651.
- 8. Telvekar, V. N.; Arote, N. D.; Herlekar, O. P. Mild and efficient method for decarboxylative bromination of α , β -unsaturated carboxylic acid with Dess–Martin periodinane. *Synlett.* **2005**, 2495.
- Telvekar, V. N.; Rane, R. A. A novel system for the synthesis of nitriles from carboxylic acids. *Tetrahedron Lett.* 2007, 48, 6051.
- Du, Y.; Liu, R.; Linn, G.; Zhao, K. Synthesis of N-substituted indole derivatives via PIFA-mediated intramolecular cyclization. Org. Lett. 2006, 8, 5919.
- Tellitu, I.; Serna, S.; Herrero, M. T.; Moreno, I.; Domínguez, E.; San Martin, R. Intramolecular PIFA-mediated cyclization, alkyne amidation, and carboxylation reaction. *J. Org. Chem.* 2007, *72*, 1526.
- Fleming, F.; Funk, L.; Altundas, R.; Tu, Y. Deprotecting dithiane containing alkaloids. J. Org. Chem. 2001, 66, 6502.
- Moriarty, R. M.; Berylund, B. A.; Penmasta, R. Direct α-hydroxylation of ketones under acidic conditions using [bis(trifluoroacetoxy)]iodobenzene. *Tetrahedron Lett.* 1992, 33, 6065.