



ONE POT SYNTHESIS OF NITRILES FROM ALDEHYDES AND HYDROXYLAMINE HYDROCHLORIDE USING ZINC OXIDE NANOPARTICLES IN DMF UNDER REFLUX CONDITION

Dinanath D.Patil*

Post Graduate Department of Chemistry, R.B.N.B.College, Shirampur-413709, Maharashtra, India.

ABSTRACT

A rapid and facile one pot synthesis of nitrile has been carried out in high yields from the corresponding aldehydes and hydroxylamine hydrochloride in the presence of anhydrous Zinc oxide nanoparticles and DMF under reflux condition.

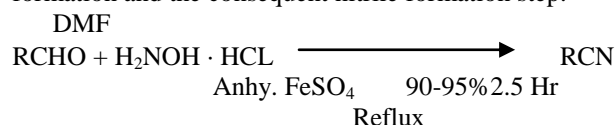
Keywords: Aldehydes, Hydroxylamine hydrochloride, Anhydrous Zinc oxide nanoparticles, Nitriles.

INTRODUCTION

Nitriles are widely used for transformation into amides amines, esters, carboxylic acid etc [1]. Hence they have been used as intermediates for the synthesis of fine chemicals such as agricultural chemicals, dyes and medicines [2]. One of the most general methods for the synthesis of nitriles is the nucleophilic substitution reaction of alkylhalide with metal cyanides. The method is however inconvenient because of high toxicity of metal cyanides and their trouble some handling. Consequently other method such as dehydration of primary amide [3] or aldoximes [4-7] has attracted attention.

It is known that dehydration of aldoximes into nitriles can be achieved by using variety of reagents like triethylamine/sulphur dioxide, zeolites [5], fluoride [6], sulfurylchloride [7] etc but many of these suffer from limitations such as high toxicity, vigorous reaction conditions, unsatisfactory yield, tedious work up and use of large excess of reagents. A rapid synthesis of nitriles in high yields from aldoximes using Silica gel [8a] and also one pot synthesis of nitrile from aldehyde and hydroxylamine hydrochloride using silica gel, Mont K.10 and KSF catalyst in dry media under microwave irradiation [8b]. Some rapid procedure for one pot synthesis of nitriles have been described using formic acid [9] and potassium peroxy monosulphate [10], but whereas the first method suffers from undesirable action of formic acid that can affect acid sensitive aldehydes, the second suffers from the undesirable oxidation of some of the functional group. So there exists a need for developing rapid and facile methods for one pot synthesis of nitriles. We report a rapid one pot synthesis of nitriles from aldehydes and hydroxylamine hydrochloride using

anhy.Zinc oxide nanoparticles and DMF under reflux condition which we thought would catalyze both the oxime formation and the consequent nitrile formation step.



Scheme 1

There has been a growing interest over the past few years to carry out organic reactions. over heterogeneous catalyst, because of simple set ups and workup, lesser chemical degradation, higher product purity and chemical yield. Investigations were initiated with 4-Methyl benzaldehyde being chosen as a model compound. It was refluxed with hydroxylamine hydrochloride in presence of anhy.Zinc oxide nanoparticles and DMF.

Spectral Data:

P-Tolunitrile (2). Bp 215-217 °C [lit. 220 °C] 61; IR (KBr) (ν_{max} , cm⁻¹): 3039, 2229; ¹H NMR (CDCl₃, 500MHz): δ H 7.23 (2H, d, *J*= 7.4 Hz, H-Ar), 7.47 (2H, d, *J*= 7.4 Hz, H-Ar).

Pentanenitrile (14). Bp 139-141 oC [lit. 142 oC]72; IR (KBr) (ν_{max} , cm⁻¹): 2742, 2683, 2247; ¹H NMR (CDCl₃, 500MHz): δ H 0.96 (3H, t, *J*= 2.8 Hz, H-Aliph), 1.68 (2H, m, H-Aliph), 1.50 (2H,m, H-Aliph), 2.34 (2H, t, *J*= 2.8 Hz, H-Aliph).

4-Methoxybenzonitrile (3h). Mp 57-59 oC [lit. 62-63 oC]66; IR (KBr) (ν_{max} , cm⁻¹): 3068, 2219; ¹H NMR (CDCl₃, 500MHz): δ H 3.73 (3H, s, Me), 6.95 (2H, d, *J*= 9.1 Hz, H-Ar), 7.40 (2H, d, *J*=9.1 Hz, H-Ar).

Experimental Reaction

General procedures, melting points were determined in open capillaries. ^1H NMR (CDCl_3) Spectra were recorded on a jeol F \times 90 Q. instrument using TMS as internal standard. IR spectra were recorded on a Perkin Elmer 782 spectrophotometer. TLC was carried out on silica gel G plates with benzene / ethyl acetate (4:1) system.

Typical experimental procedure

4-Methyl benzaldehyde (120 mg 1mmol), hydroxylamine hydrochloride (105 mg 1.2 mmol) were mixed with Zinc oxide nanoparticles (1 mmole) and taken in 25 ml Round bottom flask and 5 ml DMF was added. Whole mixture was refluxed for 3-6 hrs. The catalyst was filtered off and the resultant solution extracted and evaporated to give residue which was purified by chromatography using benzene / ethyl acetate (4:1) as eluent to afford the desired nitrile (95% yield) [11,12].

RESULT AND DISCUSSION

The best yield of 92% was obtained after 3.2 hrs. Hence, all the subsequent reactions were carried out under

this reaction conditions a variety of substituted aromatic aldehydes (1-13) and aliphatic aldehydes (14-16) including. The reactions were monitored by TLC. The products yields and reaction times are collected and presented in the table 1. All the products are known compounds and were identified on the basis of their spectroscopic analysis and by direct comparison of their M.P. with those of authentic samples¹¹. The products were obtained in more than 90% purity as determined by ^1H NMR and were further purified by chromatography. As we have observed, the nitriles were formed in high yield of 90-95% within 3-6hrs. It should be noted that the nitriles were formed with 1-2% yield under identical reaction conditions in the absence of catalyst thereby confirming the role of the catalyst in the reaction.

In summary, we have demonstrated the use of inexpensive, easy to handle and environmental friendly anhy. Zinc oxide nanoparticles as catalyst in rapid one pot synthesis of nitriles from aldehyde and hydroxyl amine hydrochloride in high yield.

Table 1. One pot synthesis of nitriles from aldehydes and hydroxylamine Hydrochloride using anhy. Zinc oxide nanoparticles in DMF at reflux condition

Entry	Reactant	Product	Isolated Yield %	Time in Hr
1	Benzaldehyde	Benzonitril	90%	3. hours 30 min.
2	4-Methyl Benzaldehyde	4-Methyl Benzonitrile	95%	3hours 20min..
3	4-MethoxyBenzaldehyde	4-MethoxyBenzonitrile	88%	4 hours.
4	2-Hydroxy Benzaldehyde	2-Hydroxy Benzonitrile	85%	4 hrs
5	4-Hydroxy Benzaldehyde	4-Hydroxy Benzonitrile	80%	4 hrs
6	2-Chloro Benzaldehyde	2-Chloro Benzonitrile	90%	2hrs 30 min.
7	4-Hydroxy-3-Methoxy Benzaldehyde	4-Hydroxy-3-Methoxy Benzonitrile	91%	5 hrs
8	2,3-dimethoxy Benzaldehyde	2,3-dimethoxy Bezonitrile	90%	5 hrs
9	2,3,4-trimethoxy Benzaldehyde	2,3,4-trimethoxy Benzonitrile	85%	6 hrs
10	3-N,N-dimethyl Benzaldehyde	3-N,N-dimethyl Benzonitrile	93%	4 hrs30 min
11	2-Nitro Benzaldehyde	2-Nitro Benzonitrile	85%	2 hrs20min.
12	4-Methyl-3-Nitro Benzaldehyde	4-Methyl-3-Nitro Benzonitrile	90%	3 hrs3
13	3-Nitro Benzaldehyde	3-Nitro Benzonitrile	83%	2hrs 20min.
14	Pentanal	Pentanitrile	90%	4 hrs 30 min.
15	Hexanal	Hexanitrile	92%	4 hrs 15 min.
16	Heptanal	Heptanitrile	95%	4 hrs.

REFERENCES

- Cohen MA, Sawden J, Turner NJ. *Tetrahedron Lett*, 317, 1990, 223.
- Fabiani ME. *Drug News Perspect*, 12, 1999, 207.
- Baxendale IR. Ley SV, Sneddon FH. *Synlett*, 5, 2002, 775.
- Olah GA, Vankar YD. *Synthesis*, 1978, 702.
- Rao M, Narayana Kumar P, Garyali K. *Org. Prep. Proceed. Int*, 212, 1989, 30.
- Olah GA, Narang SC, Garcia-Luma A. *Synthesis*, 1980, 659.
- Krynitsky JA, Carhart HM. *Org Synth. Coll*, 4, 1963 436.
- Dewan SK, Singh R. *Synth Commun.*, 33, 2003, 385.
- Dewan SK, Singh R, Kumar A. *Synth. Commun*, 2004, 20-25.
- Feng JC, Lin B, Dai L, Bian NS. *Syn. Commun.*, 28, 1998, 3765.
- Bose DS, Narsaiah AV. *Tetrahedron Lett.*, 39, 1998, 6533.
- Dewan SK, Singh R. *Synth. Commun.*, 33, 2003, 3085.