An Efficient Approach for the Conversion of Oximes into Carbonyl Compounds Using Dichloramine-T

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Received 30 March 2007; revised 27 April 2007

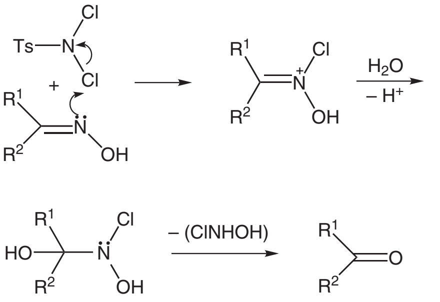
Abstract: An efficient approach for the conversion of oximes into the corresponding carbonyl compounds using dichloramine-T is described. The reaction was performed in acetonitrile in the presence of small amount of water. In comparison to reported oxidative deoximating agents, the reaction was rapid and gave good yields of the products. The conversion was found to be chemoselective and during the reaction sensitive groups, like phenolic and C=C bonds, remained intact.

Key words: dichloramine-T, oximes, carbonyl compounds, acetonitrile, chemoselective

Oximes are a very important class of organic compounds that have been used for the purification and characterization for carbonyl compounds.[1] Thus, they have been used as a protecting group for carbonyl compounds. The reverse process, i.e., regeneration of carbonyl compounds from oximes, has also been studied and reviewed extensively and a large number of reagents have been developed.[2] These methods, however, suffered from disadvantages such as long reaction times, harsh reaction conditions,[3] difficulties in product purification,[4] and low product yields.[2b] Moreover, the majority of these agents are oxidative in nature and, hence, the formation of overoxidized products is a serious problem.[2b] In the course of our investigations, we have found that dichloramine-T (*N*,*N*-dichloro-4-toluenesulfonamide, DCT) can be used as an efficient reagent for the conversion of oximes into the corresponding carbonyl compounds. Dichloramine-T is a convenient source of positive chlorine and is widely used as a chlorinating agent. To the best of our knowledge, there are no reports of the use of this reagent as a deoximating agent and, herein, we report our results on the use of dichloramine-T for the conversion of oximes into their corresponding carbonyl compounds.

Initially, we examined the reaction of benzophenone oxime with dichloramine-T. The reaction was carried out in acetonitrile at room temperature; a small amount of water was also required for completion of the reaction. The reaction was very fast and gave a quantitative yield of benzophenone. It is evident that among all the deoximating reagents, dichloramine-T was the fastest and most efficient (Table 1). Although other deoximating reagents are known that give benzophenone from benzophenone oxime in comparable yield, longer reaction times are required. The results of the deoximation of benzophenone oxime with dichloramine-T is compared to reported results for various reagents from the literature in Table 1.[2b,f,4–8]

To further prove the utility of dichloramine-T as a deoximating reagent, a variety of oximes were deoximated with dichloramine-T (Table 2). Mechanistically, the reaction of dichloramine-T with oxime proceeds with the initial electrophilic attack of positive chlorine provided by dichloramine-T on the oximic nitrogen. Subsequent nucleophilic addition of water followed by elimination of chlorohydroxylamine gives the target compound (Scheme 1).



Scheme 1

It can be inferred that the rate of the deoximation reaction will depend on the availability of the lone pair of electrons on the oximic nitrogen, which ultimately depends on the nature of the substituents attached to the oximic carbon. For this reason, ketoximes having two electron-donating alkyl groups were found to react faster than aldoximes (Table 2, entry 1 vs entry 6). In the case of aromatic oximes, the resonance of the oximic double bond with the benzene ring decreases the nucleophilicity of the oximic nitrogen, which retards the rate of the reaction (Table 2, entries 6–8), therefore, longer reaction times were required for such oximes. The presence of electron-withdrawing groups on the benzene ring further reduces the rate of deoximation (Table 2, entry 7). Dichloramine-T was found to be selective for the conversion of oximes to carbonyl compounds and no byproduct formation was observed. Unlike other reported deoximating agents, dichloramine-T is not oxidative in nature. Hence, the formation of overoxidized product was not detected

SYNTHESIS 2007, No. 13, pp 1930–1932
Advanced online publication: 18.06.2007
DOI: 10.1055/s-2007-983731; Art ID: Z08407SS

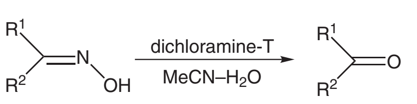
Table 1 Deoximation of Benzophenone with Various Reagents

Entry	Reagent	Time	Yield (%)	Ref.
1	dichloramine-T ($TsNCl_2$)	1 min	95	–
2	pyridinium dichromate (PDC)	4.5 h	98	4
3	chlorotrimethylsilane (TMSCl)	3 h	98	5
4	1,3-dichloro-5,5-dimethylhydantoin (DCDMH)	2 h	82	6
5	cetyltrimethylammonium permanganate {$[Me(CH_2)_{15}]Me_3N^+ MnO_4^-$, CTAP}	40 min	95	7
6	*o*-iodoxybenzoic acid (IBX)	20 min	92	2b
7	Dess–Martin periodinane (DMP)	10 min	100	2f
8	thallium trinitrate [$Tl(NO_3)_3$, TTN]	5 min	86	8

(checked by TLC and GC-MS). The usefulness of this reagent was further demonstrated by the good to excellent yield of products obtained during deoximation of cyclic (Table 2, entry 2) and sterically hindered (Table 2, entry 10) oximes in shorter reaction times. The reaction took place at room temperature with all the ketoximes, but with aldoximes and less reactive oximes, refluxing conditions were required.

The reagent was found to work less efficiently with the substrates like salicylaldehyde oxime (Table 2 entry 8) and cinnamaldehyde oxime (Table 2, entry 9) where the availability of the lone pair of electron on the oximic nitrogen was considerably reduced because of intramolecular hydrogen bonding or extended conjugation, respectively. With such oximes, longer reaction times with refluxing are required to give better yield of the product. However, dichloramine-T showed excellent chemoselectivity during these reactions and phenolic group and C=C bonds remained intact.

Table 2 Conversion of Oximes into the Corresponding Carbonyl Compounds in the Presence of Dichloramine-T



Entry	R^1	R^2	Temp	Time	Yield[a] (%)
1	Me	Me	r.t.	1 min	98
2	$(CH_2)_5$		r.t.	1 min	97
3	Ph	Me	r.t.	1 min	97
4	Ph	Ph	r.t.	1 min	95
5	$4\text{-}ClC_6H_4$	Me	reflux	1 min	96
6	Ph	H	reflux	4 h	84
7	$2\text{-}ClC_6H_4$	H	reflux	6 h	77
8	$2\text{-}HOC_6H_4$	H	reflux	8 h	89
9	CH=CHPh	H	reflux	5 h	79
10	camphor		reflux	1 h	97

[a] All the products were characterized by GC-MS and compared to authentic samples.

In conclusion, dichloramine-T was found to be an efficient reagent for the conversion of oximes into their corresponding carbonyl compounds. The conversion was very efficient, fast, and gave better yields of the product in comparison to previously reported deoximating reagents. The reagent is very mild and byproducts and overoxidation products were not formed. The peculiarity of dichloramine-T as deoximating reagent lies in the fact that sensitive functional groups also survived after the reaction. In addition, during the reaction process, dichloramine-T was converted into the 4-toluenesulfonamide, which can easily be separated from the reaction mixture and reconverted into dichloramine-T and thus can be recycled.

The carbonyl compounds formed were characterized by their physical data, which were in accord with values reported in the literature, and GC-MS analysis.

Conversion of Oximes into Carbonyl Compounds: General Procedure

To the soln of oxime (10 mmol) in MeCN containing small amount of H_2O (2%) was added dichloramine-T (10 mmol) and the resulting mixture was stirred until the reaction was complete (monitored by TLC and GC). The solvent was evaporated on rotary evaporator and the crude product was purified by flash chromatography (hexane–EtOAc, 9:1).

Acknowledgements

Authors thank Er. K. Sekhar, Director, Defence Research and Development Establishment, Gwalior for his keen interest and encouragement. We sincerely thank Dr. D. K. Dubey and Dr. P. K. Gutch for their support.

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