1,3-Dichloro-5,5-dimethylhydantoin (DCDMH) as a New Oxidizing Agent for the Facile and Selective Oxidation of Oximes to Their Carbonyl Compounds

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Oximes are converted to the parent carbonyl compounds in good yields when treated with 1,3-dichloro-5,5-dimethylhydantoin (DCDMH) (**1**). An optimized procedure has been developed; the simple work-up minimizes loss of product and oximes have been selectively oxidized in the presence of alcohols and alkenes.

Keywords: Alcohols; Alkenes; Carbonyl; Chemoselective; Oximes.

INTRODUCTION

Oximes are important for organic synthesis[1,2] and are extensively used as preferred derivatives for purification and characterization of carbonyl compounds.[3] Their synthesis from non-carbonyl compounds, such as by nitrosation of an active methylene group[4] or condensation of a nitro alkene with an aldehyde,[5] provides a valid alternative pathway to carbonyl compounds. So regeneration of carbonyl compounds from the corresponding oximes is a very important reaction. So far a good number of methods based on hydrolytic,[6] reductive,[7] and oxidative[8] reactions have been developed for deoximation. In spite of the many reagents available, there is still scope for newer reagents as the existing oxidative methods suffer from one or the other disadvantages like long reaction time, e.g. 18 hours in the case of t-butylhydroperoxide,[9] need for refluxing temperature, e.g. in case of manganese triacetate,[10] difficulties in isolation of products, e.g. with chromium based reagents,[11] and formation of over oxidation products leading to low yields. Also many reagents are not selective for oximes in the presence of alkenes,[12] or their selectivity patterns have not been explored.[13] We extended our work on the use of N-halo reagents, in organic methodology,[14] by the use of title reagent (DCDMH). In this letter we report a new oxidative method for deoximation using DCDMH (**1**), as a new selective oxidising agent that overcomes many of the disadvantages associated with oxidative methods developed so far. Dissolution of oximes in acetone with addition of a small amount of water and subsequent reaction with title reagent (**1**) under stirring at room temperature or reflux gave the corresponding carbonyl compounds in good yields, Scheme I.

RESULTS AND DISCUSSION

The results of the conversions of various oximes to their corresponding carbonyl compounds are presented in Table 1.

The aldoximes were converted to the corresponding aldehydes and no acid was formed due to overoxidation of the regenerated aldehyde (entries 3, 4, 7, 8, and 11), Scheme II.

Even the sterically hindered ketone oxime (entry 14) was succesfully oxidatively cleaved to the corresponding ketone in good yield. This procedure is also useful for the chemoselective oxidative deoximation of oximes in the presence of alcohols or for oximes that contain -OH functional group (entry 13). Thus, when equimolar mixtures of benzo-

Scheme I

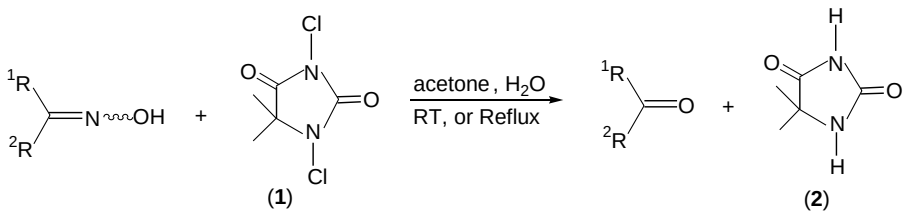
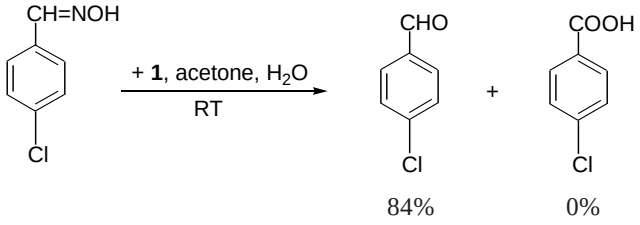


Table 1. Deoximation with DCDMH at room temperature

Entry	Substrate	Product	Time (h)	Yield (%)[a,b]
1	Cyclohexanone oxime	Cyclohexanone	1.5	88
2	Acetophenone oxime	Acetophenone	1.5	86
3	Benzaldehyde oxime	Benzaldehyde	2	84
4	4-Chloro benzaldehyde oxime	4-Chloro benzaldehyde	2	84
5	Benzophenone oxime	Benzophenone	2	82
6	4-Methyl acetophenone oxime	4-Methyl acetophenone	1.5	85
7	Isobutyraldehyde oxime	Isobutyraldehyde	2	83[d]
8	Cinnamaldehyde oxime	Cinnamaldehyde	2	68
9	Isobutyl methyl ketone oxime	Isobutyl methyl ketone	2	73
10	Diisopropyl ketone oxime	Diisopropyl ketone	2.3	70
11	2-Chloro benzaldehyde oxime	2-Chloro benzaldehyde	2.5	69[c]
12	Ethyl methyl ketone oxime	Ethyl methyl ketone	2.5	72[d]
13	Benzoin oxime	Benzoin	2	70[c]
14	Camphor oxime	Camphor	3.3	67[c]
15	Cyclopentanone oxime	Cyclopentanone	3	76

[a] Products were characterized by their physical constants, comparison with authentic samples, and melting points of 2,4-dinitro phenyl hydrazone derivatives and by their IR and NMR spectra.
[b] Isolated yields.
[c] Under reflux conditions.
[d] CH_2Cl_2/H_2O was used as reaction solvent.

Scheme II Selective formation of aldehyde from aldoxime



phenone oxime and benzyl alcohol in acetone and water were allowed to react with DCDMH at room temperature, the ketone oxime underwent chemoselectively oxidative deoximation giving (82%) benzophenone, whereas the benzyl alcohol was not oxidized to benzaldehyde, Scheme III (was checked by TLC).

The unsaturated oxime (entry 8) was cleaved to the corresponding unsaturated aldehyde without affecting the double bond. So we observed the competitive oxidation of oximes in the presence of alkenes. In a control experiment, when equimolar mixtures of benzophenone oxime and styrene in acetone and water were allowed to react with title reagent, at room temperature, the ketone oxime underwent chemoselectively oxidative deoximation giving (82%) benzophenone, whereas the styrene does not get oxidized to benzaldehyde, Scheme IV (was checked by TLC).

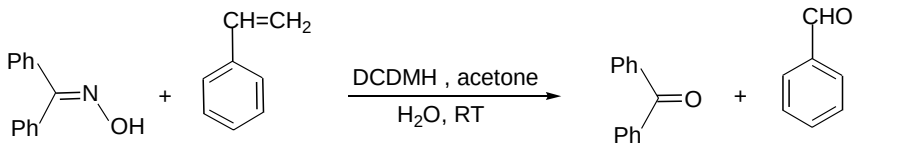
After the reaction was completed, according to Scheme I, 1,3-dichloro-5,5-dimethylhydantoin (**1**), was converted to the 5,5-dimethylhydantoin (**2**), thus **2** can be isolated, chlorinated, and reused many times as deoximating reagent.

CONCLUSIONS

In conclusion, the striking features of our method are;

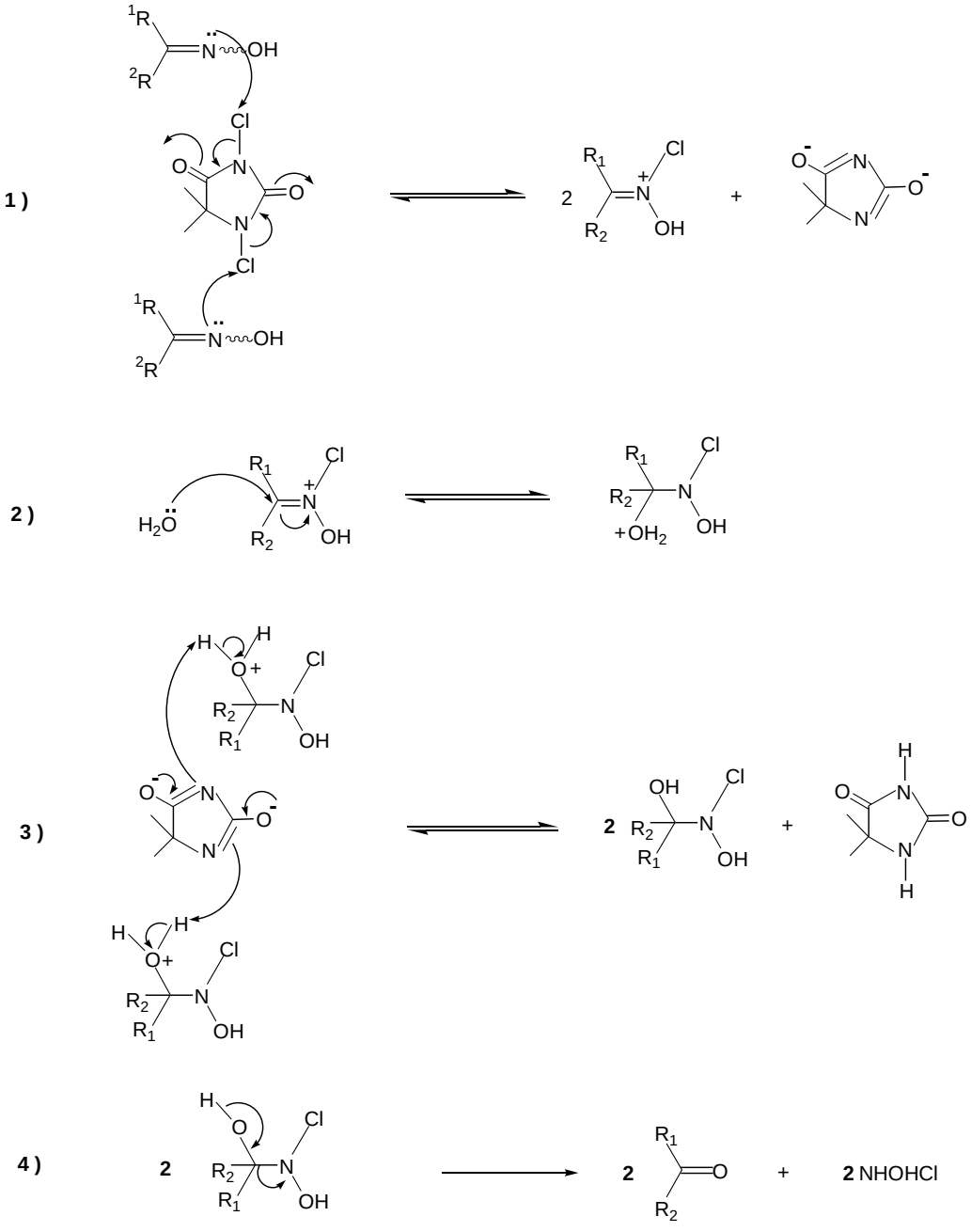
Scheme III Selective deoximation in the presence of benzyl alcohol

Scheme IV Chemoselective deoximation in the presence of styrene



82% Oxidized Alkene, 0%

Scheme V



the reaction occurs at room temperature; there is no formation of over oxidation products due to high chemoselectivity; and mild nature of the DCDMH. The OH and C=C functional groups in the oxime structure do not get oxidized to other functional groups; there is an easy work-up procedure, good yields and finally, the dechlorinated product **2** can be converted to **1** and reused several times.

The proposed mechanism for deoximation by title reagent is shown in Scheme V.[15]

EXPERIMENTAL SECTION

Melting points were uncorrected. IR and ^{1}H NMR spectra were recorded using a Shimadzu 435-U-04 spectrophotometer (KBr pellets) and a 90 MHz Jeol FT-NMR spectrometer, respectively. ^{1}H NMR chemical shifts were measured relative to TMS (int; 1H).

GENERAL PROCEDURE FOR DEOXIMATION

A mixture of the oxime (3 mmol) and 1,3-dichloro-5,5-dimethyl hydantoin **1**, (3 mmol, 591.07 mg) in acetone[a] (10 mL) and water (0.1 mL) was stirred at the temperature as indicated in Table 1 for the specified time. After the reaction was completed (TLC), the solvent was removed under reduced pressure, and CH_2Cl_2 or CCl_4* (10 mL) was added to the mixture; it was stirred for 10 minutes, then the 5,5-dimethyl hydantoin (**2**) was removed by filtration and the product was purified by column chromatography (hexane/diethyl ether)[a].

* [For benzoin oxime; after the reaction was completed, the solvent was removed under reduced pressure, and product was purified by column chromatography (hexane/Et_2O].

[a] CH_2Cl_2 was used for isobutyraldehyde, and ethyl methyl ketone.

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REFERENCES

1. Wang, E.-C.; Huang, K.-S.; Chen, H.-M.; Wu, C.-C.; Lin, G.-J. *J. Chinese Chem. Soc.* **2004**, *51*, 619.
2. Yeh, M.-Y.; Tien, H.-J.; Tung, C.-H.; Hwang, C.-C. *J. Chinese Chem. Soc.* **1988**, *35*, 459.
3. Greene, T. W.; Wuts, P. G. M. *Protective Groups in Organic Synthesis*; 3 rd. ed.; John Wiley: New York, 1999, pp. 355-356.
4. Barry, R. H.; Hartune, W. M. *J. Org. Chem.* **1957**, *12*, 460.
5. Hasi, H. B.; Susie, A. G.; Heider, R. L. *J. Org. Chem.* **1950**, *15*, 8.
6. Donaldson, R. E.; Saddler, J. C.; Boyrn, S.; Mckenzie, A. T.; Fuchs, P. L. *J. Org. Chem.* **1983**, *48*, 2167.
7. Corey, E. J.; Hopkins, P. B.; Kim, S.; Kou, S.; Nambiar, K. P.; Flack, J. R. *J. Am. Chem. Soc*. **1979**, *101*, 7131.
8. (a) Curran, D. P.; Brill, J. F.; Rakiewicz, D. M. *J. Org. Chem.* **1984**, *49*, 1654. (b) Kuo, Y.-H.; Jang, T. L. *J. Chinese Chem. Soc.* **1991**, *38*, 203.
9. Barhate, N. B.; Gajare, A. S.; Wakharkar, R. D.; Sudalai, A. *Tetrahedron Lett.* **1997**, *38*, 653.
10. Ayhan, H. D.; Tanyeli, E. A. *Tetrahedron Lett.* **1997**, *38*, 7267.
11. Drabowichz, J. *Synthesis* **1980**, 125
12. Zhang, G.; Yang, D.; Chen, M. *Org. Prep. Proced. Int.* **1998**, *39*, 713.
13. Boruah, A.; Baruah, B.; Prajapati, D.; Sandhu, J. S. *Tetrahedron Lett.* **1997**, *38*, 4267.
14. (a) Khazaei, A.; Vaghei, R. G. *Tetrahedron Lett.* **2002**, *43*, 30733. (b) Khazaei, A.; Vaghei, R. G.; Tajbakhsh, M. *Tetrahedron Lett*. **2001**, *42*, 59. (c) Khazaei, A.; Shirdarreh, A. *Synth. Comm.* **1999**, *29*, 4079. (d) Khazaei, A.; Amini Manesh, A. *Synthesis* **2004**, *11*, 1739.
15. Ghorbani-Vaghei, R.; Khazaei, A. *Phosphorus, Sulfur, and Silicon* **2004**, *179*, 1169-1173.