



## Selective and Unprecedented Oxidative Deprotection of Allyl Ethers with DDQ

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**Abstract:** An unprecedented cleavage of O-allyl ethers of primary alcohols using DDQ as the oxidizing reagent is described. Copyright © 1996 Elsevier Science Ltd

Availability of effective methods for protection and more importantly the subsequent deprotection of functional groups plays a major role in total synthesis. The vast and ready availability of different protective<sup>1</sup> groups for the hydroxy functionality is indicative of the importance of alcohol protection. Of the two broad kinds of protections viz, ether type and ester type, the former are preferred over the latter owing to their sustainability and stability towards nucleophiles, reasonably strong acids and bases. O-allyl ether is one such guarding group which is popularly used by the practitioners of carbohydrate chemistry because it could be easily 'clipped off' by a two step process, isomerisation<sup>2</sup> of the double bond to get 1-propenyl ether, and conversion of the propenyl group into the free alcoholic group using acid or  $\text{HgCl}_2/\text{HgO}^3$  reagent. Though the procedure involves mild conditions, it could not be applied to the substrates containing other isomerisable double bonds.

While studying the 'DDQ regeneration technique'<sup>4</sup> for the oxidative cleavage of mono and dimethoxy benzyl ethers (equation 1) we have observed a novel and hitherto unnoticed oxidative cleavage of O-allyl ethers<sup>5</sup> using stoichiometric amounts of DDQ. The results pertaining to this very important transformation are documented herein (equation 2).

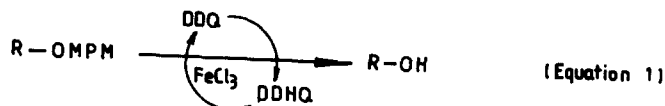


Table 1: Deprotection of allyl ethers with DDQ

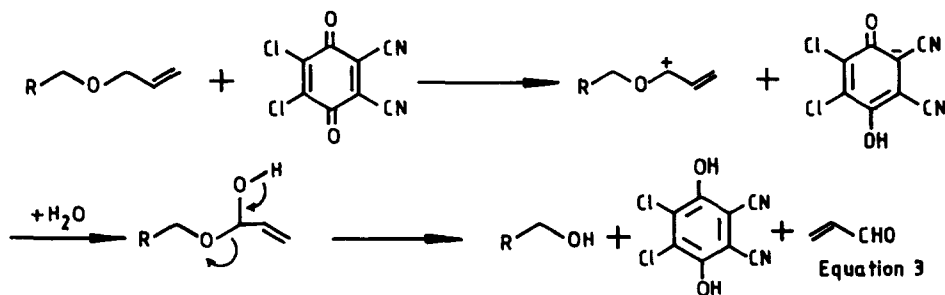
Entry	Substrate	Product	Yield (%) <sup>a</sup>
1.			92
2.			88
3.			91
4.			90
5.			85
6.			68
7.			70
8. <sup>b</sup>			70
9.			72
10. <sup>b</sup>			No reaction
11. <sup>b</sup>			No reaction

a) Yields based on chromatographically isolated products.

b) 5 equivalents of DDQ also could not cleave allyl group of secondary and anomeric alcohols.

Initially, when the O-allyl ether of n-decanol (entry 1, Table 1) was reacted with 1.2 equivalents of DDQ and  $\text{CH}_2\text{Cl}_2$  containing 10% by volume water, the parent n-decanol was obtained as a single product after stirring at ambient temperature for 18h in 92% isolable yield. Similar 'clip offs' of allyl groups were observed under the identical reaction conditions when decanediol having allyl ether functionality at one end and benzyl (entry 2), acetate (entry 3) or TBDPS (entry 4) groups at the other end. To further extrapolate the results, various sugar derivatives were prepared and subjected to oxidative cleavage (entries 6,7,8). Interestingly and surprisingly, it was noticed that only the allyl groups attached to primary alcohol functionality were removed, and secondary as well as anomeric allyl ethers were resistant to DDQ (entries 9,10,11). The preferential cleavage of a benzyl ether in the presence of anomeric allyl ether amply demonstrates the mildness and selectivity with which DDQ can cleave allyl ethers of primary alcohols.<sup>6</sup>

Mechanistically, the cleavage of O-allyl ethers follows a similar pathway to that involved in the cleavage of p-methoxy benzyl ethers. In few cases we have isolated 4,5-Dichloro-3-hydroxy-6-(3-oxo-propoxy)-phthalonitrile resulting out of Michael addition of DDHQ on to the other byproduct acrolein (equation 3).



In summary, we have for the first time observed the selective cleavage of O-allyl groups of primary alcohols using DDQ as the oxidant. Though our efficient 'DDQ regeneration technique' could not be practically extended owing to the formation of 4,5-Dichloro-3-hydroxy-6-(3-oxo-propoxy)-phthalonitrile, which was resistant to oxidative regeneration using  $\text{FeCl}_3$ , the methodology developed herein would have experimental advantages over the reported two step procedures for removal of such protective groups.<sup>7</sup>

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#### References and Notes :

1. a) Greene, T.W.; Wuts, P.G.M. *Protective Groups in Organic Synthesis* 2nd ed.; Wiley: New York **1991**.  
b) Kocienski, P.J. *Protecting Groups*. Georg Thieme Verlag Stuttgart. New York, **1994**.
2. a) Cunningham, J.; Gigg, R. and Warren, C.D. *Tetrahedron Lett.*, **1964**, 1191.  
b) Corey, E.J. and Suggs, J.W. *J. Org. Chem.* **1972**, 38, 3224.  
c) Gent, P.A. and Gigg, R. *J. Chem. Soc. Chem. Comm.* **1974**, 277.  
d) Oltvoort, J.J.; Van Boeckel, C.A.; de Konig, J.H. and van Boom, J.H. *Synthesis* **1981**, 305.

- e) Boss, R. and Scheffold, R. *Angew. Chem.* **1976**, *88*, 568.
  - f) Ogawa, T.; Nakabayashi, S. and Kitazima, T. *Carbohydr. Res.* **1983**, *114*, 225.
  - g) Nakayama, K.; Voto, K.; Higashi, K.; Soga, T. and Kusama, T. *Chem. Pharm. Bull.* **1992**, *40*, 1718.
  - h) Espanet, B.; Dunach, E.; Perichon, J. *Tetrahedron Lett.*, **1992**, *33*, 2485.
  - i) Akiyama, T.; Hirofujii, H. and Ozaki, S. *Bull. Chem. Soc. Jpn.* **1992**, *65*, 1932.
  - j) Mereyala, H.B. and Guntha, S. *Tetrahedron Lett.* **1993**, *34*, 6929.
- 3. Gigg, R. and Warren, C.D. *J. Chem. Soc. (C)*, **1968**, 1903.
  - 4. Chandrasekhar, S.; Sumithra, G. and Yadav, J.S. *Tetrahedron Lett.*, **1996**, *37*, 1645.
  - 5. a) Kariyone, K. and Yazawa, H. *Tetrahedron Lett.*, **1970**, 2885.  
b) Lee-Ruff, E. and Ablenas, F.J. *Can. J. Chem.* **1989**, *67*, 699.
  - 6. DDQ has also been used for cleavage of some other protective groups.  
a) Hayashi, Y. and Mukaiyama, T. *Chem. Lett.*, **1987**, 1811.  
b) Oku, A.; Kinugasa, M. and Kamada, T. *Chem. Lett.*, **1993**, 165.  
c) Fernandez, J.M.G.; Mellet, C.O.; Marin, A.M. and Fuemkes, J. *Carbohydr. Res.* **1995**, *274*, 263.
  - 7. All new compounds were characterized by  $^1\text{H}$  NMR,  $^{13}\text{C}$  and mass spectroscopy.

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