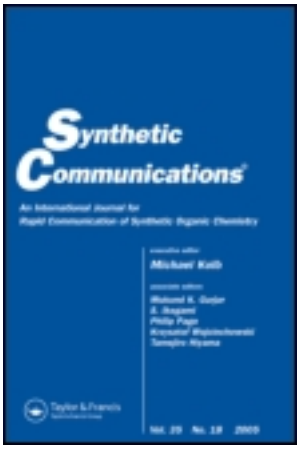


Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lsyc20

Tetrahydropyranylation and Depyranylation of Alcohols Catalyzed by Aqueous Zinc Tetrafluoroborate

Samimul Islam [a], Adinath Majee [a] & A. T. Khan [b]
[a] Department of Chemistry, Visva-Bharati University, Santiniketan, West Bengal, India
[b] Department of Chemistry, Indian Institute of Technology, North Guwahati, Guwahati, India
Version of record first published: 15 Aug 2006.

To cite this article: Samimul Islam , Adinath Majee & A. T. Khan (2005): Tetrahydropyranylation and Depyranylation of Alcohols Catalyzed by Aqueous Zinc Tetrafluoroborate, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 35:13, 1789-1793

To link to this article: http://dx.doi.org/10.1081/SCC-200063950

Synthetic Communications®, 35: 1789–1793, 2005

ISSN 0039-7911 print/1532-2432 online
DOI: 10.1081/SCC-200063950

Tetrahydropyranylation and Depyranylation of Alcohols Catalyzed by Aqueous Zinc Tetrafluoroborate

Samimul Islam and Adinath Majee
Department of Chemistry, Visva-Bharati University, Santiniketan, West Bengal, India

A. T. Khan
Department of Chemistry, Indian Institute of Technology, North Guwahati, Guwahati, India

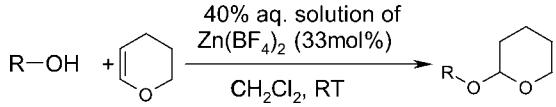
Abstract: Aqueous solution of zinc tetrafluoroborate as an effective catalyst for tetrahydropyranylation and depyranylation of alcohols has been described.

Keywords: Aqueous zinc tetrafluoroborate, depyranylation, tetrahydropyranylation

INTRODUCTION

Tetrahydropyranylation is one of the methods of choice for the protection of hydroxyl groups because of the stability of tetrahydropyranyl ethers in a variety of conditions. There are several methods for tetrahydropyranylation and depyranylation of alcohols.[1] Some reagents that can catalyze both transformations are *p*-toluenesulphonic acid (PTSA),[2] pyridinium *p*-toluene sulfonate (PPTS),[3] ammonium chloride,[4] $ZrCl_4$,[5] I_2,[6] LiBr,[7] acetonyldiphenyl phosphonium bromide,[8] tetrabutyl ammonium tribromide,[9] potassium dodecatangestocobaltate trihydrate,[10] and indium triflate.[11] Many of these reagents have been used under dry reaction conditions.

Received in India February 28, 2005
Address correspondence to Adinath Majee, Department of Chemistry, Visva-Bharati University, Santiniketan, West Bengal 731235, India. E-mail: adinathm@yahoo.com



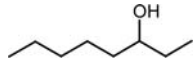
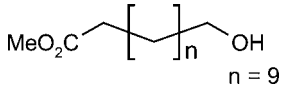
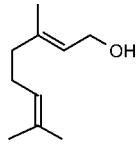
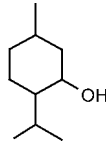
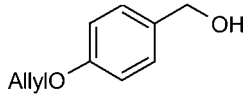
Scheme 1.

In this article we describe the use of aqueous $Zn(BF_4)_2$ for both tetrahydropyranylation and depyranylation reactions.

RESULTS AND DISCUSSION

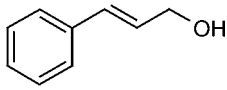
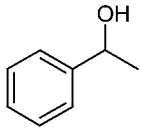
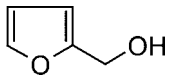
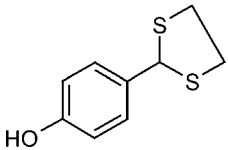
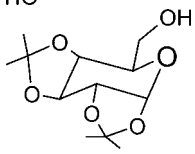
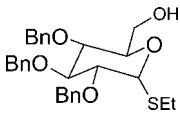
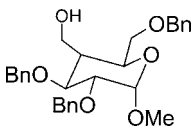
Tetrahydropyranylation (Scheme 1) of alcohols was carried out using a 40% aqueous solution of zinc tetrafluoroborate in dichloromethane at room temperature.

Table 1. Tetrahydropyranylation and depyranylation of alcohols

		Protection			Deprotection	
Entry	Alcohol	Time (min)	Yield (%)[a]	Ref	Time (min)	Yield (%)[a]
1	Cetyl alcohol	5	95	13	65	90
2	Decyl alcohol	15	90	12	45	90
3		10	87	13	25	92
4		15	89	13	60	72
5		90	78	13, 14	120	87
6		90	85	13, 15	120	90
7	Cholesterol	40	90	13, 15	90	95
8	$PhCH_2OH$	25	95	15	40	80
9		50	95	13, 6a	90	85

(*continued*)

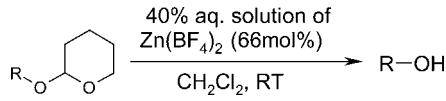
Table 1. Continued

Entry	Alcohol	Protection Time (min)	Protection Yield (%)[a]	Protection Ref	Deprotection Time (min)	Deprotection Yield (%)[a]
10		30	92	13, 6a	90	85
11		25	84	13, 6a	120	90
12		5	93	13	45	92
13		65	90	13	40	82
14		20	85	13	30	80
15		55	80	13	60	75
16		90	92	13	120	85

[a]All are pure isolated products and were characterized by IR and ^{1}H NMR.

Typical Procedure for Tetrahydropyranylation

To a well-stirred solution of appropriate alcohol (1 mmol) in dichloromethane (3 ml), 1.2 equivalent of dihydropyran and 0.33 mmol of zinc tetrafluoroborate (40% aqueous solution) were added at room temperature. After completion of the reaction (monitored by TLC), it was quenched by two drops of saturated sodium bicarbonate solution and diluted with water. The reaction mixture was extracted with dichloromethane and washed with brine. The organic layer



Scheme 2.

was dried over anhydrous sodium sulphate, evaporated, and the crude product was purified on basic alumina using 2% ethyl acetate in hexane.

As is evident from Table 1, a wide range of alcohols were converted to the corresponding tetrahydropyranyl (THP) ethers in high yields using this methodology. The reactions with sterically hindered molecules such as menthol (entry 6), cholesterol (entry 7), and carbohydrates (entries 14, 15, 16) occurred satisfactorily. Acid-sensitive functional groups, such as ketal and anomeric methoxy remained unaffected under the present reaction conditions.

For depyranylation (Scheme 2), the reaction conditions were modified and two molar ratio of zinc tetrafluroborate with methanol and dichloromethane was used. Compared to the protection, the deprotection reaction required more time.

Typical Procedure for Depyranylation

To a well-stirred solution of the THP ethers (1 mmol) in dichloromethane and methanol (2 : 1) (3 ml), 0.66 mmol of zinc tetrafluoroborate (40% aqueous solution) was added at room temperature. After the usual workup as described previously, the crude product was purified on silica gel using 2% ethyl acetate in hexane.

In conclusion the present methodology provides another alternative for the preparation of tetrahydropyranyl ethers and their subsequent deprotection in high yields.

ACKNOWLEDGMENT

We are thankful to the Department of Chemistry, Visva-Bharati University, and the Department of Chemistry, Indian Institute of Technology Guwahati, for providing general facilities to carry out the research work. We also express our sincere thanks to B. C. Ranu for his constant encouragement.

REFERENCES

1. (a) Babu, B. S.; Balasubramanian, K. K. Mild and efficient tetrahydropyranylation of alcohols catalysised by lithium perchlorate in diethyl ether. *Tetrahedron Lett.* **1998**, *39*, 9287; (b) Curini, M.; Epifano, F.; Marcotullio, M. C.; Rosati, O.; Costantino, U. Zirconium sulfophenyl phosphonate as a heterogeneous catalyst in tetrahydropyranylation of alcohols and phenols. *Tetrahedron Lett.* **1998**, *39*,

8159; (c) Marko, I. E.; Ates, A.; Augustyns, B.; Gautier, A.; Quesnel, Y.; Turet, L.; Wiaux, M. Remarkable deprotection of THP and THF ethers catalyzed by cerium ammonium nitrate (CAN) under neutral conditions. *Tetrahedron Lett.* **1999**, *40*, 5613; (d) Nishiguchi, T.; Hayakawa, S.; Hirasaka, Y.; Saitoh, M. Selective mono tetrahydropyranylation of 1,n-diols catalyzed by aqueous acids. *Tetrahedron Lett.* **2000**, *41*, 9843; (e) Deka, N.; Sarma, J. C. Microwave-mediated selective monotetrahydropyranylaion of symmetrical diols catalyzed by iodine. *J. Org. Chem.* **2001**, *66*, 1947.

2. (a) Bernady, K. F.; Floyd, M. B.; Poletto, J. F.; Weiss, M. J. Prostaglandins and congeners. 20. Synthesis of prostaglandins via conjugate of lithium trans-1-alkenyltrialkylalanate reagents. A novel reagent for conjugate 1,4-additions. *J. Org. Chem.* **1979**, *44*, 1438; (b) Corey, E. J.; Niwa, H.; Knolle, J. Total synthesis of (S)-12-hydroxy-5,8,14-cis,-10-trans eicosatetraenoic acid (Samuelsson's HETE). *J. Am. Chem. Soc.* **1978**, *100*, 1942.
3. Miyashita, M.; Yoshikoshi, A.; Grieco, P. A. Pyridinium p-toluenesulfonate. A mild and efficient catalyst for the tetrahdropyranylation of alcohols. *J. Org. Chem.* **1977**, *42*, 3772.
4. Yadav, J. S.; Srinivas, D.; Reddy, G. S. A mild and versatile method for the tetrahydropyranylation of alcohols and their detetrahydropyranylation. *Synth. Commun.* **1998**, *28*, 1399.
5. Rezai, N.; Meybodi, F. A.; Salehi, P. Protection of alcohols and phenols with dihydropyrans and detetrahydropyranylation by $ZrCl_4$. *Synth. Commun.* **2000**, *30*, 1799.
6. (a) Kumar, H. M. S.; Reddy, B. V. S.; Reddy, E. J.; Yadav, J. S. Iodine-catalyzed mild and efficient tetrahydropyranylation/depyranylation of alcohols. *Chem. Lett.* **1999**, 857; (b) Deka, N.; Sarma, J. C. Microwave-assisted catalytic protection and deprotection of alcohols with 3,4-dihydro-2h-pyrans. *Synth. Commun.* **2000**, *30*, 4435.
7. Reddy, M. A.; Reddy, L. R.; Bhanumathi, N.; Rao, K. R. A mild and efficient method for tetrahydropyranylation/depyranylation of alcohols and phenols under neutral conditions. *Synth. Commun.* **2000**, *30*, 4323.
8. Hon, Y.-S.; Lee, C.-F. Acetonyl triphenyl phosphonium bromide in organic synthesis: An extremely efficient catalyst for the protection and deprotection of alcohols as alkyl vinyl ethers. *Tetrahedron Lett.* **1999**, *40*, 2389.
9. Naik, S.; Gopinath, R.; Patel, B. K. Tetrabutylammonium tribromide (TBATB)-promoted tetrahydropyranylation/depyranylation of alcohols. *Tetrahedron Lett.* **2001**, *42*, 7679.
10. Habibi, M. H.; Tangestaninejad, S.; Mohammadpoorbaltork, I.; Mirkhani, V.; Yadollahi, B. Potassium dodecatangestocobaltate trihydrate ($K_5CoW_{12}O_{40} \cdot 3H_2O$): A mild and efficient catalyst for the tetrahydropyranylation of alcohols and their detetrahydropyranylation. *Tetrahedron Lett.* **2001**, *42*, 2851.
11. Mineno, T. A fast and practical approach to tetrahydropyranylation and depyranylation of alcohols using indium triflate. *Tetrahedron Lett.* **2002**, *43*, 7975.
12. Leena, H. K.; Tapio, A. H. Cleavage of the THP protecting group under Pd/C-catalyzed hydrogenation conditions. *Tetrahedron Lett.* **2001**, *42*, 7699.
13. Khan, A. T.; Mondal, E.; Borah, B. M.; Ghosh, S. A highly efficient and chemoselective synthetic protocol for tetrahydropyranylation/depyranylation of alcohols and phenols. *Eur. J. Org. Chem.* **2003**, *68*, 4113.
14. Chandrasekhar, S.; Ramachandar, T.; Reddy, M. V.; Takhi, M. A single step conversion of tetrahydropyranyl ethers to acetates. *J. Org. Chem.* **2000**, *65*, 4729.
15. Ranu, B. C.; Saha, M. A simple, efficient and selective method for tetrahydropyranylation of alcohols on a solid phase of alumina impregnated with zinc chloride. *J. Org. Chem.* **1994**, *59*, 8269.