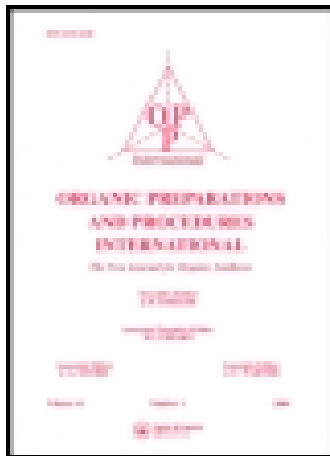


This article was downloaded by: [UQ Library]

On: 19 November 2014, At: 17:14

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Organic Preparations and Procedures International: The New Journal for Organic Synthesis

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uopp20>

DEPROTECTION OF TRIMETHYLSILYL AND OF TETRAHYDROPYRANYL ETHERS AND OF ETHYLENE ACETALS WITH BENZYLTRIPHENYLPHOSPHONIUM CHLOROCHROMATE

A. R. Hajipour^a, S. E. Mallakpour^a, I. M. Baltorkt^b & H. Backnezhad^a

^a Pharmaceutical Research Laboratory, College of Chemistry, Isfahan University of Technology, Isfahan, 84156, IR, Iran E-mail:

^b Department of Chemistry, Isfahan University, Isfahan, 81744, IR, Iran

Published online: 11 Feb 2009.

To cite this article: A. R. Hajipour, S. E. Mallakpour, I. M. Baltorkt & H. Backnezhad (2002) DEPROTECTION OF TRIMETHYLSILYL AND OF TETRAHYDROPYRANYL ETHERS AND OF ETHYLENE ACETALS WITH BENZYLTRIPHENYLPHOSPHONIUM CHLOROCHROMATE, *Organic Preparations and Procedures International: The New Journal for Organic Synthesis*, 34:2, 169-175, DOI: [10.1080/00304940209355753](https://doi.org/10.1080/00304940209355753)

To link to this article: <http://dx.doi.org/10.1080/00304940209355753>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

**DEPROTECTION OF TRIMETHYLSILYL AND OF TETRAHYDROPYRANYL
ETHERS AND OF ETHYLENE ACETALS
WITH BENZYLTRIPHENYLPHOSPHONIUM CHLOROCHROMATE**

A. R. Hajipour*, S. E. Mallakpour, I. M. Baltork† and H. Backnezhad

*Pharmaceutical Research Laboratory, College of Chemistry, Isfahan University of Technology
Isfahan, 84156, IR IRAN, E-mail: haji@cc.iut.ac.ir*

†Department of Chemistry, Isfahan University, Isfahan 81744, IR IRAN

The protection and deprotection of the hydroxy and carbonyl groups play an essential role in synthetic strategy.¹⁻¹⁷ Chromium (VI) oxide is an inexpensive, water-soluble and stable oxidizing reagent that is commercially available, but this reagent is insoluble in organic solvents. Very recently, we have introduced new reagents to oxidize different substrates under non-aqueous conditions.^{18,19} We now report benzyltriphenylphosphonium chlorochromate (**BTPPCC**) as a new and efficient reagent for the oxidative deprotection of trimethylsilyl and tetrahydropyranyl ethers or ethylene acetals and ketals to the corresponding carbonyl compounds in refluxing acetonitrile in the presence of catalytic amounts of aluminum chloride.

Benzyltriphenylphosphonium chlorochromate ($\text{PhCH}_2\text{P}^+\text{Ph}_3\text{CrO}_3\text{Cl}^-$), a mild, efficient, stable and inexpensive reagent,²⁰ is an orange powder which is quite soluble in methylene chloride, chloroform, acetone, and acetonitrile and insoluble in non-polar solvents such as carbon tetrachloride, n-hexane and diethyl ether. Since deprotection of benzyltrimethylsilyl ether in refluxing acetonitrile with this reagent failed in the absence of catalyst, the effect of several Lewis acids such as ZnCl_2 , $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$, AlCl_3 and BiCl_3 was investigated; surprisingly, only AlCl_3 was effective. The optimum molar ratio of aluminum chloride was 0.4 mole-equiv. Under these conditions primary and secondary trimethylsilyl ethers were converted to the corresponding carbonyl compounds in high yields and short reaction times (Table 1). The reaction of primary and secondary tetrahydropyranyl ethers with **BTPPCC** was carried out in acetonitrile under reflux to the corresponding carbonyl compounds in good to excellent yields (Table 1).

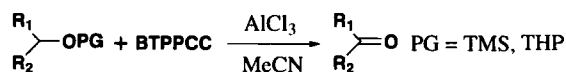


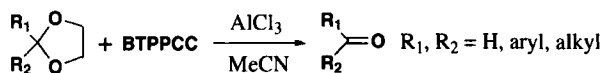
Table 1. Oxidative Deprotection of Trimethylsilyl and Tetrahydropyranyl Ethers with BTPPCC/AlCl₃ in refluxing CH₃CN^a

Entry	Substrate	Product	Time (min)	Yield (%) ^b
1	PhCH ₂ OTMS	PCHO	45	90
2	2-MeOC ₆ H ₄ CH ₂ OTMS	2-MeOC ₆ H ₄ CHO	75	80
3	3-MeOC ₆ H ₄ CH ₂ OTMS	2-MeOC ₆ H ₄ CHO	45	95
4	3-O ₂ NC ₆ H ₄ CH ₂ OTMS	3-O ₂ NC ₆ H ₄ CHO	150	95
5	2,5-(MeO) ₂ C ₆ H ₃ CH ₂ OTMS	2,5-(MeO) ₂ C ₆ H ₃ CHO	30	75
6	PhCH(Me)OTMS	PhCOMe	45	98
7	4-ClC ₆ H ₄ CH(Me)OTMS	4-ClC ₆ H ₄ COMe	60	99
8	Ph ₂ CHOTMS	Ph ₂ CO	60	95
9	4-PhC ₆ H ₄ CH(Me)OTMS	4-PhC ₆ H ₄ COMe	75	90
10	TetalolTMS	Tetalone	45	95
11	PhCH ₂ OTHP	PhCHO	60	95
12	2-MeOC ₆ H ₄ CH ₂ OTHP	2-MeOC ₆ H ₄ CHO	90	70
13	3-MeOC ₆ H ₄ CH ₂ OTHP	3-MeOC ₆ H ₄ CHO	30	88
14	4-MeOC ₆ H ₄ CH ₂ OTHP	4-MeOC ₆ H ₄ CHO	30	85
15	3,4-(MeO) ₂ C ₆ H ₃ CH ₂ OTHP	3,4-(MeO) ₂ C ₆ H ₃ CHO	45	80
16	2,5-(MeO) ₂ C ₆ H ₃ CH ₂ OTHP	2,5-(MeO) ₂ C ₆ H ₃ CHO	90	78
17	PhCH(Me)OTHP	PhCOMe	40	90
18	4-ClC ₆ H ₄ CH(Me)OTHP	4-ClC ₆ H ₄ COMe	60	85
19	Ph ₂ CHOTHP	Ph ₂ CO	90	94
20	TetalolTHP	Tetalone	60	82

a) Substrate/Oxidant/AlCl₃ (1:1:0.4). b) Yields based on the products after column chromatography.

BTPPCC was also used to convert ethylene acetals to aldehydes and ketones in acetonitrile under reflux conditions in good to excellent yields (Table 2). Under these conditions, cinnamaldehyde ethylene acetal gave several by-products in addition to the expected product.

DEPROTECTION OF TRIMETHYLSILYL AND OF TETRAHYDROPYRANYL ETHERS


Table 2. Deprotection of Ethylene Acetals with BTPPCC/AlCl₃ in refluxing CH₃CN^a

Entry	Substrate	Product	Time (min)	Yield (%) ^b
1	Acetophenone ethylene acetal	Acetophenone	35	90
2	2-Methoxybenzaldehyde ethylene acetal	2-Methoxybenzaldehyde	60	87
3	3-Nitrobenzaldehyde ethylene acetal	3-Nitrobenzaldehyde	180	78
4	4-Chloroacetophenone ethylene acetal	4-Chloroacetophenone	75	80
5	Tetralone ethylene acetal	Tetralone	60	90
6	4-Phenylacetophenone ethylene acetal	4-Phenylacetophenone	150	80

a) Substrate/Oxidant/AlCl₃ (1:1:0.4). b) Yields based on the products after purification with column chromatography.

A noteworthy advantage of this reagent lies in its selectivity. We carried out competitive reactions between trimethylsilyl ethers and tetrahydropyranyl ethers, ethylene ketals, tetrahydropyranyl ethers, ethylene ketals, and ethylene acetals. It was found that trimethylsilyl ethers are selectively oxidized in the presence of tetrahydropyranyl ethers or of ethylene ketals. It was also observed that ethylene ketals are selectively deprotected in preference to ethylene acetals. Further competitive reactions between alcohols and other compounds such as trimethylsilyl, tetrahydropyranyl ethers, ethylene acetals, and ketals were performed with this reagent in the presence of 0.4 molar ratio of aluminum chloride in refluxing acetonitrile. It was found that alcohols in the presence of trimethylsilyl or tetrahydropyranyl ethers were not oxidized. Ethylene acetals or ketals were selectively deprotected to the corresponding carbonyl compounds in the presence of alcohols (Table 3).

Table 3. Competitive Oxidative Deprotection with BTPPCC/AlCl₃ in refluxing CH₃CN^a

Entry	Substrate	Product	Time (min)	Yield (%) ^b
1	2-Nitrobenzaldehyde ethylene acetal	2-Nitrobenzaldehyde	75	0
	Acetophenone ethylene acetal	Acetophenone		90
2	3-MeOC ₆ H ₄ CH ₂ OTMS	3-Methoxybenzaldehyde	60	50
	2-ClC ₆ H ₄ CH(Me)OTHP	2-ClC ₆ H ₄ CH(Me)OH		50
3	3-MeOC ₆ H ₄ CH ₂ OTHP	4-ClC ₆ H ₄ CH(Me)OTMS	60	40
	4-ClC ₆ H ₄ CH(Me)OTMS	4-ClC ₆ H ₄ COMe		60
4	4-Phenylacetophenone ethylene acetal	4-Phenylacetophenone	40	0
	3-MeOC ₆ H ₄ CH ₂ OTMS	3-Methoxybenzaldehyde		90
5	4-Phenylacetophenone ethylene acetal	4-Phenylacetophenone	60	10
	3-MeOC ₆ H ₄ CH ₂ OTHP	3-Methoxybenzaldehyde		90
6	PhCH ₂ OH	PhCHO	45	0
	PhCH(Me)OTMS	PhCOMe		100

Table 3. Continued...

Entry	Substrate	Product	Time (min)	Yield (%) ^b
7	PhCH ₂ OH	PhCHO	55	0
	PhCH(Me)OTHP	PhCOMe		100
8	PhCH ₂ OH	PhCHO	60	20
	Acetophenone ethylene acetal	PhCOMe		80
9	PhCH(Me)OH	PhCOMe	60	10
	2-Methoxybenzaldehyde ethylene acetal	2-Methoxybenzaldehyde		90

a) Substrate/Oxidant/AlCl₃ (1:1:0.4). b) Yields based on the isolated products after purification with column chromatography.

In order to show the oxidative ability of this reagent, we compared some of our results with those reported for silver bromate¹² and 3-carboxypyridinium chlorochromate⁵ (Table 4). This reagent is superior to silver bromate and 3-carboxypyridinium chlorochromate⁵ in term of selectivity, high yields, cost, purity of products and ease of work-up. The benzyltriphenylphosphonium cation could be recovered in quantitative yield. When the reaction was complete, the reaction mixture was cooled to room temperature and passed through a short pad of silica gel, and then washed with acetonitrile. The silica gel layer was washed with 10% HCl and then this aqueous layer was treated with a fresh batch of a solution of chromium (VI) oxide in HCl 6N to produce the reagent **1** in quantitative yield.

Table 4. Comparison of Oxidative Deprotection of Some Trimethylsilyl and Tetrahydropyranyl Ethers with BTPPCC, CPCC⁵ and Silver Bromate¹²

Entry	Substrate	Product	Yield % (h)		
			BTPPCC	CPCC	AgBrO ₃
1	PhCH(Me)OTMS	PhCOMe	98 (0.75)	93 (1.15)	----
2	Ph ₂ CHOTMS	Ph ₂ CO	95 (1)	80 (2)	----
3	4-PhC ₆ H ₄ CH(Me)OTMS	4-PhC ₆ H ₄ COMe	90 (1.25)	98 (2)	----
4	PhCH(Me)OTHP	PhCOMe	90 (0.66)	----	90 (0.6)
5	3-MeOC ₆ H ₄ CH ₂ OTHP	3-MeOC ₆ H ₄ CHO	88 (0.5)	93 (0.1)	82 (2.5)

In order to evaluate the synergy between **BTPPCC** and aluminum chloride, several experiments were performed. The reaction of 2-MeOC₆H₄CH₂OTMS (1 mmol) with **BTPPCC** (1 mmol) without aluminum chloride failed after 2 h refluxing in acetonitrile. When equimolar amounts of aluminum chloride and 2-MeOC₆H₄CH₂OTMS were refluxed in acetonitrile without **BTPPCC** for 2 h, the corresponding alcohol was obtained in only 20% yield. Only when **BTPPCC** was used in the presence of a catalytic amount of aluminum chloride (0.4 mmol) was the corresponding aldehyde obtained in excellent yield (Table 1).

EXPERIMENTAL SECTION

Trimethylsilyl ethers, tetrahydropyranyl ethers, ethylene acetals were prepared according to described procedures.^{3a,14,21,22} All yields refer to isolated products. The products were characterized by comparison with authentic samples (IR, ¹H-NMR spectra, melting and boiling points and TLC). All ¹H-NMR spectra were recorded at 90 MHz in CDCl₃ and CCl₄ relative to TMS (0.00 ppm). The Research Institute of Petroleum Industry, Tehran, I.R. Iran performed elemental analysis. BTPPCC was prepared according to our previous work.²⁰

General Procedures. Oxidative Deprotection of Trimethylsilyl and Tetrahydropyranyl Ethers with BTPPCC/AlCl₃.- In a round-bottomed flask (25 mL) equipped with a reflux condenser and a magnetic stirrer, a solution of trimethylsilyl ether or tetrahydropyranyl ether (1 mmol) and AlCl₃ (0.06 g, 0.4 mmol) in acetonitrile was prepared. Benzyltriphenylphosphonium chlorochromate (0.49 g, 1 mmol) was added to the solution and refluxed for 30-150 min. The reaction progress was followed by TLC (eluent: cyclohexane/EtOAc: 8:2). To remove the triphenylphosphonium salt, the reaction mixture was cooled to room temperature and the mixture was passed through a short pad of silica gel and washed with acetonitrile (15 mL). The filtrate was evaporated and the resulting crude material was purified by column chromatography on silica gel using a mixture of ethyl acetate and hexane as eluent (10:90). Pure carbonyl compounds were obtained in 70-99% yields (Table 1).

Conversion of Ethylene Acetals and Ketals to the Corresponding Carbonyl Compounds with BTPPCC/AlCl₃.- In a round-bottomed flask (25 mL) equipped with a reflux condenser and a magnetic stirrer, a solution of ethylene acetal or ketal (1 mmol) and AlCl₃ (0.06 g, 0.4 mmol) in acetonitrile was prepared. Benzyltriphenylphosphonium chlorochromate (0.49 g, 1 mmol) was added to the solution and refluxed for 35-180 min. The reaction progress was followed by TLC (eluent: cyclohexane/EtOAc: 8:2). The reaction mixture was then cooled to room temperature and passed through a short pad of silica gel and washed with acetonitrile (15 mL). The filtrate was evaporated and the resulting crude material was purified by column chromatography on silica gel using a mixture of ethyl acetate and hexane as eluent (10:90). Pure carbonyl compounds were obtained in 78-90% yields (Table 2).

Acknowledgement.- The authors are thankful to the Isfahan University of Technology (IUT), IR Iran for the financial support.

REFERENCES

1. T. W. Greene and P. G. M. Wuts, *Protective Groups in Organic Synthesis*, 2nd ed., John Wiley, New York, 1991.
2. a) E. W. Colvin, *Chem. Soc. Rev.*, **7**, 15 (1978); b) M. Lalonde, T. H. Chan, *Synthesis*, 817 (1985); c) E. Schaumann, *Houben-Weyl, 4th ed.*; Kropf. H. Ed., Thieme: Stuttgart, 1984.

HAIJPOUR, MALLAKPOUR, BALTORK AND BACKNEZHAD

3. a) H. Firouzabadi and B. Karimi, *Synth. Commun.*, **12**, 1663 (1993); b) H. Firouzabadi, Z. Khayat, A. R. Sardarian and S. Tangestaninejad, *Iranian J. Chem. & Chem. Eng.*, **15**, 54 (1996); *Chem. Abstr.*, **127**, 220704p (1997).
4. J. Muzart, *Synthesis*, **11** (1993).
5. I. M. Baltork and Sh. Pouranshirvani, *Synthesis*, 756 (1997).
6. M. M. Heravi, D. Ajami and Ghassemzadeh, *Synthesis*, 393 (1999).
7. A. Sarkar, O. S. Yemul, B. P. Bandgar, N. B. Gaikwad and P. P. Wadgaonkar, *Org. Prep. Proced. Int.*, **28**, 613 (1996).
8. S. Hoyer, and P. Laszlo, *Synthesis*, 655 (1985).
9. P. E. Sonnet, *Org. Prep. Proced. Int.*, **10**, 91 (1978).
10. E. J. Parish, S. A. Kizito and R. Heidepriem, *Synth. Commun.*, **22**, 223 (1993).
11. I. M. Baltork and B. Kharamesh, *J. Chem. Research (S)*, 146 (1998).
12. I. M. Baltork and A. R. Nourozi, *Synthesis*, 487 (1999).
13. F. A. J. Meskens, *ibid.*, 501 (1981).
14. P. Gros, P. L. Perchee and J. P. Senet, *J. Chem. Research (S)*, 196 (1995).
15. C. Johnstone, W. J. Kerr and J. S. Scott, *Chem. Commun.*, 341 (1996).
16. E. Marcantoni and F. Nobili, *J. Org. Chem.*, **62**, 4183 (1997).
17. E. C. L. Gautier, A. E. Graham, A. Mckillop, S. P. Standen and R. J. K Taylor, *Tetrahedron Lett.*, **38**, 1881 (1997).
18. I. M. Baltork, A. R. Hajipour and H. Mohammadi, *Bull. Chem. Soc. Jpn.*, **71**, 1699 (1988)
19. a) A. R. Hajipour and N. Mahboobkhah, *Synth. Commun.*, **28**, 3143 (1998); b) A. R. Hajipour, and N. Mahboobkhah, *Indian J. Chem.*, **37B**, 285 (1998); c) A. R. Hajipour and N. Mahboobkhah, *J. Chem. Research (S)*, 122 (1998); d) A. R. Hajipour, and N. Mahboobkhah, *Indian J. Chem.*, **37B**, 1041 (1998); e) A. R. Hajipour, I. M. Baltork and G. Kianfar, *Bull. Chem. Soc. Jpn.*, **71**, 2055 (1998); f) A. R. Hajipour, I. M. Baltork and G. Kianfar, *Indian J. Chem.*, **37B**, 607 (1998); g) A. R. Hajipour, and N. Mahboobkhah, *Org. Prep. Proced. Int.*, **31**, 112 (1999); h) A. R. Hajipour, I. M. Baltork and K. Niknam, *ibid.*, **31**, 335 (1999); i) I. M. Baltork, A. R. Hajipour and A. R. Haddadi, *J. Chem. Research (S)*, 102 (1999); j) A. R. Hajipour, S. E. Mallakpour and H. Adibi, *Chemistry Lett.*, 460 (2000); k) A. R. Hajipour, S. E. Mallakpour and Gh. Imanzadeh, *ibid.*, 99 (1999); l) A. R. Hajipour, S. E. Mallakpour, I. M. Baltork and S. Khoei, *ibid.*, 120 (2000); m) A. R. Hajipour and S. E. Mallakpour, *J. Chem. Research (S)*, 32 (2000); n) A. R. Hajipour, S. E. Mallakpour and S. Khoei, *Synlett*, 740 (2000).

DEPROTECTION OF TRIMETHYLSILYL AND OF TETRAHYDROPYRANYL ETHERS

20. A. R. Hajipour, S. E. Mallakpour and H. Backnejad, *Synth. Commun.*, **30**, 3855 (2000).
21. G. Maity and S. C. Roy, *Synth. Commun.*, **23**, 1667 (1993).
22. K. Tanemura, T. Horaguchi and T. Suzuki, *Bull. Chem. Soc. Jpn.*, **65**, 304 (1992).

(Received August 2, 2000; in final form November 5, 2001)